THE RELIGIOUS AND THEOLOGICAL FOUNDATIONS

OF

NATURAL SCIENCE

by

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C O N T E N T S

PART I : AN HISTORICAL PERSPECTIVE ON THE FOUNDATIONS OF SCIENCE

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LIST OF DIAGRAMS

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SUMMARY

This thesis examines the religious and theological foundations of natural science. A mythology has arisen, both popularly and academically, that locates the historical origins of science in the great humanistic movements of the Renaissance and Enlightenment. Conversely Calvinism and Puritanism are regarded as regressive forces, the enemies of freedom and progress, interested only in rigorous morality and otherworldly piety. Philosophically there is a wide-spread divorce between faith and knowledge, religion and science; while sociologically science is seen to advance with the shaking off of the fetters of religious belief.

The choice of approach was difficult. I elected for an overview rather than an exhaustive detail of one aspect. This was a choice against specialisation and the abstractive loss of concrete reality. It also seems more consonant with the topic under consideration.

The major divisions are as follows:

Part I: An historical section which contextualises the study and indicates origins and motivations of modern science in religious interests - particularly Calvinism. By the nature of such a study there is a degree of ambivalence.

Part II: The thesis is established by a review and brief critique of secular philosophies of science. This again is ambivalent though I have sought to plant signposts to the clearer statement presented in Part IV.

Part III: A survey of Christian responses to the topic. While remaining within Protestant thought I have tried to do justice to as many divergent positions as is consistent with overall coherence.

Part IV: This seeks to establish the religious and theological foundations of natural science on Christian perspectival grounds - viewing religion as the orientation of the heart in a basic commitment to the universe; and seeing in the theology of the sovereignty of God, His law, the doctrines of creation and cultural activity, clear motivations to scientific activity. So this is the crux of my thesis. I also give some practical application in terms of the problems of the environment and technic, and how the fundamental issues pertain therein.

I believe the basic contribution to the subject is not, in the first instance, detailed originality but in an original synthesis of material. Detailed contributions are _inter alia_:

1. A critical introduction to the thought of 'Cosmonomism' where that impinges on my topic. The study, based within the parameters of Dooyeweerd's 'Cosmonomic Idea', seeks to apply cosmonomism in a more scientific field than that in which most of its proponents work.
2. More specifically I point to my suggested solution of MacKay's complementary model of science and religion;
3. My causal-perspectival interpretation of the influence of Calvin(ism) which goes further than Merton, Hooykaas or Torrance;
4. My critique of the theological spectrum - liberal and evangelical. I point particularly to my analysis of evangelicals who are largely uncritiqued from within their own perspective and ignored by liberals, despite their vast amount of literature on science and belief; and
5. The exposure of a confusion between 'science' and 'scientia'; and between 'religion', 'theology' and 'faith'.

Inter alia my conclusions include:

1. Religion and natural science (but not theology and natural science) are not separate entities, for the former founds and activates the latter. The whole discussion of science 'and' religion/belief is a false dichotomy and therefore a pseudo-problem.
2. The religious foundation of science does not dictate/coerce scientific theories. While it can give a definite 'no' to some theories, it can only give a conditional 'yes' to theories.
3. There is, strictly speaking, no 'theology of science' but a theological framework within which science can be understood.
4. Unnecessary conceptual problems have been created by seeing laws of nature as autonomous from the law of God.
5. 'The' scientific method is mythological.

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INTRODUCTION

We live in a world dominated by science and technology. Contemporary life-style is unthinkable apart from the great strides science and technology have made, especially in the last century. The inevitable consequence of this development has been increasing specialisation which creates problems for a study such as this as to what aspects to focus upon. Although there is a decided shift of interest to the life sciences today I have concentrated on the physical sciences. I have pursued this course because the physical sciences have been crucial in forming worldviews; present fundamental problems that affect a wide arena of thought; and because they form my own background and I am therefore better equipped to work in that field. But even physical science is a wide field and little will be said about such topics as chemistry, thermodynamics, electricity, materials, structures or hydrodynamics. To restrict my material in this way does not negate the importance of other areas of scientific research. There is a wide range of scientific work that possesses great practical and ethical problems. In agriculture there are ecological problems stemming from the chemical control of the environment; there are moral and philosophical problems that medicine has given rise to, such as abortion and euthanasia; in genetics there are ethical problems devolving from the ability to interfere with the control and creation of life; psychology throws up innumerable questions of similar intent concerning the nature of man; there is the problem of using mind drugs to control man's aggressive instincts, and the philosophical-ethical problem concerning the nature of the self and free-will in relation to the implantation of electrodes in the brain; and there is a behaviourist problem in the endeavour to dissolve the mind-matter debate. This last point highlights reductionism and I will contend that the reductionistic approach which is widespread today is inadequate to answer the real questions concerning the nature and task of man in the world. Reductionism shall be indicated to be a deification of a modal aspect of reality and therefore a failure to appreciate the essential inner coherence of created reality.

It is now generally recognised that our culture is in crisis - a crisis not unconnected with our scientific and technological powers. R. de Ropp (1972, pp. xi-xiii.) has suggested with a degree of plausibility that the great scientific Prometheans have given way to the destructive tinkering of Epimetheans. Accepting the crisis thesis, it is imperative that man: recovers a stable philosophical and religious platform for his aspirations and calling to subdue and have dominion over creation; gains a perspective that avoids naive reductionism; spurns a misplaced faith in the objectivity of 'scientific' knowledge as attained through an 'infallible' scientific method; rejects the idea that more and more technology is the solution to our troubles; and realises that his problems are not reducible to an error in brain-building. While it is common either to fall into a fatalistic pessimism or adopt a naive romanticism, I will contend that neither is the appropriate reaction to the present crisis. What is needed is an approach to the problems raised by science and technology which is firmly rooted in the Word of God; in the being and nature of man; and which is therefore rooted in a comprehensive worldview which provides a stable religious and theological basis for life and scientific activity. It is virtually redundant to point out that such a worldview will be at variance with the current 'Zeitgeist'.

Before fixing on the present title - 'The Religious and Theological Foundations of Natural Science' - I was working within the umbrella of 'The Interaction Between Science and Religion'. However I became increasingly unhappy with the denotation of this title and arrived at the view that strictly speaking there could be no conjunction of science 'and' religion in this manner as though they were facets of a complementary approach to reality, each shedding their own light from a different perspective. While recognising that such a complementary approach to science 'and' religion is very popular I hope to show that religion in fact undergirds science which cannot exist apart from its religious foundations.

Perhaps this is an appropriate point to note a convention that I will use to distinguish science as referring to the natural sciences. Fully realising the root of science in 'scientia' I have opted for the sake of clarity to use 'science' when referring to the natural sciences, and 'scientia' when referring to the more general spectrum of knowledge. Thus in my convention 'theology' is 'scientia' but not 'science'.

I will also seek to make clear distinction between 'religion' and 'theology'. I believe it proper to speak of 'science' and 'theology', but I will hold to the view that there is no possibility of a 'theology of science' although we can talk of those aspects of theological concern which are conducive to scientific activity; that is, of the theological framework (in distinction from the religious roots) within which science operates. It will be clear from this that I wish to reject a disjunctive approach to science and religion as well as the conjunctive approach. In fact I will seek to promote a perspectival understanding of science within the overall motive of creation, fall into sin, and redemption in Jesus Christ. Such an approach needs particular emphasis in our culture where the study of worldviews and ideologies has to some extent been bypassed - probably due to the influence of British empiricism and American pragmatism. Thus in presenting my thesis I acknowledge a bias to a more continental-rationalist-Cartesian tradition although I certainly would not locate my thought here.

I would wish to locate my thought within a neo-Calvinian framework as stimulated by the philosophy of the Cosmonomic Idea. This philosophy is in no way a settled school of thought as its proponents have deep differences and emphases. My interest in this movement is through personal acquaintance with some of its leading figures - such as H. van Rissen, J.Dengerink and E.Schuurman. The main founder of the Philosophy of the Cosmonomic Idea is Herman Dooyeweerd (1894-1977) and some of his insights will be appealed to in developing my thesis. But due to a tragic unfamiliarity in British thought concerning this philosophical movement I feel unable to push through to a more developed critical discussion which would presuppose a fairly intimate awareness of the principal aspects of the philosophy. So I have merely sought to utilise the Cosmonomic Idea where it impinges in a profitable way on my thesis.

The structure of the thesis is fourfold and I have given a preface and postscript to each part to provide orientation and integration of the diverse aspects.

Part I concerns the historical foundations of science, the religious and theological aspects of which are all too often passed over in haste by reputable historians of science. For example Bernal (1954), Hall (1970) and Kearney (1971) have virtually nothing to say about the Reformation or Puritans. Some scientific detail is included with this in order to contextualise what is being said. Philosophical and theological comment on scientific matters often seems to display a naive awareness of the actuality of the history of science and consequently much mythology abounds. (cf. 2.2.3.3. and 7.4.) So Part I seeks (a) to in its own right point out something of the religious and theological foundations of the natural sciences; and (b) to provide an introduction to the rest of the thesis.

Part II seeks to provide a more theoretical approach to the nature of scientific activity. While this is largely a review of secular philosophies I have sought to plant signposts for the development of an integral Christian approach to a philosophy of science. Today the secular philosophies of science, outside of instrumentalism, are helpful in pointing to the metaphysical basis of science - which for my purposes can be developed with respect to the religious foundations of science. Part II may therefore profitably be seen as introductory to Part IV.

Part III is a brief review of stances that have been taken up by theologians or other non-professional theologians (chiefly scientists who indulge in theological reflection). Of the four parts in the thesis this is the only one which does not specifically point to either the religious or theological foundations of the natural sciences. Rather it indicates the confusion of Christian positions. A confusion I would venture to suggest which often stems from the synthesis of Christian ideas with humanistic philosophy. Nevertheless this is an important part of my thesis as it provides the context for Part IV, as well as a sounding board for my own position.

Part IV seeks to take steps towards formulating a Christian approach to the religious and theological foundations of natural science. I would not for one instant claim it as definitive or final, but see it as a few faltering steps towards the development of 'a' possible Christian perspective. Here I hope that what is implicit in Part II is made more explicit with respect to the religious foundations of science. From there I move on to formulate the theological framework which I believe exists and which is conducive to science.

In writing an interdisciplinary thesis such as this it is necessary that many thinkers in the disparate fields of science and theology be left out and many books remain unread. I make no apology for this as the number of books is legion - for example, the annual crop of evangelical books that are merely a superficial variation of the design argument. Having made this confession I would add that I believe I have read extensively and covered all the critical works - as I hope is clear from the Bibliography.

Perhaps I should add here that one area I had hoped to include as a fifth part, but which space precluded, was the sociological aspect of science - particularly with reference to the responsibility of science to society. Much useful material can be gleaned about this from Rose and Rose (1971), B.Barnes (1972), Goodfield (1977) and Laszlo (1977).

The only field work done was in the form of a questionnaire concerning popular beliefs about science and religion. This is omitted as documentation and analysis would be prohibitive in length. In any case the results would not add significantly to the central theme of the thesis. Therefore I confine this thesis to my research within the corpus of material listed in the bibliography.

The Harvard system of referencing as recommended by the University of Glasgow is adopted for this thesis. (See the introduction to the bibliography for further details.)

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PART I

AN HISTORICAL PERSPECTIVE ON THE FOUNDATIONS OF SCIENCE

PREFACE

It is not intended that Part I should be read as an history of science or as an exhaustive treatment of the involvement of religion/theology in the development of natural science. The consequence of the development of science and technology has been increasing specialisation and hence a somewhat arbitrary selection of material has to be made. While focusing on the physical sciences I recognise the importance of the life sciences and concentrate on the Darwinian controversy in chapter 7. But the main thrust of science/technology in influencing world views and theology seems to me to reside in the physical sciences, in the development from Ptolemy through Copernicus and Newton to Einstein. The basic thesis is to indicate the religious and theological foundations in science, not to give a general history.

A few introductory notes are in order. (a) To reiterate, I am aware of selecting only a few episodes from the many available - for instance in considering only the evolutionary issue in the 19th century, and even here my original notes were some two to three times the present chapter length. (b) I have sought to focus on aspects such as the attitude of Calvin and Luther, the Puritans, and the positive side of industrialisation rather than reiterate what is more commonly noted. (c) However a certain degree of simple history of science is included in order to contextualise the more abstract reflections. (d) Chapter 1 is crucial although it is a very superficial spanning of more than 2,000 years, mainly outside the Hebraic-Christian tradition; while chapter 8, though not dealing to any extent with the religious or theological foundations of science, is included to give a brief, but necessary, background to modern physics and indicate something of the philosophical basis underlying it, the problems it raises for epistemology, and the attendant demise of positivism.

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CHAPTER 1

THE RISE AND DECLINE OF EARLY SCIENCE

1.1. INTRODUCTION

Modern man often regards the origins of Western civilisation from Judaistic and Hellenistic sources as of little value or importance. The scientific theories of old are seen as superstition or metaphysical speculation and therefore of no relevance today. But the ancients who saw that everything was water, or atoms, or a void, or number were really in a comparable position to the modern advocates of cybernetics, negative feed-backs, entropy and mind theory. (Toulmin & Goodfield 1962, p.41.) Both involve the creative ideas of man in interaction with his culture as he attempts to explain and understand the world.

What is remarkable in a survey of this ancient period is that the seeds of so many modern theories are contained in Greek, or earlier, thought. Darwin is foreshadowed in Anaximander's theory of development out of the sea, and in Empedocles' theory that the fittest survive; and we come across heliocentricity and atomic theories. Thus a legacy was formed that, even in its errors, had a great forming influence on later days. Aristotle exercised a virtual stranglehold on science right up to the birth of modern science in the 17th century.

A study of the early civilisations of Mesopotamia and Egypt, which in turn influenced Greece and Medieval Europe via Syria and Arabia, is therefore fundamental. But first a word concerning the other two great civilisations of old - China and India. Neither made major contributions to science basically because they failed to: (a) develop a theoretical geometry; (b) form a working scientific method; (c) and unite philosophy and religious belief with techniques. This, coupled with a Taoist return to nature and away from the city, the Confucian lack of interest in natural philosophy, and the absence of any divine law-giver (Needham 1956, p.25f.) led to sterility of scientific thought in the lands of the East. The contribution of most importance probably being the Hindu (under Babylonian influence) system of numerals and the multiplication of algebraic equations.

1.2. THE LEGACY OF MESOPOTAMIA AND EGYPT

These were exceptionally high cultures. The royal cemetery at

Ur, dating from early in the third millenium B.C. reveals that all except a few of the metal working processes now in use were known; leaving open the possibility that other processes were also known. (Derry & Williams 1970, p.119.) The Egyptians were capable of tempering bronze to a degree where they were able to shave with it - a process that we cannot reproduce today. From 2,500 B.C. the Summerians had advanced multiplication tables and the Babylonians were in fact able to handle complicated linear equations in several unknowns, even going as far as to try and solve cubic and biquadratic equations. (Singer 1962, p.7f.)

It is generally recognised that Mesopotamia led the way in mathematics and astronomy, while Egypt dominated in medicine and anatomy. (Mason 1962, p.17f.) We have a list of eclipses, dated 747 B.C., from Babylon, while the mumifying procedures of Egypt necessitated medical and anatomical knowledge. Thus both in the arena of cosmology and technical crafts this period is significant. An important point is that these aspects of life were firmly in the hands of the priests.

> "Archaeological evidence points to the growth of the Summerian city round the temple; the surplus was brought to propitiate the god; the land was his land; his priests were the first leisured class and the crafts which did honour to the god marked the beginning of civilisation." (Derry & Williams 1970, p.6,7.)

In late Babylon, Marduk was Lord of Gold; Ea of Erdu was protector of smiths; while the fire god Gibil was known as the 'divine smith'. The recipes of these artisans, working under the priests, involved necessary incantations and rituals to assure the benignity of the gods and spirits.

The history of cosmology tended to be the history of the calendar. The priest could and did make astronomical observations, but they were motivated by the needs for the prognostication of dates and seasons of religious significance. On the medical front the pursuit of medicine was a struggle against evil and possessing spirits with little room for the concept of natural causes. Again mention can be made of the Ziggurmauts of Mesopotamia (c. 2,000 B.C.), the Great Pyramid of Egypt, and the recipes from the Library of Assurbanipal (c. 700 B.C.) all of which reflect the interaction of technical skill and religious observances. (Cf. Mason 1962, p.23 ; Toulmin & Goodfield 1962, p.36 ; Bernal 1973, p.67.) It seems clear that religious belief was not merely neutral but was the guiding influence and control over science and technology.

1.3. THE LEGACY OF GREECE

The development of Greece stands in line with the cultures of Egypt and Mesopotamia. As science developed its origins lay in two traditions - the technical and the spiritual. The experiences and skills of men to form and fashion were handed on and developed, and this coupled with the dreams and aspirations of creative thinkers furthered the scientific quest. The Hellenistic period was rich in skills and dreamers, but there were several distinct periods and schools within this era which make generalisations dangerous.

It is wrong to see a rationalistic Socratic influence sweeping aside the religions of Marduk and Zeus. What was involved was a reorientation of emphasis in an attempt to rationalise earlier thought. It was not an attempt to destroy earlier attempts at explaining the world but, following Thales, the implementation of an attitude of critical argumentation instead of the blind acceptance of tradition - though the rigours of traditionalism would return. The desire to know and explain the world [1] was joined by a desire to understand the self. As Mumford notes: "Know thyself runs through this whole culture; Thales utters it; Hippocrates formulates it; the Delphic Oracle has it written over the gates of the Temple; Socrates repeats it." (1973, p.22.) Greek science is identifiable with Greek philosophy. Speculation, not experiment, was the order of the day and while the social conditions and attitudes precluded experiment, theories still had to measure up at the bar of reason and justify the requirements of logic.

After its early advances through the Ionian, Athenic and Alexandrian periods the Greek era succumbed to decay and traditionalism. Alexandria was the centre of decline due to the separation of science and philosophy which provided no basis for development and led to stagnation. This failure of nerve was followed by a lack of inspiration under the practical but unspeculative Romans, and so foundations for Medieval scientific sterility were laid.

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1. Of consuming interest to the Greeks was the cosmos - what was it made of, and how did it operate? This involved a strong externalistic influence from cultural factors and it is interesting to note that the early meaning of the Greek word 'cause' - aitia - was in fact 'guilt'. This being a carry over from the Babylonian idea of retribution in nature, derived from man in society, and the reading of an organic approach into nature.

The Greeks developed general tools of science but no real details; they had elaborate world-pictures and founded several scientific disciplines. But their legacy was their attitude - a deification of nature, an overestimation of reason and an under-estimation of technology. (Hookyaas 1973, p.xiii.) This led to two divergent views: an ascending Epicurean universe based on progressive, evolutionary premises; and a descending Platonic view which saw creation and a fall. (Koestler 1970, p.131.)

The basic motive [2] of the period was 'form' and 'matter'. According to Leicester (1971, p.12. cf Losee 1972, p.7f.) the division of all Greek material objects was into 'form' and 'matter' with the earlier Ionian thinkers emphasising 'matter' and the later Athenian thinkers stressing 'form' behind this 'matter'. But it is not as simple as this. In the pre-Homeric era there was a clear religion of life and death where the amorphous deities had no individual form and their existence was limited and subject to fate and death (Gk: Anangke). Here we see the relevance of Anaximander's setting the origin of all things in the 'apeiron' (the indefinite and infinite). A shapeless stream of life flowed through the process of birth, decline and death of all corporeal form which is essentially the deification of the biotic sphere of existence before it returns to the chaos.

Then there was the later cultural religion of the Olympian gods which enshrined for Greece the deification of the cultural aspect of existence. The gods had left the earth and its limitations for Olympus , but they were still limited with no ultimate power over death and necessity. Dooyeweerd maintains that these newer gods exercised their influence primarily in the polis and the public life of the community, whereas the country and individual private life remained centred on the more earthy gods of 'matter'. (1969, Vol.I, pp.25,61,66,181; Vol.II, pp.9,56; Vol.III, pp.7-15; 1972, p.38f.) This meant that in later thought there was no clear distinction between 'form' and 'matter', but rather a dialectical ground-motive that became the religious starting-point for all thought and determined their view of nature, and established the base of their metaphysical view of Being in opposition to the visible world of becoming and decline.

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2. I wish to use the designation 'motive' throughout rather than the more common term - motif - as the idea of motive as direction-giving is much more expressive.

The Ionians, then, deified the 'matter' motive, making no distinction between mental and physical spheres. In this nature-philosophy time brought retribution as 'form' was ultimately dissolved back into 'matter' and carried back to its form-less origin. Aristotle, however, deified the 'form' motive and, while having an animating view, reversed the Ionian procedure and saw the 'psyche' as the form of the material body. His cosmonomic idea of nature entailed the domination of a dual teleology where all strove for perfection. There are substantial forms arranged in an hierarchy, with 'matter' as the lowest and 'form' as the highest. Form has the basic primacy and deity is pure form. But the deity is not the origin of matter which possesses blind arbitrary 'anangke', and this permeates through the categories of Aristotle. Yet he was probably the first to really try and synthesise the two motives, and 'form' while not the origin is the cause of 'matter'. He abandoned Plato's separation of the noumenal world of 'ousia', the sensible world of decline and decay, and conceived of substance as the immanent point of reference in the process of change. 'Ousia' for Aristotle always meant the primacy of the category of being, that is the thing in itself, and does not relate to sensory aspects. 'Form' is therefore an immanent teleological principle.

The form-matter motive therefore lies in the encounter between the pre-Homeric and the later cultural religions of Greece. The first deified the stream of life which was not fixed in any one form and is seen in the worship of Dionysus and the Orphic movement. The later 'form' motive based on form, measure and harmony, became dominant over the matter motive and is seen in the Delphic Apollo as law-giver.

1.3.1. The Ionian Period.[3] The philosophers of nature from Milos, Elea and Samos were concerned about the origin, evolution, structure, form, substance and laws of the universe. Their desire was to find some simple explanatory principle. Thus we read of Thales who sought a unitary formula based on water; of Anaximander who saw the universe originating out of an indefinite, undifferentiated (apeiron) something, and the earth as suspended; of Pythagoras who sought a key in the numerical and concluded the earth to be a sphere; of Anaximenes with his 'breath theory' where 'pneuma' was the basic common substance,

3. Magill (1968) provides many excellent summaries of various thinkers in this and the following sub-sections.

and who employed atomism and continuum theory. Parmenides saw form in metaphysical opposition to matter with the true Being analagous to logical thought. From monistic premises he saw reality as a solid homogeneous sphere with all appearance of change and motion as illusion. Heraclitus posited a 'logos' by which all things were one, claiming opposites the same; Empedocles formulated the classic structure of the world as based on earth, air, fire and water with these elements motivated by love and strife; Anaxagoras conceived an infinite number of minute particles (seeds) with a guiding 'nous' behind them (which Empedocles rejected). Anaxagoras is famous for his expulsion from Athens on the accusation of impiety for locating the sun and moon (gods) at a great distance from the earth. With Democritus the minute seeds became atoms (cf. Leucippus) which, though obviously not the atoms of modern physics, were in principle the same below-sensory concept of basic building blocks for reality.

The early Ionians accepted the idea of creation/development by and large, and also the idea of some impersonal force outside which imposed order and justice on matter - nous, logos, etc.. They saw nature in a more impersonal light as they went on and the gods were removed from nature into the sphere of the abstract and spiritual. These, then, are the first rational attempts to put science on a firm footing, but they did not constitute any attack on religion. Indeed Heraclitus, though scornful of popular belief, advocated the reform of religion on a pantheistic basis.

<u>1.3.2. The Athenian Period.</u> Here Hippocrates followed an inductive method and founded the first real religion of science in opposition to traditional religious beliefs. Socrates, however, was sceptical as regards scientific pursuits for cosmology did not advance the soul.

Plato, faced with a multiplicity of theories, was sceptical. Was he to adopt Parmenides, Anaxagoras, Pythagoras, Democritus or Empedocles?; was he to follow the Ionian concept of raw material, the logical axioms of the Eleactics, the unity numbers of the Pythagoreans, the atomic theory of the four elements? He certainly was under the influence of the Pythagoreans, finding inspiration in geometry, but it was as a plausible and not a full mathematical certainty. Thus Plato developed the Pythagorean idea concerning the uniform circular motion of the heavens and saw intelligent design. But the creating 'demiourgos' was no supreme god but tied to follow the eternal Ideas, tied to trying to fashion the chaos as orderer, not creator. Nor does the demiourgos sustain the world and man is further made by secondary gods in the image, not of themselves, but of the universe. Plato rejected the blind necessity of anangke, and also Democritus for having denied the existence of Mind. Mathematics alone does not change and they are therefore the true field of science. Even so it is the concept of saving the appearance that comes to the fore, the distinguishing between physical truth and hypothesis which saves the appearance. Thus 'form' and 'matter' are posited against each other and all we can achieve is "a likely story in such matters." (Plato 1971, p.41.)

His division of matter and soul, with the material body being the prison of the soul which longs for release, led to a separation of science into experimental and speculative aspects. Overall the philosophical-religious belief directs the trend in the scientific world for the soul is the place of 'forms'. Contempt for the body led paradoxically to advances in anatomy as it freed the body for dissection. Therefore while seeking the ground of being in numbered and geometric figures, Plato tried to synthesise the Eleatic ever-resting ideal form of being and the Heraclitean flux. But he finished up in a dialectical idea of Being that led to a crisis in the doctrine of Ideals. (Dooyeweerd 1969, Vol.II p.9f.) His positive contribution to science was the establishment of mathematics in education, and the method of working back from an assumed solution to the original details.

Aristotle was not as speculative as Plato and stressed the visible Ideas as opposed to the abstract mathematical forms of Plato. He assumed that the heavens had an eternal uniform circular motion round the earth. Aristotle writes: "The heaven, moreover, must be a sphere, for this is the only form worthy of its essence, as it holds the first place in nature...." (in Hurd & Kipling 1964, Vol.I p.29.) He further assumed, from Empedocles with a mixture of Pythagorean details, that the earth existed and consisted of the four elements, plus the ideal quintessence which had neither upward or downward tendencies.

Aristotle's method was to progress from observation to general principles and then back to observation, that is inductive-deductive.

(Losee 1972, ch.1.) He held the principle of demonstration to be that of Identity, Non-Contradiction, and the Excluded Middle. Further there were four causes, or more correctly 'becauses'; namely the material out of which a thing came to be; the formal designs, patterns and forms impressed on matter; the efficient whereby designs were realised; and the final purpose. In other words - from what?; what was it?; by what?; and in aid of what? To these he added change and spontaneity as causes - though often overlooked as they are not open to knowledge. The final cause was important for him as he envisaged all scientific explanation having an account of the final 'telos'. (Theophrastus maintained that the concern of science was with the efficient cause.)

His approach to the nature of the heavens was speculative in method and Eudoxian in content. The universe was seen as limited in space, but not in time, and the outermost sphere of the fixed stars was moved by the Unmoved Mover. This in turn governed all the other spheres. God was the Primum Mobile, a final but not an efficient cause; he was not the creator for the Forms and the world were eternal. So Aristotle established a break between celestial and terrestrial physics (Pythagorean influence).

Aristotle saw matter as potentiality and form as actuality. The soul became the form or actuality in living things which were seen, not as substances but, as species. He divided creatures into three classes: man, who had a rational soul; animal, which moved by a sensitive soul; and vegetable, which grew by a vegetable soul. (Cf. the individuality structures of Dooyeweerd). Within the change from potential to actual he imposed a pneuma-theory on top of his matter-theory, with the heart as the true seat of life (Cf. the centrality of the heart in the Cosmonomic Idea - 20.1.3.3.) Opposing Democritus and siding with Socrates and Plato he saw matter as continuous. This was of significance for later ages as the church's total rejection of the materialism of Epicurus, who used atomism as a weapon against religion, left the Aristotelian view as the only real alternative. Thus a worldview was given to following generations that became a creed to be adhered to with the strictest devotion - a legacy of vitalism and teleology. The idea of vitalism being the result of his biological work diffused through his thought. (He classified over 540 species. (Bernal 1973, p.91.; Hookyaas 1973, p.55.))

1.3.3. The Alexandrian Period. Following Athens, Alexandria became the great centre of learning in the ancient world. It owed its rise to Alexander the Great as did much of the scientific acquisitions of the Greeks from the surrounding nations - the astronomy of conquered Babylon, the algebra of Mesopotamia, the idea of fate from Babylon which was to play a large role in Stoic philosophies. Under King Ptolemy the museum was founded at Alexandria employing over 100 professors, having half a million scrolls, a zoo, botanical gardens, an astronomical observatory and dissecting rooms. Thus Greek science from 300 B.C. is Alexandrian science - though it was not the sole important centre (cf. Rhodes and Pergamum). But it was here that science was to blossom and specialise and then to lose its general relation with philosophy and slide into decline.

Despite decline eventually setting in, the list of those who participated in the Alexandrian period is impressive. There were Strato, a disciple of Aristotle; Euclid and Aristarchus in mathematics; Galen in the medical field whose work was still standard in the 17th century; Herophilus, Apollonius, Eratosthenes, Hipparchus, Hero, Cleomedes, Diophantus, Hypatia, Mary the Jewess, and Zosimus; the atomist Erasistrates who held that the pneuma circulated in the body drawn from the pneuma of the world. There was also contact with Archimedes, who though not based at Alexandria evidently visited it. He is of particular importance for his attempt to combine the inductive method of Aristotle and the deductive method of Plato. Here too Ptolemy formulated his influential cosmology. Debate would rage whether these theories were representations of reality or computational models. In the 'Almagest' he says his theories are only for computation, but by the time he writes 'Hypotheses Planetarum' he claims to reveal the structure of physical reality.

Other influences were at work in Alexandria - social and religious. While Athens had drawn its thinkers from the elite, who were suited to detached theoretical attitudes to life and society, this was not so at Alexandria where the patrons were the merchants and traders who wanted some return for the money they were investing. This is important for modern science did eventually arise in a commerce-orientated society. On the religious fronts several features are noteworthy. In Athens there had been a certain scepticism towards the Olympian gods, but in Egypt the gods were far more central in the life of people. Here was the meeting place of Isis and Mithras, Jews and

Christians, Gnostics and neo-Platonists. So in Egypt the religious standing of the clergy was higher and tended to exercise a monopoly over learning; they were the clerks as well as the clerics.

Thus there was pressure in the general climate of thought away from scientific endeavour to the mystical religions of the East and the rising influence of Gnosticism. The rational theorising of Athens gave way to the mystical quest of knowledge by initiation into religion. While in Athens the quest had been to free oneself from perplexity and gain rational understanding, it became to free oneself from sin and obtain salvation and blessedness.

Alexandria was at one and the same time the brighest flower of ancient learning (the museum lasted over 600 years) and the trap which sprang shut on scientific curiosity. (Toulmin 1974.) This being so it militates against any internalistic approach to science which ignores the cultural milieu (cf.9.3.1.) It is difficult to explain the aridity of science from then until the 15th century apart from the powerful influence of social and religious factors that made up the worldview within which people lived. There was also the tacit canonization of Aristotle which made any attack on his theories suspect in scientific circles (though not religious); and thus science became as sterile and hidebound as religion.

If any further nails in the coffin of science were needed - Rome supplied them. Roman civilisation was based on the warrior-agricultural community, and lacked the quantitative and spatial concepts necessary for any fruitful advances in science. Rome had no astronomy of note or mathematics, only a certain practical hygenic approach to medicine. The strong thrust of Stoic philosophy further heightened this hiatus as it gave little stimulus to knowledge and research; it blurred the differences between structure and function, seeing the universe possessing a world-soul which helped to relate it to the Astral religions of Alexandria. Paradoxically itsmonotheistic premises and concept of providence gained a degree of acceptance in Christian circles. Epicureanism, if anything, gave less encouragement to science. Thus the old school was in decay and the field was left to the flux of Christian, Jewish and pagan elements. While the fight for supremacy raged there could be little concern given, orworldview provided, for the mundaneness of scientific investigation.

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I conclude that for this long period of science the basic approach of science was a way of looking at the world and not primarily a way of dealing with, or trying to explain, it. By and large the theories were speculative, isolated from, or superimposed upon, observations.

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1.3.4. Attitude to Work/Technology. This militated against any real scientific advance. Here the motives of 'matter' and 'form' come to the fore again. As Hookyaas (1973, p.76f.) points out, in pre-Socratic Greece the manual activities were seen in favourable light. The crafts flourished around the time of Solon (639-559 B.C.) who required each citizen to learn a trade and decreed (according to Plutarch) that a son need not support his father unless the father had taught him a trade. This is the period of Greek invention - the bellows, improved anchors, the potter's wheel, the level, set square, lathe, ruler and key. "It was a time too," writes Mason (1962, p.35.), "when the Greek word 'sophia' still meant technical skill, and not intellectual wisdom." At one level this tradition continued, and as late as Hero of Alexandria there was a strong technological interest, though with little civil application.

For Socrates the virtue of temperance applied to workers meant they were to know their place and be satisfied. Plato had severe contempt for the manual aspects of life. He might have regarded agriculture as the basis of his ideal state, but the labour associated with this activity was to be left to slaves. Thus as long as the idea that a social stigma rested on the mechanical arts (Xenophon) there could be little advance in science, for without this science was shorn of the tools it needed - technologies that could have improved techniques and observations, and experiments that could have been performed to investigate phenomenon under specific conditions. When experiments were used it was to demonstrate a hypothesis and not to discover. Only in medicine was work with the hands considered honoured.

Thus science was limited, not by skill, but the contempt of the manual. There were of course artisans and engineers who were involved at a practical level, but they did not have the speculative cosmologies or scientific curiosity to give science impetus. The divorce that resulted between philosophy and technology reached a peak at Alexandria.

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In general this was a period where few distinguished ultimately between religious and natural knowledge for life was seen as a whole. (Toulmin & Goodfield 1962, p.113; Hookyaas 1973, p.1.) On the theoretical front if one theory above all others had to be singled out as retarding science it must be the triumph of hylozoism (vitalism) over the atomism of the mechanical school. This led to the viewing of everything through an organic grid (cf. Aristotle's application of biological categories to physics); nature was alive and striving for perfection. Nature, immanent and divine, was a living organism full of reason and logical necessity which the gods had to obey. Indeed it produced all things - gods, men, animals and the inanimate by generation. The evidence suggests that hylozoism succeeded because the atomistic view was ruled out on religious grounds because of its association with materialism. Atomism was itself quite wrong, but in the environment of more sensitive souls it may have led science forward. As it was sterility set in and lasted till the birth of modern science.

1.4. THE EARLY CHRISTIAN ERA AND THE DECLINE OF SCIENCE

After the disintegration of science at Alexandria, Greek science echoed on in Southern Italy and Byzantium before a small but important spread and revival under Islam brought it east to Bagdad and west to Spain. Islam is a crucial link between Greek science and the western revival of learning from the 12th century onwards. Yet the first thousand years of the Christian era has been characterised by Singer (1962, ch.5.) as 'The Failure of Knowledge'; Hurd and Kipling see "discovery at a low ebb" (1964, Vol.I p.55.); while Toulmin and Goodfield (1962, p.137f.) see a proliferation of rival theories that are but variations on the old themes of Greek thought. Despite this, and the lack of any coherent philosophical system - quite inconsistent beliefs being held by the same person without any qualms - there was nevertheless a number of fundamental innovations in Europe through this period that helped to pave the way for the scientific reorientation when it came. Technology has had a much more steady development than science.

Through the break-up of the Roman Empire the church struggled to establish itself. A struggle revolving primarily around theological questions and the acquisition of power - not on the validity or otherwise of science or technology. Theologians split into two camps over the question of the world:

> "A summary discussion of some characteristic authors sufficed to make clear that, on the whole, two types of synthesis are involved in the Fathers' critique of culture, namely, one favouring cultural solidarity and the other opposing it." (Popma 1973, p.112.)

Tertullian spoke out fiercely against alchemy, seeing it as the corruption of men by fallen angels. Augustine denigrated 'those imposters, the mathematicians', though he possibly meant astrologers. (cf. Singer 1962, p.169.) Isidore however saw astrology in part at least as valid and distinguished a natural and a superstitious version. Astrology and alchemy did indeed have pagan superstitions attached and this association did not recommend itself to the church. The church in fact issued several condemning statements of these activities, not because they were science, but because they were superstitions. Nevertheless suspicion of science was present due to its concern with this world as opposed to the soul, and Bonaventura could comment that the 'tree of science' was cheating men out of their inheritance in the 'tree of life'. (Mason 1962, p.115.)

Nestorians were prominent in the translation of physics into Islam. From the Syriac speaking Nestorians at Gondisapur science passed into the Moslem world and from about 750 - 1200 A.D. Islam was the custodian of scientific activity. This heritage passed back to the West by commercial contact from the 12th century onwards. Thus the influence of Islam is important, but swiftly fades after 1500 A.D. and the history of modern science draws little from it or the East. The history of science becomes the history of western science.

1.5. THE LEGACY OF THE MIDDLE AGES

The sources of the Medieval tradition are varied. The basic worldview comes undoubtedly from the synthesis of the Greco-Roman traditions with the Hebrew-Christian traditions of Christianity. But it was a synthesis full of antimonies that refused to be welded and finally split assunder during the revival of learning, art, religion and science. Confusion arose from the failure to separate the reality of a worldview and a world-picture. The former gives a conceptual evaluation of the world and the latter provides a physical model. In terms of the worldview the gulf between biblical and

Greek thought was immense. The Bible envisages a Creator God who created external to himself, transcends reason and sustains the world in existential existence. The Greek view was of a self-sufficient creation and a self-supporting divine Nature. The synthesis of Aristotle and Plato with the church in terms of their scientific theories could never be more than uneasy.

In the first instance the scientific works of Aristotle were lost and it was Plato, through Ptolemy and Pliny, who influenced the early science of the Middle Ages. Pliny's work became a primer on Greek science, while Ptolemy gave a universal cosmological theory based on epicycles, equants and excentrics with an immobile earth. This theory was attractive to theologians and was accepted by Aquinas as a working hypothesis. Plato's 'Timmaeus' survived directly into this period and fitted well with the neo-Platonising tendencies of Christian belief. But trouble was being sown for much that was being adopted and canonised as science was inherited from the period of classical decline in Alexandria.

Theology tended to the intellectual and abstract as opposed to concern for the practical affairs of life. This fitted the dominance of 'grace' over 'nature'; grace being for the Aristotelian Christian (or Platonic) the equivalent of 'form', and nature the lower sphere of 'matter'. It was a world dominated by the eternal, heaven and hell were more real than the immediate reality of nature. Man's spiritual destiny ruled over his temporal affairs and the religious meaning he gave to the world was the tool of interpretation. The world of nature was viewed as an organism which left the door open for the Greek demonisation of nature (the matter-motive), the personification of the forces of nature and the hold of superstition. The motives of 'grace' and 'form' craved an ordered universe on an organic model, and imposed primarily mystical and symbolical methods of interpretation on the data available.

This was a time when science really meant scientia. There was no discipline of science as such. Indeed science was often a by-product of medicine, magic or alchemy, or self-taught in the pursuit of some career. But there was no systematisation, interaction or flow of science such as developed after Copernicus. Within what we now call physics, sound was tied to music which in turn was tied to mathematics; heat was tied to alchemy; and optics to geometry and perspective.

Thus the pre-Renaissance world-picture was dominated by the rediscovered Aristotelian cosmology and the astronomy of Plato developed through Ptolemy. Over all was Aristotle's a-priori Law of Necessity; god had to follow the natural law. This of course conflicted with the Christian God and the church made moves to condemn such thought (Tempier's 219 theses of 1277). The Aristotelian world-picture had its disadvantages for it could not account for the observed irregularities of the planets or explain their varying distance from earth. Yet mentally it was aesthetically and psychologically attractive in its internal simplicity and coherence. Indeed such was its hold that the great sceptic Pomponazzi, a rationalist who denied that personal immortality could be proved, mocked tradition and doubted prayer, nevertheless meekly accepted the traditional cosmology and interlocked man's destiny with the stars. (Hale 1971, p.314.)

It is easy to look down on astrology, but it did serve to build up a body of astronomical observations. Actually astronomy and astrology were still largely inseparable. Even when astrology was attacked the reasons are interesting. Mirandola had many arguments against astrology but his key one was that God had given man the ability to choose his own destiny and could not therefore be bound to the stars!

Astronomy was of course at the centre of the scientific reorientation when it came and was the area of science to alter and refocus the worldview and world-picture of men. Through the Middle Ages astronomy was linked with religion for the determination of dates for feasts and services, and for arranging the ecclesiastical calendar. The system of Ptolemy was not rigid and had undergone many modifications and was beginning to reach a crisis. In fact the time of Copernicus was one when something needed to be done about the stars, reform was necessary to get Easter back into place. Thus Copernicus and Clavius were called in by Rome to help sort out the mess that the Julian calendar was in.

> "Perhaps this is the place to mention the common misunderstanding that in the Middle Ages men believed that the earth was flat. True this was held by a sixth-century Byzantine eccentric, whose entertaining figures are often reproduced. Nevertheless, his opinion can be discounted. For the Middle Ages - as for our own - it would be hard to say what illiterates thought on the matter - if they thought at all - but educated medieval men assumed the earth to be a sphere." (Singer 1962, p.175.)

1.5.1. Alchemy. This was an important facet of medieval science and divides roughly into two camps. There were the practical discoveries of the craftsmen who did not theorise; and the scholars who theorised but remained ignorant of practical advances. The former were often marred by charlatans; the latter were more in line with the rational encyclopaedists who believed in Aristotle and the transmutation of base metals, but who were quite opposed to the trickery and superstition of some of the practioners. Attempting some sort of synthesis Paracelsus helped efface the border between art and nature, seeing all artificial procedures as founded on natural ones. He brought the change from animal spirits to iatrochemistry. In a sense he was the first academic to take the alchemists side. With supreme confidence in his own theories he ceremoniously burned the works of Galen and Avicenna, but he was still caught in a mystical world of Aristotelian elements under the influence of astrology.

The discipline (chemistry) was advanced as it emerged out of the monastries into the towns with the decline of feudalism and the rise of the new middle classes. Its importance largely lies in the development of gunpowder and the improved techniques of distillation. Here, too, we have in Agricola the great foundation work of modern minerology (1546) as he turns, in his mining environment, from the mysteries of the secret formula to the experimental and detailed recording of observations.

But despite some emergance of alchemy into a more modern approach, there was at heart stagnation and superstition. Thus the general learning of the time by-passes this work, caught as it was in mystical religions and manual activity. Alchemy was forbidden by a bull of Pope John XXII in 1317.

1.5.2. Medicine. The great works are late and two stand out above all others. There is the marvellous work of Vesalius culminating in 'De Fabrica Corporis Humani', published interestingly enough in 1543; and the breakthrough of William Harvey who at last revealed the secret of the flow of the blood, seeing the heart as a pump. These two are actually linked in a direct pupil-teacher relationship - Vesalius: Fallopius: Fabricus: Harvey. (Pledge 1966, p.28.)

Vesalius' breakthrough was in his careful dissections. Up till now this had been left to some menial while the doctor lectured the students; the dissection merely an illustration of the received doctrines of Galen. Indeed Vesalius, despite his anatomical advances and care in dissection, was caught in Galen's web, claiming the blood passed through the septum of the heart although the evidence before him denied this. But Galen said it: therefore it must. So by seeing what he looked for he missed the point of the valves in the veins, and when blood was seen to flow the wrong way it was simply asserted that the incision had caused it to flee in the opposite direction like a 'frightened hen'. But if medicine was guilty of dissecting merely to illustrate, the church was guilty of opposing dissection on the basis that it was the 'shedding of blood'.

Harvey, in 'De Motu Cordis' (1628) set medicine on the right path by seeing the importance of the heart as a pump though it would be many years before his theory was accepted. But the analogy was at hand at this time for pumps were well known through the dependence of areas in England and the Lowlands on hydraulic engineering. (Pledge 1966, p29.)

<u>1.5.3. Methodology.</u> In terms of scientific techniques this period shows little advance over Greek science. (Van de Laan 1973, p.74.) It sought explanations, with little recourse to experiment, in terms of the true forms or essences of an object and its purpose. Causality was described in terms of future goals, the striving for actuality out of potentiality. The system was teleological, the world rational in structure and to be unfolded by reason; and the method therefore deductive. This was too rationalistic for science to flourish. The only experience referred to was that found in books and there was a multiplication of theories with no attempt to decide between alternatives. Experiment was not yet part of the scientific scene.

Several methods of inquiry were posited such as Scotus' method of agreement, Occam's method of difference, and Grosseteste's method of falsification. (Losee 1972, ch.5.) Occam's Razor shifted the simplicity seen in nature and placed it as a requirement on theories. Grosseteste (1175-1253), Bishop of Lincoln, was the first to analyse the problem of induction and verification, seeing induction as the resolution of a problem into its constitutive elements and deduction as the composition back to the original phenomena. He went on to evaluate alternative explanations, and with Roger Bacon, posited a third stage of a further induction and testing.

1.5.4. Technical Progress. The later Middle Ages (1150-1348) saw rapid commercial expansion and population growth. Technical arts developed. From Egypt and Mesopotamia there were books on raising water, water wheels, balances and water clocks. (Cf. 'Book of Artifices' giving 100 technical devices, many of them practical - c. 860 A.D. (Singer 1962, p.152.)) The Teutonic Barbarian invasion of the creaking Roman Empire brought advances in the cultivation of crops; the use of the stirrup and the heavy wheeled plough. A further agricultural revolution in Lombardy in the 1470's saw cattle being kept alive through the winter, and the use of manure to improve crops. Again we have the new windmill designs; from China came the process of paper-making; the discoveries of the sternpost and bowsprit and the development of astronomy for navigation. At a seemingly mundane level the invention of spectacles was probably more significant than we tend to think.

These technical innovations were often on a wide scale and generally associated with the religious life of the community. Like theoretical thought it was was bound up in the religious outlook of the age. The guilds were often "pledged to the communal performances of religious duties." (Armytage 1970, p.50.) It has been estimated that the money spent on cathedrals in France between 1170 and 1270 was the equivalent of 1,000 million dollars. (Mason 1962, p.106.)

Printing was a key facet in the Renaissance of learning. But in the first instance it had little impact on scientific thought. The first works to be printed were the Bible and the recovered classics. Thus printing aided the Reformation more than it did science. Even where it impinged on science it would be in the printing of some classic text, so spreading errors and slowing s peculation.

There was the fact of technical progress, but it was not a general or correlated progress, but rather the isolated breakthrough on many fronts with no unification. Craftsman and scholar were divorced (cf. 13.2.1.) The crafts and the academic world were still apart and A.R.Hall (1959, p.80.) suggests a time lag of some 250 years before science caught up with the developments and problems raised by the crafts in this period.

It must be noted that the biblical view of man as it gained influence through the Reformation elevated the standing of the crafts and technological innovations by raising the status of the manual and the menial. But for most of the scholastics there was a clear divorce of nature and grace, coupled to a rationalistic spirit.

1.5.5. The Scholastic Influence.

> "The situation became quite different when the dialectical ground-motive of nature and grace made its entry into Christian scholasticism. This occured in the period of Aristotelian Renaissance, in which, after a bitter struggle, the Augustinian - Platonic school was pushed out of the dominating position that it had hitherto enjoyed...... The two fundamental tenets of this system were the positing of the autonomy of natural reason in the entire sphere of natural knowledge, and the thesis that nature is the understructure of supernatural grace."
> (Dooyeweerd 1969, Vol.I p.179.)

For the church and hence for learning in general this was of crucial forming power. With a twofold authority in reason and revelation the scholastics split into schools of nominalism and realism. Nominalists held that all universals were but names rather than realities, and that only a particular individual object or event had reality. Realists, derived from Plato, held the reverse.

In this setting we can think of Thomas Aquinas, Occam and Jean Buridan. Aquinas held to a Christianised Aristotelianism, to one finite universe with a base motionless earth at centre with the celestial spheres arranged according to degrees of increasing perfection and kept moving by angelic power. Occam revived the impetus theory of Philoponos that an arrow could fly in a vacuum and advocated the nominalist idea of universals. Buridan advocated the alternative impetus theory of Aristotle, where air rushed round from front to back to push the arrow along, pointing out that it avoided the need for the angelic motive power in the heavens. This was the beginning of the end for the heavenly propelling agents.

Nicolas Oresme (c.1362 f.), Bishop of Lisieux, advocated a moving earth and dropped the difference between the heavenly and terrestrial motions - an important step, for following Aristotle the earth and heavens were seen as two separate organisations with their own laws. As well as reviving the idea that the earth revolved daily on its axis, he represented velocity graphically and set forth for the first time the rule for uniform acceleration. He saw science dealing only with probabilities and not certainties as understanding depends on the senses and these are not exhaustive and cannot penetrate the immaterial. Thus he concerned himself with saving the appearances and gives delightful expression to the concept of pre-abstractive thought (cf.21.1.4.) (Ross & McLaughlin 1972, p.583.)

Nicolas of Cusa (1401-64), Bishop of Brixen, marks, according to Singer (1962, p.178.) the passage from scholasticism to science. He saw that measurement implied discreteness and atomicity; held that the earth rotated due to an initial impetus; and that the heavens were not more perfect than the earth. As with Oresme, God was the centre of all:

> "Except for God, one would not know how to find precise equidistance to diverse points, because He alone is infinite equality. Thus He who is the centre of the universe, namely God whose name is blessed, He is the centre of the earth and of all the spheres, and of everything in the universe." (In Ross & McLaughlin 1972, p.585.)

This of course utilised different spatial concepts from ours. Like Oresme again, he writes (cf. 19.7.3. and 21.1.4.):

> "And for this reason if someone finds himself on earth, in the sun, or another star, it will always seem to him that he is at the immobile centre and that all the other things are in motion.....Hence the machine of the universe has, so to speak, its centre everywhere - and its circumference nowhere because God is circumference and centre, He who is everywhere and nowhere." (In Ross & McLaughlin 1972, p.586,587.)

Thus for both these men scientific speculation was seen as profitable for the defence of the faith. But they were still children of their time struggling within the variations possible within the Greek world-picture. The point of criticality had not yet been reached as far as the scientific reorientation was concerned.

1.6. THE IMPACT OF THE RENAISSANCE

This long period of history ends with a number of quite separate revivals. There was a revival of learning from the 12th century culminating in the work of Thomas Aquinas; there was the artistic revival of the 15th century onwards, commonly called The Renaissance; and there was the revival of religion in the Reformation. It is my contention that neither of the first two aided science as positively as the latter, though I note the move to read into the Renaissance the origins of the scientific revolution. (Cf. Kline

1954, p.18f.; Butterfield 1973/a, p.3f. and Butterfield 1973/b p.vii.)

But is this attempt to elevate the scientific achievements of the Renaissance justified? Certainly the artists left medical orthodoxy far behind in their penetrating anatomical studies (e.g. the dissection work of Leonardo), but even here they did not establish or lead forward the science of anatomy. Their interest was artistic, not medical, and without medical interest as a primary concern there could be no advance. This I believe is generally true; science was brought in (especially geometry and mathematics as tools in perspective) but merely as tools to an end. There was no commitment to mathematics as mathematics, to unfold the secrets of the scientific disciplines.

The first renaissance of letters was mixed with occultism, magic and mysticism and evinced little sympathy at a general level for science. The second renaissance was primarily of art, not science. It had a scientific influence in the study of nature, anatomy, optics and mathematics, but led ultimately to little in the way of a scientific revolution. Again this Renaissance did little to stop the rot in the universities, an indication that the head and the hand were still separate (Zilsel 1973, p.94.). This was the continuing problem for science and in a way the decisive and destructive separation in the history of science. Thus while the artist went some way to bringing head and hand together he still stood either in the stream of craftsmanship or of abstract thought. Alberti, the brilliant architect, showed disdain for the manual, noting that: "the manual operator being no more than an instrument to the architect." (In Ross & McLaughlin 1972, p.528.) However the artist was generally a craftsman toiling in his workshop; essentially a 'technician'. (Butterfield 1973/b, p.38.)

Leonardo da Vinci (1452-1519) was the outstanding figure. He saw the future of the flying machine, the helicopter, the parachute, the nature of flight, the parabolic compass, and the vertebrate skeleton. In his jottings there are tanks, submarines, looms, link chains, gears, screw-cutting machines, cranes, breach-loading and steam cannons. But this was engineering and not science. He attacked the astrologers, maintaining that practice must be based on sound theory and held mathematics and mechanics in high esteem. He even jumped forward to the concepts of Newton's first and second laws, but as Pledge notes: "without mathematics, he failed to develop them." (1966, p.15.) Like Alberti he denigrated the manual, and poured scorn on the 'sweaty sculptor'. Thus despite his praise of experience, he failed to reconcile the various strands of thought in a unified picture. Though, to be fair, we must remember that for Leonardo 'science' and 'art' were distinctions he could not make. (Gombrich 1971, p.62.)

The Renaissance provided no scientific reorientation but merely continued within the Greek legacy. Therewere no new scientific concepts let loose, nor any general fundamental change of attitude within the scientific arena. The division of thought and craft, though partly overcome, remained strong; the theory of science a mixture of Greek thought.

1.7. REVIEW

What conclusions can be drawn? The scientific reorientation still lies in the future and Aristotle, Ptolemy and Plato still reign supreme. But the hold they exercised was beginning to disintegrate under the pressure of time and change. New theories and methods were beginning to appear; the scientific view was changing from an examination of the ingredients of the universe to a quest to understand how it worked; spirits and potentialities were being replaced by corpuscles and attractions, though it must be noted with about as much scientific justification for the one as for the other. The method of experimentation may have been advocated by some but it was certainly not implemented even by them in any rigorous way. If the materials of modern science are to be found in the Greeks, then the vitamins are going to be found in the biblical tradition. As yet the two have not come together. Thus the change from medieval to modern science is abrupt more in practice than in theory; more in worldview than world-picture; the methods were known but not used because of various cultural and religious judgements. The hold of Aristotle had to be overthrown rather than false cosmologies 'per se', and Italy, the home of the Renaissance, was especially loyal to Aristotle. (Cf. Randall 1973, p.51f.)

It seems to me that for the origins of modern science we have to look for the fusion of two quite separate traditions - the scholar and the craftsman - within some suitable unitary worldview. This only could, and did, happen when the philosophical revolution had provided a framework in which it could occur. (Hall 1959, p.76,81.)

It was not just a simple matter of craft and theory coming together, there had to be fertile ground for any fruitful union. Thus a new method of inquiry had to be linked with an intellectual transformation that would provide a new way of looking at the world. New world-pictures and theories were in a void until the general advent of a new worldview. A conceptual revolution was needed to break down the barriers between the two ingredients of 'skill' and 'concept'. There must be no doubt about the reality of the gulf that existed between these two areas; a deep dichotomy that had to be resolved before modern science could flourish; a separation of craftsman and scholar that was social, intellectual, teleological and educational. The first steps in this conceptual change were however beginning to break over Western Europe. There was the beginning of the disintegration of the Greek traditions; the break from Galenic anatomy; the needed reform of the calendar indicating serious faults in Ptolemy's system; and the ever present biblical view, which after 1500 years of Christendom, was about to break with the Greek motive of form-matter and its Christianised variation of grace-nature.

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CHAPTER 2

THE RISE OF MODERN SCIENCE

The scientific reorientation giving birth to modern science is the so-called 'Copernican Revolution'.[1] One of the considerations of this study is the question why such a 'revolution' took place at this particular time and culture.

> "The First Scientific Revolution......is also associated...... with the events of the time. It is a peculiarly European movement though, of course, it has now spread all over the world. One of the great historical problems, which has not yet been solved and may not yet be susceptible to solution, is to find out why this Revolution happened when and where it did."
> (Bernal 1973, p.132.)

2.1. THE BACKGROUND TO CHANGE

2.1.1. The General Roots of Change. There have been many proposed solutions to this problem. Some see the key resting in the individual genius of men like Leonardo, Copernicus and Galileo; others point to a crucial, but inevitable, moment in the evolutionary character of science; others emphasise the social and cultural background. (a) Koyre emphasises the scientific charisma of Galileo; (b) Santillana sees the importance of a new concept of space stemming from the Renaissance artists; (c) Weber, Merton, Reid, Hookyaas and Oppenheimer point to the influence of the Reformation; (d) Marxists, not unnaturally, point to the importance of the economic sub-structure; (e) while Koestler sees it as much an accident as anything else. Some combination of these may be more convincing, and the above named combine secondary facets to their main emphasis.

Many commentators (e.g. (b),(c),(d) above) stress the importance of a conceptual change underlying the scientific theories. A.R. Hall notes that the scientific 'revolution' involved "the direct consequences of a philosophic revolution." (1959, p.76.) It was not simply a matter of new theories and observations (Copernicus was new in neither), but new perspectives. (Cf. Butterfield 1973/b, p.1.)

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1. In focusing on Copernicus I am well aware of the thesis of C. Raven (1953, p.7.) who argues that the history of science is not to be reduced to "a papal succession, Copernicus, Kepler, Galileo, Newton.."

Of course without new theories and data science could not develop. So the refinement of observation under Tycho Brahe was a key factor in driving Kepler on to his suggestion of ellipses – the crucial break from Aristotelian circles. But as Butterfield points out, observations are not enough. (1973/b, p.4.)

This great reorientation of thought occurred only once, and it did so in a period of general cultural change. Culturally many facets were involved in the new conceptual perspectives. (i)With the break from feudalism, society was turning to a more rationally orientated life-style. (ii) There was the emergence of a quantitative approach, a "counting and calculating spirit" (Zilsel 1973, p.88.) typified by the first literary exposition of double-entry book-keeping in 1498. (iii) In a period of exploration and rising commercial interests, the spirit of individual enterprise came to the fore. (iv) The rise of urban populations aided the development of technological inventions, such as the telescope and microscope.

Change was cultural, political and religious as well as scientific. The rise of capitalism has been noted as a key feature. (Cf. Bernal 1954, p.343f.) But a problem is encountered here for capitalism was based on free labour and the absence of slaves, yet:

> "In China, slave labour was not predominant, and money economy had existed since about 500 B.C. Also there were in China, on the one hand, highly skilled artisans and, on the other, scholar-officials, approximately corresponding to the European humanists. Yet causal, experimental, and quantitative science not bound to authorities did not arise. Why this did not happen is as little explained as why capitalism did not develope in China." (Zilsel 1973, p.99.)

Clearly social conditions alone are not sufficient to explain the scientific revolution.[2] Similarly, to claim the origins of this reorientation in men of genius is inadequate for as Bernal, writing of India and China, notes: "These areas had an abundance of extremely clever men, men of genius, and yet they did not make this particular step." (Bernal 1973, p.132.) It seems to me that the critical factor is the religious-philosophical perspective engendered in a culture – though this can never be seen in isolation from social conditions or intellectual leaders.

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2. The label 'revolution' is one I dislike as it seems to carry connotations of 1789. There was no absolute switch in the 16th or 17th centuries from old ways and methods to new. While some may contend that the new methodology in physics and astronomy can be seen as of general significance, science is not reducible to method.

2.1.2. The Scientific Roots of Change. The revolution undoubtedly started in the heavens and the field of physics. Chemistry, biology and other disciplines were later in experiencing their own modern reorientation. The shift in physics and astronomy can be broken down into stages. (a) An early period of preparation up to Kepler where the old system of Ptolemy was found wanting; (b) a period from Kepler to Galileo which saw the impact of the Renaissance and Reformation at a general level of cultural life; and (c) from here up to the Newtonian formulation which would last substantially for many years. There is no one critical figure or moment.

Observational astronomy began to revive in the 15th century under the stimulus of navigational needs and calendar reform. Among the precursors of Copernicus were George Purbach (1423-61) and Johannes Muller (1436-76). Muller was the first to correct observations for atmospheric refraction and use mechanical clocks in connection with astronomy. His work was continued by Walther and Durer. Thus renewed observations and planetary tables were made prior to Copernicus who curiously tended to rely on the older observations of Ptolemy.

Of pressing need was the reform of the Julian calendar. The Egyptians, using the 'gnomon' (a primitive device for measuring sun angles), had arrived at the length of year as 360 days, corrected to 365 days - the five extra days being holy-days. However 365 days were still too short and Julius Caesar reformed the calendar with astronomical advisers to 365¼ days. The Julian calendar was used from 45 B.C. right up to the time of Copernicus. By this time, however, problems had arisen for the seasonal year is 11' 14" shorter than 365¼ days, which meant that the equinoxes were about ten days adrift. The call for reform was not simply a technical concern - Easter had slipped out of place and the need for reform was theological as well as scientific. Copernicus was called in by Rome but declared that the whole of astronomy needed reformed first. When the calendar was in fact reformed in 1582 (the Gregorian) it used the work of Copernicus in its calculations.

Two factors unite and separate at this point, namely astronomy and cosmology. Kuhn (1957, p.103.) sees a bifurcation at Alexandria of these two into different strands of thought, while in the older Hellenic tradition they were held together. For the Hellenics, astronomy had to be true to the perceived cosmology; while for the Hellenistics this was not necessarily so and astronomy could be seen as a mathematical device for saving appearances, a tool for calculation.

But observations, on which astronomy are based, do not of themselves give cosmologies. There is a conceptual step between observations and fitting them into a cosmological framework. It is perfectly feasible for two different cosmological frameworks to provide equally good reference points for interpreting data. This is what happened at the time of Copernicus, for in terms of accuracy and prediction his system had little to offer over Ptolemy.

2.1.3. Reasons Against Change to Sun -Centredness.

2.1.3.1. Theoretical. The traditional conceptual framework put the earth at the centre for various reasons. Aristotle's theory of motion necessitated a central earth, as did his basic division into terrestrial and celestial arenas; and the theory of a full universe also required an earth-centred finite system. The primitive concept of space which saw it as up/down, east/west, also tended to put the earth at the centre, as does modern pre-theoretical thought which stands in opposition to the Newtonian concept of space as isatropic and homogeneous. Again there was the animistic view of reality quite foreign to a modern adult - though found in primitives and young children. Finally in terms of theory: it was firmly held that the stars influenced the life of men - hence the widespread practice of astrology - and this became meaningless with the earth displaced from the centre. Interestingly, Copernicus appears to be one of the few astronomers not to cast horoscopes.

2.1.3.2. Observational. From the viewpoint of common-sense observations it was obvious that the earth did not move. It was clear that the earth was big and heavy, and therefore if rotated would tend to fly outwards to pieces as do large rotating objects on earth. Or if something was dropped from a high tower, the tower would rotate away from the object and leave it trailing westwards. (Cf. Kuhn 1973, p.43.) On a more technical level there was the absence of parallax. If the earth moves, there should be a different view of the universe from the extremes of its orbit. But no change in the angle of the fixed stars was capable of being observed. The only way out of this was to put the stars a long way away and this involved distances beyond the comprehension of those early scientists. Parallax was not in fact discovered until 1838. Thus from the point of view of common-sense and technical astronomy, the earth was considered at rest.

2.1.3.3. Theological. There was possibly some transference of thought from the earth being theologically important as the home of the Incarnation to the physical realm. This, coupled with the Aristotelian outlook prior to Copernicus, created a powerful metaphysical perspective that militated against new theories. But this aspect is often over-emphasised.

2.1.4. The Ancient Theories. The ancient theories are not to be denigrated for they were perfectly reasonable to those who held them. (Cf. Kuhn 1957, p.3.) Of the basic ingredients - sun, moon, fixed stars and planets - the planets were the real problem. The planets (derived from a Greek word for wanderer) possess a westward diurnal motion with the stars, also moving east through them until they return approximately to their original position. They also stay near the eliptic - the apparent path of the sun in its annular motion through the sky. Their irregurality was noted as early as 1900 B.C. in Mesopotamia where the appearance and disappearance of Venus was recorded. The basic problem was the apparent retrogression of the planets which interrupted the desired uniform circular motion that they were thought to possess. The endeavour to solve this led to the complicated epicycles, excentrics and equants of Ptolemy.

2.1.4.1. The Two-Sphere Universe. This rested on the idea of an internal sphere of the earth for men, and an external sphere for the stars. Its origins are obscure but probably stem from the domed conceptions of the sky coming from the Egyptians and Babylonians, plus the Pythagoreen emphasis on circularity. Outside the sphere of the stars there was nothing - no space or matter - while between the two spheres were the various secondary spheres (or paths) of the planets. As this system developed it was able to explain and predict important celestial phenomenon such as eclipses. Nor is it to be thought that this is merely of historical interest for this is still the perspective used in navigation and surveying. (Cf. Kuhn 1957, p.37.)

Oneof the earliest attempts to derive an explanation of uniform and ordered movements among the planets was by Eudoxus (c. 408 - 355 B.C.), a pupil of Plato. He placed each planet on the inner sphere of a group of two or more interconnected and concentric spheres. These spheres rotated simultaneously on different axis and gave the observed motion of a planet. This was soon abandoned, but the importance of Eudoxus goes beyond his actual theory, for his homocentric spheres became a key factor in the development of cosmological thought. The reason being that his system was prominent during the lifetime of Aristotle.

Aristotle held to a motionless spherical earth at the centre of a finite universe. He divided motion into two realms and two types. There was the break between terrestrial motion (up/down in rectilinear form) and celestial motion (uniformly circular). On earth motion could be natural (the flame going up, the stone down) or unnatural (the flight of an arrow). The heavens, on the other hand, were divine and unchanging, consisting not of the four elements of earth but one, the aether or quintessence.

By the end of the Middle Ages this view was seen to fail to account for planetary irregularities and the varying distances of the planets from the earth. It was further under attack from the church for its teaching that an aspect of creation was eternal and unchanging. Nevertheless belief in the difference of celestial and terrestrial composition was not fully abandoned until spectroscopy developed in the 19th century.

There were several alternatives to this in Greek thought, and it was the recovery of the ancient texts setting these out that helped stimulate the search for a new and better theory. By Copernicus' time it was no longer a matter of Aristotle and Ptolemy; now there were the theories of Philolaus, Heraclides, Aristarchus and the atomists. The atomists did not hold to the earth as the centre and saw no uniqueness, rest or centre anywhere for all was a flux of changing atoms in an infinite universe; with Philolaus the earth revolved round a central fire; Heraclides suggested that Mercury and Venus circled the sun; while Aristarchus had posited the idea of a greatly increased universe in which the earth travelled round the sun in a circle. Apollonius and Hipparchus suggested the use of deferents and epicycles to explain the motion of the planets with respect to the stars. But most of these ideas were rejected (cf.2.1.3.)

<u>2.1.4.2. Ptolemy.</u> Ptolemy did in fact consider a moving earth but rejected it as inadequate because it did not square with Aristotle or reason. Thus he utilised epicycles and excentrics as previously posited, and added the equant. The epicycles kept Mercury and Venus close to the sun and provided the necessary mechanism for loops of retrogression. The excentric helped to explain the varying brightness

of planets (i.e. distance from earth). The equant provided for an apparent variation in the speed of the sun which retained uniform angular velocity about the equant point. His achievement was significant and his 'Almagest' was the first systematic mathematical work to "give a complete, detailed and quantitative account of all the celestial motions." (Kuhn 1957, p.72.) But as time passed, as epicycle was added to epicycle, excentric to excentric, the whole system became over-complicated. The endeavour to get precise 'fit' was destroying the simplicity and beauty the heavens were held to possess. Indeed by keeping adding on and rearranging the sizes of the above devices, virtually any motion can be explained.

2.2. N. COPERNICUS (1473-1543)

Born in Poland, Copernicus was a student at Cracow, Bologna, Ferrara and Padua, and thereafter canon at Frauenberg till his death. A typical renaissance scholar with interests in economics, medicine, mathematics, law, politics and the church, as well as astronomy, he was influenced at Cracow by Brudzewski (a critic of Ptolemy) and at Bologna by Domenico Novaro (professor of mathematics and astronomy). Novaro was a Pythagorean in his belief in the simplicity and harmony of the universe, and critical of Ptolemy; he encouraged Copernicus to study the classics and note the alternatives to the standard doctrine of Ptolemy; probably taught him techniques of observation; and encouraged him in a resurgent neo-Platonism. Despite this apparently critical background on Ptolemy, Copernicus became recognised as one of the great men of astronomy with an unrivalled grasp of Ptolemaic doctrine. His interest in this field being linked with navigation - a main stimulus for astronomy. So he was famous quite apart from 'De Revolutionibus' which was published as he lay dying in 1543. His earth-moving views had been held for many years previously and he had circulated among friends a short version of his theories in about 1530 - his 'Commentariolus'. This was followed in 1540 by the 'Narratio Prima' of Rheticus, a protestant from Wittenberg.

He was deeply dissatisfied with Ptolemy; but this is not to be construed as dissatisfaction with the past generally. There was no "wild spirit of rebellion." (Toulmin & Goodfield 1961, p.164.) Indeed he had great reverence for the past, quoting Pythagoras, Hipparchus, Philolaus and Heraclides in his defence. (Cf. C.Russell 1972/a, p.41.) He saw the inaccuracies of Ptolemy reflected in the calendar; regarded him as positing epicycles and excentrics that upset the homocentricity of Aristotle; as being too complicated, positing a separate scheme for each planet; and as rejecting the premise of uniform circular motion about the earth in the equant.[3] To this was added the problems of the recent discovery by Columbus of the New World, which struck a blow at Ptolemy's geography; and of 'precession' which was extremely difficult to explain on a static earth. Hence the factors involved were astronomical (precession), social (Columbus), and aesthetic (complexity), going far beyond a mere evolutionary step within a scientific discipline. But despite his dissatisfaction with Ptolemy, Copernicus faithfully adhered to his observations. Ptolemy's star catalogues lay before him as he worked and if Ptolemy erred on some point the chances were that Copernicus too would err.

2.2.1. His Method. The methodology of Copernicus is interesting for he failed to adopt an experimental approach, and where he did enter the field of observation-making was not very accurate. Gillespie (1967, p.22.) notes that he "studied the figures not the stars." Singer (1962, p.212.) comments that he was "not at all active as a practical astronomer." His results were attained in his study and involved a rearrangement of the Ptolemaic data, a shuffling of his system, and a search for a better point 'to hold' familiar to anyone who has ever worked with problems of epicyclic gearing. Indeed he used the methods and the 'facts' of Ptolemy to such an extent that Kepler could accuse him of interpreting Ptolemy, not nature. The method of Copernicus was based on economy, better mathematics, and symmetry - typical Pythagorean characteristics.

At root, however, his method and motivation were governed by his metaphysical outlook - an outlook that fitted his cultural milieu. "Copernicus was doubtless won over to the new point of view by its greater symmetry and coherence. These virtues would appeal to one imbued with Neo-Pythagorean ideas." (Wolf 1963, p.107.) He clung tenaciously to the Platonic-Pythagorean notion that immobility was a nobler thing than movement, and that the sphere was the perfect shape, confidently writing that:

> "First of all we assert that the universe is spherical; partly because this form, being a complete whole, needing no joints, is the most perfect of all." (In Hurd & Kipling 1964, Vol.I p.99.)

3. For a discussion of whether Copernicus was aware of Aristarchus' heliocentric theory cf. C.Russell (1972/a, p.43 and Hooykaas 1974, p.63.)

This fits into the neo-Platonic tradition which was to reach its height in the work of Kepler. The centrality and importance of the sun in this scheme of thought had various aspects that would have suggested themselves to Copernicus. "There were good Renaissance reasons, emotional rather than intellectual reasons, that made him choose the golden sun as the other place." (Bronowski 1973, p.196.) Note here his association with Italy where the sun was a centre of thought at that time, tying in with renaissance art and literature. Thus it is not surprising to find Copernicus writing in poetic imagery:

> "In the middle of all sits sun enthroned.....He is rightly called the Lamp, the Mind, the Ruler of the Universe... the Sun sits as upon a royal throne ruling his children the planets which circle round him." (In Kuhn 1957, p.179.)

<u>2.2.2. His Theory.</u> What then were his reasons for transposing sun and earth? To start with: <u>he did not finish up with the sun at the centre of the universe.</u> Certainly the earth moved in a circle round the sun, but the sun was not the centre of that circle. While the sun was given the central role, the 'true' centre became the centre of the earth's orbit. Remember that he did not deduce from observations the centrality of the sun; rather he shifted (a priori) the centrality of the earth to the sun and then modified this to fit the observations he had. The whole exercise being an attempt to get back to a truer uniformly circular motion. Thus the reason for the transposition was aesthetic rather than pragmatic, a matter of personal predilection, of taste.

This allegiance to the received doctrine of the necessity of circular motion has to be borne in mind when assessing Copernicus. From Book III, chapter four, of the original manuscript, the following quotation was later omitted. (From Koestler 1970, p.218.)

> "It should be noticed, by the way, that if the two circles have different diameters, other conditions remaining unchanged, then the resulting movement will not be a straight line but....what mathematicians call an ellipse."

Actually it was not an ellipse but a cycloid, but the point is that he rejected it as it did not conform to Aristotelian motion.

What, then, of his system? Its basic thrust was to impart a threefold motion to the earth. He gave the earth a diurnal axial rotation, a daily spin on its axis; an annular orbital motion round the sun; and an annular conical motion of its own axis, a gyration. This enabled Copernicus to develop a model of the heavens in which he could dispense with Ptolemy's equant.

However his system is more complex than it seems for he had to introduce minor epicycles to provide accuracy and greatly increase the size of the universe. He still used excentrics and assumed the universe finite, terminating in the sphere of the fixed stars. It is fair to say that his simplicity is "more apparent than real." (Singer 1962, p.214.) His system was not regarded as basically new and was called 'Pythagorean' or 'Aristarchan' by his contemporaries. (Cf. Kuhn 1957, p.169.) The simple fact was that his system was not as new or as revolutionary as later generations made it out to be, a feature noted by countless historians of science.

This is where it is necessary to distinguish between the Copernican theory and the Copernican system. The theory which placed the earth into orbit round a fixed point (not the sun) was taken up and was of dramatic consequence for science even if it had been arrived at for purely metaphysical reasons. His system itself was a patched up Ptolemaic picture which sought to recover the pristine purity of Aristotelian metaphysics via the aid of Pythagoras and the resurgent neo-Platonism.

The title of his book 'De Revolutionibus Orbium Coelestium Libri Sex' (The Revolution of the Spheres) is interesting for it implies spheres in which the planets and stars are imbedded, rather than free movement through empty space. Copernicus viewed the tradition as having become 'monstrous' and set out to improve it. But what was he improving? It was not the philosophy or cosmological framework - these he accepted - but the mathematics that had become 'monstrous', and it was this that he set out to reform. As Kuhn notes : "it was the reform of mathematical astronomy that alone compelled him to move the earth." (1957, p.142.)

Hence the purpose of 'De Revolutionibus' is open to debate. There was the difference between the philosophical and mathematical approaches: the first contemplated the 'physis', the true nature of things; while the 'art' of astronomy concerned itself with hypotheses that worked. Osiander, in his preface, followed the mathematical approach, but Copernicus seems to be looking for a physical reality. But it was a physical reality that would not infringe Pythagoras and concentrated on saving the appearances. (Cf. Mason 1962, p.128.) Astronomy had returned from Alexandria to Athens!

"The superiority of the Copernican system, therefore, was conceptual rather than actual." (Gillespie 1967, p.25.) Only future adaptation and improvement involving a total break with Aristotle and Ptolemy would vindicate the sun-centred universe. There were in the final analysis some advantages over Ptolemy in that the periods of revolution of the planets followed the same order as their distances from the centre - the bigger the circle the longer the year. Among other plus marks were the more natural explanation of why the sun and moon never reverse direction along the zodiac, and a more rational use of epicycles. But he failed to see the importance in his theory of the fact that in it the planes of all the planetary orbits pass through the centre of the sun - perhaps its greatest advantage. Kepler was left to discover this. The whole enterprise highlighted the basic problem of what in fact moved the earth and planets, and Copernicus gave no answer.

Was there a 'revolution'? Was Copernicus the last in the Ptolemaic line or the first of the moderns? It is not an easy question to answer, and historians have argued both ways, but on balance I think Copernicus can only be understood in the tradition of Ptolemy. To treat him as a modern leaves him open to savage, and valid, criticism on the basis of his lack of observation and blind acceptance of traditional doctrines. Perhaps a handy way to view him may be as Kuhn suggests: to see him on the corner from the old to the new by virtue of the fact that if he did not, in his system, revolutionise astronomical thought, then nevertheless as the sun-centred universe developed, climaxing in Newton, a new framework of thought was instituted. Toulmin and Goodfield (1961) pointedly deal with him in a chapter entitled 'Interregnum'. Butterfield comments that: "He closes an old epoch much more clearly than he opens any new one." (1973/b, p.32.) Hookyaas writes: "The Copernican 'Revolution' was no revolution." (1974, p.58.) Only a few such as Gillespie tend to treat him as a true revolutionary, claiming that "his ideas had to swim upstream against the tide of common sense." (1967, p.19.) This may be true, but it does not make him revolutionary, for as Gillespie himself notes:

> "It was not by eliminating epicycles that he thought to simplify and rationalise the procedures of astronomy; rather, it was by discerning the structure of things which befits the foundation of order. That foundation was the circle, the perfect figure. And it is the principle of circularity rather than of economy which conveys the inwardness of his vision of the world." (1967, p.24.)

But where in this have we advanced significantly beyond Aristotle or Pythagoras?

The more I study Copernicus, the less of a revolution there appears to be in his work or in his immediate impact. If the event itself was not of great significance, then the influence of it on the life and culture of the time cannot be of tremendous importance. This is of particular note for the question of the religious reaction; where mythology has accumulated; where there is a remarkable lack of consistent scholarship; and where reputable historians repeat facile speculations.

The revolution is supposed to be a sun-centred universe with a spherical and moving earth. But the classic objections to rotating and spherical earths had long since been countered, thus militating against the 'newness' of Copernicus (though cf. 2.1.3.2.). Copernicus' 'newness' rested primarily in reaching back beyond Ptolemy to the purer strands of Greek thought. Certainly he attacked Ptolemy for his inaccuracy, complexity and inconsis tency, but 'De Revolutionibus' is open to criticism precisely at these points. Thus though he might fear scorn for his 'newness' (from whom?), he in essence returns to the ancients. His system is a restoration rather than a revolution, and his style is marked by a conservative rather than a progressive attitude. Hence Kuhn comments that: "In an age marked by such obvious upheavals in political, social, and religious life, an innovation in planetary astronomy could at first seem no innovation at all." (1957, p.124.)

Though his ideas were not novel he confounded the popular Aristotelian idea that the heavens were divine and changeless with the earth the corrupt and imperfect centre. But the church could hardly object to this as it was one of the facets of Aristotle that did not square with biblical teaching. An attack on the eternity of the heavens would hardly cause a worried frown in Rome. It is therefore probably true to say that the geographical discoveries of the period had far greater impact on popular cosmology; while on the technical front, the appearance of the new star of 1572 was a far more shattering event than any theory of Copernicus. But whatever the inadequacies of Copernicus, from this point in time, the heliocentric universe was to become part of the cosmological scene and not merely a piece of speculation. "Copernicus eventually succeeded where Aristarchus had failed, because he was fortunate in his successors." (Toulmin & Goodfield 1961, p.164.) It may safely be concluded that: "The Copernican Revolution, as we know it, is scarcely to be found in the De Revolutionibus." (Kuhn 1957, p.154.)

2.2.3. Reactions to Copernicus.

2.2.3.1. The Scientific Response. Astronomers did not take readily to the new theory and Tycho Brahe returned to an earth-centred model based on a more observational approach. Most astronomers simply adhered to a central earth, and, while adopting parts of the Copernican model, either ignored the movement of the earth or dismissed it as absurd. Rarely did they mention his basic thesis with respect and even those who were more favourable tended to regard his hypothesis as false.

Before 1620 there were few Copernicans even in the field of astronomy. His hypothesis was "regarded by all but a few enthusiasts as fantastically absurd." (Hall 1970, p.14.) As late as 1623 in France, Marin Mersenne could publish a work in which he set out the weaknesses of the Copernican system (he became a Copernican about 1630). In England, William Gilbert made the rotation of the earth a central facet in his magnetical philosophy but refrained from letting the earth go free to revolve round the sun. There was sound scientific reason for this reluctance to accept the new theory for : "When Copernicus moved the Earth he knocked the bottom out of the old doctrine of lightness and heaviness; if bodies continued to fall they did so without rational reason for their behaviour." (Hall 1970, p.285.) Therefore, while Copernicus' theory was used for computational purposes, his basic thesis was not generally accepted. (Cf. 2.1.3.)

Erasmus Reinhold (1511-53) was the first to do service for the new theory. Eight years after 'De Revolutionibus' he issued a new set of astronomical tables based on Copernicus' work - the Prutenic Tables. These tables were not very accurate and the length of year determined from them was further out than in the older tables, but most factors gave an advantage and the tables swiftly became an astronomical prerequisite of the time. Copernicus' reputation correspondingly advanced. In 1576, Thomas Digges aided the spread of Copernicanism by writing a popular defence of the system; while the chair of astronomy founded in 1619 at Oxford stipulated that Copernicus and Ptolemy should be taught side by side. Digges was the first to actually try and describe an infinite Copernican universe - a step which Copernicus had not reached.

2.2.3.2. The Popular Response. Francis Bacon opposed many of the chief trends in science of the period and notably that stemming from the work of Copernicus. Opposition also came from the famous political philosopher Jean Bodin who was radical and atheistic enough to find himself on the Index twelve years after Copernicus had been placed there (i.e. in 1628). Of special importance was the reaction of the poets and popularisers, for most people did not come in contact with scientific treatises but were influenced more through the arts. (Cf. Kuhn 1957, pp.189-194.) Milton included a lengthy description of the Copernican and Ptolemaic systems in 'Paradise Lost' and though not taking sides worked out the details of his poem using the older, traditional framework of reference. Previously, in 1611, John Donne had conceded in the poem 'The Anatomy of the World' that the Copernicans might be right but all he could see coming out of this was evil! In the 16th century there were few non-astronomical reactions, and those that did respond were sceptical.

The reason for this opposition is not hard to find for at root it was not a clash of scientific theories but a confrontation of two worldviews.

> "It is safe to say that even had there been no religious scruples whatever against the Copernican astronomy, sensible men all over Europe, especially the most empirically minded, would have pronounced it a wild appeal to accept the premature fruits of an uncontrolled imagination, in preference to the solid inductions, built up gradually through the ages, of men's confirmed sense experience...." (Burtt 1951, p.25.)

2.2.3.3. The Theological Response. It is popularly believed there was a strong and violent reaction to Copernicus from the church which saw in his theories a destruction of God's universe; the earth's uniqueness; and the demotion of man to the role of a spectator. In general, Protestants are seen as leading opponents of Copernicus and Luther, Calvin and Melanchthon are quoted as typical examples. From the Catholic side there was no great opposition and Copernicus stayed respectable down to 1615 before the Catholic church thought there was anything amiss. Indeed there is a letter from Nicolaus Schoenberg, Cardinal of Capua, to Copernicus in 1536 which, in full awareness of his theories, encourages him to go ahead and publish. (L.B.Young 1963, pp.111,112.) This is in no way surprising when it is borne in mind that the church was not uncritical of the traditional view of the heavens.

It is necessary to note the historical fallacy of I.G.Barbour (1968/b, p22f.) when he sees Copernicus representing an attack on the church by displacing man from the central and important role on the stage of life. This has been admirably countered by Hookyaas (1974, p.67.) who points out that theology saw man as insignificant and lost.

The Protestant opposition to Copernicus is generally seen as bitter and basic. I will concentrate on Kuhn's presentation, but similar sentiments are found in Butterfield (1973/b, p.56.), Gillespie (1967, p.22.), Kearney (1971, pp.101-103.) and Reid (1966, p.19.). The heart of the matter rests on two oft repeated quotations from Luther and Calvin which Kuhn uses in a manner that seems determined to paint them in the blackest possible scientific light. I will return to this in a moment. Kuhn, to attack Protestantism, cites arguments from Reinhold's silence; Osiander's preface; and the fact that Rheticus was away from Wittenberg when he wrote his 'Narratio Prima'. (Kuhn 1957, p.196.) As for Reinhold's silence I can but note that many astronomers were silent on the matter and Reinhold did in fact utilise Copernicus in his computations, and as a convinced Copernican continued to teach at Wittenberg. Osiander's preface may be an attempt to cover up some supposed opposition, but it can equally and validly be the approach of one working from a different methodological stream from that of Copernicus; that is, one who sees the whole exercise as mathematical. Copernicus too may be considered this way! On the basis that Osiander wrote the preface to gain acceptance for what followed, it is difficult to tar him with anti-Copernicanism. It seems to me that Kuhn's argument is weak here for the fact remains that these three Protestants were instrumental in furthering Copernicus' system and are hardly fruitful ground on which to build a theory of general Protestant opposition.

To return to Luther, Calvin and Melanchthon. Kuhn cites Luther:

<u>Quote A</u>: "People give ear to an upstart astrologer who strove to show that the earth revolves, not the heavens or the firmament, the sun and the moon......This fool wishes to reverse the entire science of astronomy; but sacred Scripture tells us (Joshua 10;13:) that Joshua commanded the sun to stand still, and not the earth." (Kuhn 1957, p.191.)

Next Kuhn cites Melanchthon as writing:

Quote B: "The eyes are witnesses that the heavens revolve in the space of twenty-four hours. But certain men, either from the love of novelty, or to make a display of ingenuity, have concluded that the earth moves; and they maintain that neither the eighth sphere nor the sun revolves.....Now, it is a want of honesty and decency to assert such notions publicly, and the example is pernicious. It is the part of a good mind to accept the truth as revealed by God and to acquiesce in it." (Kuhn 1957, p191.)

Then, in most misleading fashion he continues:

Quote C: "Other Protestant leaders soon joined in the rejection of Copernicus. Calvin, in his 'Commentary on Genesis', cited the opening verse of the Ninety-third Psalm - "The earth is established, that it cannot be moved" - and he demanded, "Who will venture to place the authority of Copernicus above that of the Holy Spirit."" (Kuhn 1957, p.192.)

Quote A: Luther. It can in fact be questioned if these words were actually uttered by Luther. The phrase first appeared in Aurifaber's version of the 'Table Talk', while the earlier and generally more reliable Lauterbach notes for 1539 containing the same general passage omits the pertinent phrases. These accounts include the notes of others "and in this instance, we know that Aurifaber definitely did." (Dillenberger 1961, p.38.) The phrase itself, unpublished until twenty years after Luther died, does not square with "similar views elsewhere in Luther's writings" (C.A. Russell 1972/a, p.52.); while the attributed date of 1539 is significantly four years prior to the publication of 'De Revolutionibus' - though that does not necessarily mean that Luther had not heard the views of Copernicus. But from the dates and the fact that Luther died in 1546, it can hardly be the case that he mounted any systematic opposition to the new theories.

Assuming that Luther did utter the above phrase it can be construed as no more than an offhand remark by a rather volatile personality. As such it would seem unwise to try and build a case for general Protestant opposition to Copernicus from it. Indeed Luther writes: "I like astronomy and mathematics, which rely upon demonstrations and sure proofs. As to astrology, 'tis nothing." (1878, p.341.)

Quote C: Calvin. Calvin has suffered strong accusations of anti-Copernicanism by many modern authors and the above quotation is often cited as a case in point. Certainly Calvin wrote in many places, Psalms 19 and 93 for example, in a manner that assumed the correctness of the Ptolemaic system. But then for a theologian, this was but the equivalent of a contemporary theologian assuming the correctness of Einstein's theory of relativity. Calvin was simply operating within the consensus of astronomical belief for his age. In Psalm 19 he points out that we have not a scientific statement but one of God's accommodation!

Kuhn is in fact not quite fair for the above quotation, when looked up in his references, is found to be from Melanchthon's 'Initia Doctrinae Physicae' and not from Calvin at all! Indeed Calvin in all pertinent passages writes quite simply and calmly and there "is no evidence that he was defending it from vehement attacks." (Dillenberger 1961, pp.38-39.) Dillenberger notes that he can find no reference to Copernicus at all in the works of Calvin (1961, p.39.) Thus having failed to mention him the charge that he led a bitter opposition to Copernicus falls to the ground. In fact Luther and Calvin adopted a positive approach to science by using an embryonic principle of 'sphere-sovereignty' (cf.19.7.4.1,2. and glossary), thus distinguishing between the disciplines and maintaining that each had its own sphere of investigation. Science and Scripture were sovereign within their own province. This ties in with the use of the accommodation principle, the insistence that the Bible was written for the layman from a pre-theoretical standpoint and was not a scientific textbook even if it did contain scientific truths. Thus Calvin can write concerning astronomy:

> "Nevertheless, this study is not to be reprobated, nor this science to be condemned, because some frantic persons are wont boldly to reject whatever is unknown to them. For astronomy is not only pleasant, but also very useful to be known; it cannot be denied that this art unfolds the admirable wisdom of God." (1554, pp.86,87.)

Luther and Calvin had a positive view of science. Luther distinguished clearly between astronomy and astrology, accepting the former and rejecting the latter. Calvin likewise wrote his 'Admonition against the Astrology that is called Judicial'; while in the Institutes (1;5;2.) he asserts:

> "To investigate the motions of the heavenly bodies, to determine their positions, measure their distances, and ascertain their properties, demands skill, and a more careful examination; and where these are so employed, as the providence of God is thereby more fully unfolded, so it is reasonable to suppose that the mind takes a loftier

flight, and obtains brighter views of his glory."
(1560, p.16.)

Quote B: Melanchthon. Melanchthon was more negative but his background as a humanist entrusted with the educational aspect of the newly born Reformation needs to be remembered. He believed the decay of the church was tied to the break-up of the Aristotelian system and that only a return to Aristotle could unite the sciences and revive the church. Not surprisingly he opposed neo-Platonism. "Hence, Melanchthon's problem was not so much scientific or Biblical as it was philosophical." (Dillenberger 1961, p.41.) Yet while he has negative comments there are also favourable references to Copernicus - hardly epitomizing a crusade against science. Further, Melanchthon wrote letters of introduction for Rheticus, praising him, and though one of them holds reservations concerning his Copernicanism it also points out how Rheticus is missed at Wittenberg. Again he helped Reinhold in publishing works of Copernican nature - all of which gives little support to Kuhn's argument.

Thus of three key figures, only Melanchthon actively writes against Copernicus and even here it can hardly be construed as a general attack on science or astronomy. This episode provides a good example of the mythology that can arise, depicting a conflict situation between science and religion. (Cf. C.A.Russell 1972/a pp.52-54.) In the light of the reaction among scientists there was little for theologians to attack. As yet Copernicus had no evidential support, nor offered any specific theological challenge.

2.3. MARTYRS OF SCIENCE?

In the search for martyrs of science in the face of intolerant religious dogma three victims have been put forward - Servetus, Bruno and Galileo. (Cf. Singer 1926, p.122.) With the first two the matter is theological and philosophical and not scientific; while Galileo can be claimed to be not altogether innocent himself. Bruno (1548-1600) did make specific scientific contributions, but in the final analysis it was theological reasons, totally removed from the arena of science that condemned him. He denied particular providence in the acts of God and the possibility of miracles; claimed that prayer was a useless exercise; and implied that liberty was equivalent to necessity. This was compounded by the identification of God with the 'universal substance', thus binding

God to the universe in a pantheistic manner which denied Him as being over and above creation. (Cf. Gillespie 1967, p.67.; Hurd & Kipling 1964, Vol.I p.135.; Kuhn 1957, p.199.)

2.4. TYCHO BRAHE (1546-1601)

The next giant in the development of astronomy was hostile to Copernicus, rejected the sun-centred system and devised a compromise system of the universe which retained the harmony of the circle in the best Pythagorean manner while keeping the earth at the centre of the stellar sphere. In his system the five planets - Mercury, Venus, Mars, Jupiter and Saturn - revolved round the sun while the sun and moon rotated annually about a stationary earth. By including epicycles the three features of planetary motion were accounted for - that is loops of retrogression, variation of distance, and irregularity of motion with respect to the fixed stars. This may seem a backward step, but in the absence of observations to the contrary it was perfectly adequate. Kuhn comments that "judged purely by technical proficiency, Brahe was the greater man." (1957, p.200.) In essence the choice of earth or sun was a question of taste and: "The Tychonic system is, in fact, precisely equivalent matematically to Copernicus's system." (Kuhn 1957, p.202.) The only possible mathematical difference being that of parallactic motion which Brahe had searched for and not found. It was on the basis of observations that the earth was reinstated at the centre.

His contribution, however, went beyond his system and an order of priority can be arranged as follows - regular observations of the planets; observation of the new star of 1572; observation of comets; compilation of a star catalogue; his search for stellar parallax; his building of new instruments of observation; and his system itself. It was his observations that were crucial, rather than the system he formulated. It is interesting to note, however, that he denied the possibility of making observations without some hypothesis to guide and direct those observations.

The discovery of the new star of 1572 undermined belief in the incorruptibility of the heavens in a far more radical way than did Copernicus' putting the earth into orbit in the heavens. This observation was so revolutionary that Brahe noted: "I was so astonished at this sight that I was not ashamed to doubt the trustworthiness of my own eyes." (1573, p.594.) Here was hard data as opposed to cosmological speculation. When this was followed by the observation of comets in 1577, 1580, 1585, 1590, 1593 and 1596, which were clearly seen to have parallax that put them beyond the sub-lunar sphere, then the old Aristotelian cosmology was under severe strain. Thus Brahe was able to suggest that the path of a comet may be oblong - the first suggestion that celestial movements might not be circular. This was the legacy he gave to Kepler.

2.5. JOHANNES KEPLER (1571-1630)

Two basic aspects, the scientific and religious, combined to drive Kepler on in the face of immense difficulties. On the scientific side he was a convinced Copernican, one of the first to embrace this idea at a technical level, noting that "among the mass of students the idea is still unfamiliar." (Kepler: In Hurd & Kipling 1964, Vol.I p.122.) Also on a technical level he had the accurate observations of Brahe which were to play a crucial role. [4] On the religious side he was influenced by the neo-Platonic and Pythagorean themes on the harmony of the spheres and the music of mathematical formulas. He also, though a Lutheran, had strong leanings towards Calvinism. This religious aspect was important and Kepler himself made much of it. "Indeed the entirety of Kepler's momentous astronomical work was inspired by a fervant desire to discover the divine plan of the universe." (D.C.Goodman 1974/a, pp.101,102.) Kepler writes in a letter to Johann Herwart, dated March 16, 1598:

> "But I think in this way; since we astronomers are priests of the most high God with respect to the book of nature, it behoves us not to think of the praise of our abilities, but above all of the glory of God.....Enough for me is the honour of guarding, with my discovery, the door of God's temple, in which Copernicus serves before the high altar." (1598, p.603.)

His mystical search for mathematical harmony and simple numerical relations runs through his work. [5] This was coupled to an adulation of the sun which (cf. Copernicus) had roots in the neo-

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4. He was in fact Brahe's literary legatee.
5. In his 'Epitome Astronomiae Copernicae' (1618-21) Kepler outlines his concept of astronomical method. He envisages five basic aspects: (a) the observation of the heavens; (b) the formulation of hypothesis to explain (a); (c) the physics or metaphysics of cosmology; (d) the requirement to compute past and future positions of the heavenly bodies; and (e) the technical aspect of mechanics with respect to instruments for observation etc.. Of these he held that (c) was not essential.

Platonism of the Renaissance. This mystical quality is well characterised in one of his early works, 'Mysterium Cosmographicum', which appeared in 1596. So, looking for a pattern which the Creator might have used, Kepler came up with the idea with which he remained enamoured all his life, that the planetary spheres were in order proceeding outwards the circumscribed and inscribed spheres of the five regular solid figures - cube, tetrahedron, dodecahedron, icosahedron, and octahedron.

Assuming two conditions: a geometric aspect that the planes of the earth and Mars orbits intersect in the sun; and an aspect of physics, that the sun appears to have a power to move the planets - Kepler was ready to work out his main contribution in the field. After years of work he came up with a theory, but found that when he checked with Brahe's observations there was a discrepancy of eight minutes of arc, a discrepancy which before would have been quite acceptable. So he sacrificed another six years to solving the problem of the missing eight minutes. The way was open for Kepler's laws to be formulated: the first two published in 'Astronomia Nova' in 1609; and the third in 'De Harmonice Mundi' in 1619.[6] These were the first natural laws in the modern sense - precise, verifiable statements about universal relationships between phenomena given in mathematical terms. These laws were not absolutely precise although they stood the test of observation for two hundred years before any error was found. Nor must it be thought that Kepler presented them as the final ultimate answer, for these laws were but "snatches of melody in search of a symphony." (Gillespie 1967, p.37.) However for the first time a neat explanation was available, and reduced the 34 circles of Copernicus to 7 ellipses. Planets obeying these laws could be seen as incurring changes in speed, direction and curvature at each point of their orbit - changes which need to be explained by physical means. Kepler himself formulated two aspects of this: the 'anima motrix' whereby the influence of the sun weakens at a linear rate with distance in pushing round the planets; and (from Gilbert) the theory of the earth's magnetism. The former imparted circular

6. The laws are: (a) That planets move round the sun in ellipses, not circles, and that the sun is one of the foci; (b) That planets do not move uniformly but in such a way that the line joining planets and sun sweeps out equal areas in equal times; (c) The squares of the periods of the planets are as the cubes of their mean distances from the sun.

motion and the latter accounted for the elliptical motion. This was a new step for no one before had thought of the planets as driven, or of some force acting between the sun and the planets.

Hence we find a bringing together in a modern way the two aspects of observation and computation, combined with the sun-centred universe. Yet clearly his hypothesis and computation were guided and directed by his neo-Platonic guesses; while only his firm conviction in the worthwhileness of his task could have driven him on through the disappointments and frustrations he endured. His great achievement was to breech the Aristotelian circle and introduce the ellipse as part of a mechanical system that called for physical explanation. The stage was being set for Newton. (Cf. Kepler: In Hurd & Kipling 1964, Vol.I p123.; Butterfield 1973/b, p.66.)

2.6. GALILEO GALILEI (1564-1642)

2.6.1. His Scientific Contribution. Galileo brought to a head several strands in the scientific world and provided the final jumping off point for Newton; he was a key figure in the popularising of science; and on the religious front there was his famous clash with the Roman authorities. Several commentators see in him the true break with the past. (e.g. Singer 1962, p.249.) But he is not to be seen solely in the light of his astronomical work for his contribution to dynamics was probably more important. He laid dynamics out on an experimental basis of careful measurement which excluded all teleological factors, making the distinction between primary (dynamic) and secondary qualities.[7] His work in dynamics was not entirely original for Stevins, in the Lowlands, had prefigured quite a lot of the work for which Galileo is now famous. (Cf. Pledge 1966, p.59.)

However Galileo did establish the science of dynamics on a scientific basis and broke from the statics of the ancients. He actually got as far as the principles of the Differential Calculus but

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7. By 1590 Galileo had come to several objections against Aristotle in connection with falling bodies. There was the famous experiment where he dropped two different weights from the top of the leaning tower of Pisa and noted their identical rate of fall - thus disproving Aristotle that they should fall at rates proportional to their weights. The theory may be sound, but the story is mythical and if carried out would not have yielded the required results. Another myth is the claim that he discovered the law of pendulum motion by watching the motion of the candelabra in Pisa cathedral. The cathedral did not have a candelabra at that time.

failed to unfold it; while in his work are found in embryo fashion the three laws of motion(Newton); but Galileo did not have the mathematical genius to develop either of these facets. There is no space here to include details of his important work in the theory of acceleration, but suffice it to say that for the first time the dimension of time was included within the scientific structure. (Cf. Gillespie 1967, p.42.) The mechanical world-picture was beginning to take shape.

The area where he is best known and which caused his clash with the ecclesiastical authorities was Copernicanism. He was a convinced Copernican from early years but failed to make his position fully known for fear of scorn and ridicule. But like Copernicus it was fear of scorn from the Aristotelian academics in the universities and of the ignorant masses, not the church. Thus we find Kepler writing to him:

> "You advise us, by your personal example, and in discreetly veiled fashion, to retreat before the general ignorance and not to expose ourselves or needlessly to oppose the violent attacks of the mob of scholars." (1597, p.599.)

Kepler then goes on to encourage him to make his views public.

Eventually his position came out and this turned out to be of crucial importance for he wrote to the layman, often leaving the technical arguments aside. This aided the popular acceptance of the new theory of the earth's motion. Interestingly he ignored the work of Kepler and stuck rigidly to the theory of pure circular motion. But having rejected any possibility of heavenly intelligence or prime-movers, he began to move close to later ideas of inertia. Like Copernicus and Kepler there was in his thought an element of sun-worship. Yet he failed to produce demonstrable proof of the earth's motion, for his discoveries with the telescope, while falsifying Ptolemy and Aristotle, did not prove Copernicus.

In connection with his emphasis on experiments it is important to note that many of his experiments are more correctly described as 'thought experiments'. Experiments were valid, it would seem, only as long as they agreed with his theories and he would have little hesitation in rejecting experimental evidence if it seemed to count against his theories. (Cf. Butterfield 1973/b p.83; Losee 1972, p.57.)

The observations that he made with the telescope were swiftly published in a little work of 24 leaves called 'Sidereus nuntius' -

The Starry Messenger - in 1610. This did not proove Copernicus but struck a mortal blow at the theories of Aristotle and Ptolemy. His observations of continually narrowing sunspots led to the suggestion that the sun's orbit was itself rotating; turning to the moon it now appeared that its surface was pitted with craters, and he calculated heights of four miles for its mountains which cut right across the Aristotelian idea of perfection and smoothness in the heavenly bodies. Thus where Copernicus had put the earth in the same order as the heavens; Galileo made the heavens of the same order as the earth.

<u>2.6.2. Galileo and the Church.</u> The clash between Galileo and the Roman Catholic Church is one which is still far from settled. It is often regarded as a brutal hounding of the man of science who stood firm for truth until forced into submission by intolerant religious fanatics. Even in his submission it is said that he arose, defiant to the end, muttering the famous words: 'And yet it moves.' However from the 19th century historian, Karl von Gebler (cf. D.C.Goodman 1974/a, p.91f.), to more recently Arthur Koestler (1961, p.426.) there has been a move to present the church in a better light.

It is important to realise that the movement against Galileo was not simply a question of a clash between scientific theories and church doctrine. Pledge notes that: "The Aristotelian universities moved the Church to action" (1966, p.62.); others note the rivalry of a powerful Jesuit competitor in the area of observational priority; and yet others note the outraging of general public opinion at the concept of a plurality of worlds. It was not simply a case of dogmatic opposition from "fools and rogues" (Singer 1962, p.252.) and many intelligent men were opposed to the new theories for (to them) reasonable reasons.

Up to this point Copernicanism had been treated as a minor facet of astronomical speculation and the church had not felt constrained to take serious thought of the matter. But with the observational backing of Galileo's telescope, plus the popularising works he wrote, the matter was brought to the fore. Note should also be made of his attitude to the Bible which he regarded as primarily a book concerned with the salvation of souls not science, and could remark that the Scriptures tell us "how to go to heaven, not how the heavens go," (In D.C.Goodman 1974/a,p.105.) But unlike men such as Calvin, Kepler and Wilkins, he looked for veiled statements to back up the Copernican system.

(a) 1611: He visits Rome and enjoys 'great success' (Goodman, D.C. 1974/a, p.99.). He is well received and has a cordial interview with the Pope. Cardinal Bellarmine asks Jesuit mathematicians for their opinion on Galileo's discoveries and is told that they are more or less confirmed. For Galileo the problem is still the Aristotelianism of the universities, not the dogma of the church.

(b) 1612: The first recorded criticism from within the church, made by a Domincan monk, Lorini, who was not sure of Copernicus' right name. The criticism was however made only in private conversation and not in public.

(c) 1613: A discussion at the dinner table of the Grand Duke Cosmino II leads to a letter to Castelli by Galileo, and then a longer clarifying statement under the title 'Letter to the Grand Duchess Christina'. Despite Lorini's protest to the Inquisition little in fact comes of the matter. However it is still true that theological interest had been connected to the theories of Copernicus and the Inquisition is not happy.

(d) 1615/1616: Galileo goes to Rome to defend himself and while able to counter the Aristotelian and Ptolemaic arguments, fails to convince of the correctness of the Copernican system. Pope Paul V asks for an official statement on the subject and on the 24th February 1616 the Congregation of the Index decrees that the idea of a central stationary sun is 'foolish and absurd.' The works of Copernicus are not condemnded but are to be corrected. Other works of this nature (e.g. Foscarini) are put on the Index.

(e) Dec. 1616: Galileo is hardly yet under church persecution for on the 21st December a fiery sermon preached against him brings forth an apology from the Master-General of the Dominican Order in Rome. Caccini, who preached the sermon, had previously been disciplined for unethical behaviour, and appears throughout the Galileo affair as "an arch-villian." (D.C.Goodman 1974/a, p.103.) Galileo had been told not to discuss his theories except as a mathematical device or caprice. But in his 'Dialogue Concerning the Two Principal Systems of the World', published in 1632, it is plain that he takes the Copernican side because he believes it is physically true. Not unnaturally the Pope is angry at this flaunting of authority.

(f) 1633 : His trial duly begins on 12th April. Galileo, now almost 70 and ill, is allowed to stay in comfortable quarters throughout, rather than being confined to the prisons of the Holy Office which could quite well have been possible if the authorities so wished. Debate centres over a suspect minute from 1616. Galileo maintains that he had been told not to hold or defend the Copernican opinion, but the Inquisitor produces a Vatican file which states that he was not to teach or defend in any way this view. Everything turns on this and Galileo is finally manoeuvred into making an insincere concession, found guilty and sentenced.

It is safe to say that the affair retarded science in the Roman Catholic Church and Galileo's 'Dialogue' was not taken off the Index until 1831. But the fault of the clash was not entirely due to the strictures of an intolerant church. Galileo must take his share of the guilt as well, though this in no way mitigates the action of the church. Whatever the truth of the suspect minute, it is fair to say that Galileo had knowingly flaunted an injunction from his church superiors and displayed throughout "no humility". (Gillespie 1967, p.49.) He was condemned eventually, not for his scientific theories, but for failing to obey authority.

In conclusion it can be claimed that Galileo was less original than appears in terms of details, but led "in a policy of simultaneous attack on the whole front" (Butterfield 1973/b, p.68.) against the Aristotelian synthesis. But it was an attack that as yet could not achieve a decisive break with the past for Galileo was constrained by the ancient concepts of circular motion. His ideas were hampered by his knowing neglect of the crucial work of Kepler. This failure was critical for it would only be when the mechanics of Galileo became wedded to the astronomy of Kepler that the new scientific order would be firmly established.

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CHAPTER 3

THE INFLUENCE OF CALVINISM-PURITANISM ON THE RISE OF MODERN SCIENCE

3.1. GENERAL BACKGROUND

3.1.1. How Interpret? The impetus of the Reformation to science is often ignored or denied. Singer claims that: "The reforming leaders were, if anything, less sympathetic to scientific investigation than the Catholic leaders." (1926, p.122.) Merton claims that Calvin depreciated science (1957, p.26.). Many writers construct complex arguments to avoid attributing plus marks to the Reformation, getting themselves into academic contortions due to antipathy to what the Reformers clearly said and believed. (cf. 3.4.2.)

The question is: was the general Protestant attitude to science hostile, neutral, or conducive to the pursuit of scientific activities? Was there, or was there not, a dependent link between Calvinism and science; and if so, was it direct or indirect? It is wrong to dismiss the Reformation when in fact science blossomed exactly in those geographical areas which were the home of the Reformation - the Lowlands, England and Scotland. This does not detract from, or denigrate, any positive attitude in the Roman Catholic Church up to the end of the 16th century. Only with the philosophical reluctance to abandon Aristotle, and the Galileo affair, did Rome set herself against any positive approach to science.

During the Middle Ages the dominance of Aristotle and Plato led to the split motive of 'nature-and-grace' which through time had hardened into 'nature-against-grace' (cf. Appendix A). By 1500 this dualism led to confusion in scientific method. Fully fledged Aristotelians followed a deductive method; Nominalists tended to the study and classification of phenomenon; while practical scientists assumed a working uniformitarianism. But nowhere was there a rational, integrated worldview. This was impossible because of the inner antimonies of the dualistic motive. It is my contention that the Reformation (not only in ethos) brought stability to this situation - stability in that Calvin brought to the scene a unified philosophical motive of creation, fall and redemption which provided a solid doctrinal and metaphysical basis for the study of all aspects of life. It brought all the individual particulars of creation together and envisaged a coherent, created cosmos where nature and grace were interwoven instead of dualistically separated. (Cf. Dooyeweerd 1969, Vol.I p.516.)

3.1.2. The Puritans. The work of many historians (e.g. Candolle, Merton and Hookyaas) indicates a correlation between the rise of the scientific communities and the worldview engendered by Protestantism, especially the Calvinistic and Puritan streams. Prior to the reign of Elizabeth I, science in England was generally at a low ebb; while from 1560 onwards Puritanism began to develop (parallel to science) distinctive features. These features must not be confused as simply anti-establishment; nor must it be thought that the term 'Puritan' can be confined to non-conforming elements outside the Church of England. Indeed doctrinally there was little divergence in the initial stages between the non-conformers and the Church of England, both being basically Calvinistic in theology. Under Elizabeth the church was, generally speaking, Calvinistic; under Charles I the Puritans tended to Calvinism in opposition to establishment Arminianism; while in the Commonwealth there existed many non-Calvinistic Puritans. The problem of designation is compounded by the fact that at least four disparate areas were viewed as Puritan - church policy, theology, state, and morality. But it was not necessary to hold a 'Puritan' position in all four to be regarded as such. John Milton, for instance, was an anti-Arminian Puritan in politics and church policy, but an Arminian Puritan in theology (cf. Hookyaas & Lawless 1974/a, p.19.)

> "Even Francis Bacon, though from some points of view clearly no Puritan, shared many of the characteristic features denoted by the term. In his personal confession of faith, as well as in his advice to king James I, he clearly testifies to Puritan convictions. (Hookyaas & Lawless 1974/a, p.11.)

3.1.2.1. Theology of Social Implication. Puritans stressed that man was to glorify God, but do so by working to the 'good of their brethren.' This carried political overtones and meant that Puritan sympathies lay from the beginning with parliamentary democracy over against the Crown and church absolutism. They defended the civil rights of the individual, and political rights of Parliament, against the concept of the divine right of kings and church. Thus a practical, political and social outworking ensued from their basic theological tenets. In London they instituted mathematical lectures for the benefit of captains of 'trained hands' to counter the threat of the Armada; and when peace returned, redirected this to more simple nautical pursuits. They were to the fore in giving their blessing to voyages of discovery and in writing for the artisan.

Thomas Digges (1543-95) was a typical Puritan. Engineer and astronomer, he was one of the first to embrace the Copernican system, and in doing so found no incompatibility with his faith. Like his father, Leonard Digges the mathematician, he was as his epitaph puts it 'Zealous for true religion.' Digges epitomises the new experimental approach to science, boasting that he spent fifteen weeks at sea in order to test navigational theories. In Parliament he defended Hitchcock's Political Plat, a typical Puritan proposition involving the need for good preaching (to uplift the morality, vision and responsibility of fishermen) as an integral facet of improving the English fisheries against the Netherlands.

3.1.2.2. Educational Impetus. The only university to be founded in England between the Middle Ages and the 19th century was by Cromwell - Durham University which was 'for all the sciences.' The traditional universities were slow to adopt the teaching of science as a subject in its own right, but not so the dissenting academies. These academies, founded by non-conformists forced out of the universities by their refusal to submit to the Church of England, had a broader vision than the traditional institutions of learning. Similarly in France the Protestant academies were more scientific and utilitarian in outlook than their Catholic counterparts. While in America:

> "Correspondents and members of the Royal Society who lived in New England were 'all trained in Calvinistic thinking'. The founders of Harvard sprang from this Calvinistic culture, not from the literary era of the Renaissance or from the scientific movement of the seventeenth century." (Merton 1957, p.35.)

From this general ethos of the Puritan life-style, Merton (1957), Stimson (1935) and others have argued for a positive correlation between religious belief and scientific endeavour in this crucial forming period of the scientific tradition. Stimson (1935, pp.321-334.) argues forcefully that Puritanism provided the favourable conditions in England for the growth of modern science, especially through the emphases on the right of private judgement, a critical spirit, an insistence upon knowledge and reason, independence, uprightness of character, and the need for man to spend his time in a profitable manner.

3.2. THE SCIENTIFIC SOCIETIES

The 17th century saw the rise of the great scientific societies - specifically the Royal Society of London in 1662, and the French

Academy of Science in Paris in 1666. These societies arose because of the need for: cooperation between scientists; communication of findings to fellow workers and the public at large; and patronage. In France the Academy was a professional body with statutory responsibilities for technological supervision and improvement of industry. Official appointments were made and pensions paid by the crown. This spirit differed markedly from the 'honest amateurishness' of the Royal Society. By constitution the Academy had three pensioners and three students for each of its six sections - geometry, astronomy, mechanics, anatomy, chemistry and botany - whereas in the Royal Society the only qualification for membership was a "personal undertaking to be interested." (Gillespie 1967, p.111.) Yet it was the Royal Society rather than the more institutionalised Academy that was to dominate through the crucial forming period of the 17th century.

<u>3.2.1. The Royal Society: Its Origins.</u> This resides in the following.

<u>3.2.1.1. Francis Bacon.</u> (Cf. 3.5.2.; 4.3.) His influence is testified to from the beginning by members of the Society; it was the spirit of his empirical method which they were to follow. Bacon saw progress for man through science and art that recovered his rightful dominion over nature, and through religion as the way back to God. Both of these aspects were derivative of a deeply held faith in God, and it is quite erroneous to posit that because he kept the two activities separate that he thought of them as independent. The Book of Nature and the Book of Scripture were complementary, not separate, avenues of knowledge.

<u>3.2.1.2. Gresham College.</u> From 1620 onwards this London college came to occupy an important role in the history of science, providing the venue for informal meetings of interested parties. While some (e.g. Hall and Kemsley; cf. 3.4.2. and 3.4.3.) see this as a secular influence, it should be noted that:

> "Like most Londoners, the founders and supervisors, as well as most of the professors, were in favour of Puritanism which in those days was the parallel 'modern' movement in politics and religion." (Hookyaas & Lawless 1974/a, p.19.)

Henry Briggs, first professor of geometry, was strongly influenced by Puritan theology and was a friend of James Ussher and Theodore Haak. Like other Puritans he was keen on voyages of discovery and colonialisation.

This developed into the 'Invisible College' of Boyle. Stimson suggests that of the ten who constituted this group in 1645 only one, Scarborough, was evidently non-Puritan. (Cf. Merton 1957, p.31.) The fact that this group excluded religion in their discussion is an irrelevant objection as they met to discuss science. This feature is indicative of religious moderation, not indifference.

We see the development of this during the Civil War. The scholars at the Oxford Colleges were loyal to the king, but when the Puritans gained the ascendancy they were replaced by scholars from the more Puritan Cambridge University. "Then for a short period of about ten years science flourished at Oxford - and it flourished in a big way. The new scientists or virtuosi met in each other's rooms and discussed things." (Bernal 1973, p.192.) Among those involved were Boyle, Hooke, Wren, Willis, Wilkins and Sprat. That this should have happened in this particular setting is an historical fact requiring explanation, not glossed over as insignificant in the scientific tradition

<u>3.2.1.3. Puritanism.</u>[1] While the contribution of an individual is not necessarily marked by Puritan theology; it is my contention that the Puritan spirit, in the widest sense of the term, gave a general environment and set of mind that permeated through the science of England. Science was regarded as an aid for faith and there is little to suggest that religion was at fundamental variance with science or that both were independent developments of some common origin (such as a revolutionary spirit (cf. Barber 1952, p.58.)). It remains clear that, despite recent attempts to disprove any connection, the Puritan ethos was conducive to the pursuit of science. How else can it be readily explained that the origins of the Royal Society lie in the group meeting from Gresham College and subsequently at Oxford, when these groups were dominated by men who were either Puritans, or had Puritan sympathies.[2]

1. For a modern reinstatement of the Puritans which demolishes much of modern mythology concerning them, consult Fraser (1975).
2. It is further clear that Comenius and Haak were influential in initiating the Society, and many commentators accord to Haak the role of prime mover in instigating the Society. Barnett (cf. Kemsley 1968, p.79.) shows Haak as envisaging the Society going beyond the pursuit of scientific studies and deepening an understanding of others and the Creator through the progress of science.

3.2.2. The Royal Society. M.D.Stimson (1935), in her examination of the founding 119 members of the Royal Society at its legal incorporation in 1662, concluded that nearly half of the 87 for whom there is relevant information had a Puritan experience. [3] The Royal Society set the tone of science for many years and its origins were important. It developed, not from brilliant discoveries of which there were many, but through the honest and open discussion of men eager to comprehend and further the scientific quest. Yet also eager to "further those discoveries in their bearing on godliness, learning, and humanity." (Gillespie 1967, p.112.) To this end they started producing in 1665 the 'Philosophical Transaction' - a record of their work and endeavours. In the early days it ran into controversy over its tendency to indulge any theory no matter how frivolous. This no doubt stemmed from the Baconian tradition of gathering all the available data, and was soon replaced by a more rigorous approach to scientific questions. Those involved were, however, essentially religious men trying as best they could to further science and religion.

The fact that in the Royal Society, as in the Invisible College, religion and politics were not discussed does not obviate the underlying religious motivation and environment. This principle had already been presented in 1627 by Isaac Beekman, a staunch Calvinist in Rotterdam; while Thomas Sprat, the first historian of the Society, who clearly indicates that religion was not to interfere in scientific work, nevertheless sees science as a valuable aid to religion and posits an essential liaison between them. (Sprat 1667, pp. 370-372.)

A further feature in favour of a firm connection between science and Puritanism is that both the Royal Society and Gresham College were attacked in the 17th century because of their Puritan origins, especially by the conservative universities. This charge can be seen as a reason for excluding religious controversy from the formal discussion of those groups as they endeavoured to become established in the academic world. They existed primarily for science not to feed the extremes of religious enthusiasm.

3. Turner (cf Kemsley 1968, p.80.) extended Stimson's approach to cover the whole century, and fitted Boyle, Ray, Willis, Wilkins and even Newton in the 'puritan type'; largely based on their approach to the importance of the Bible.

So the virtuosi, the founders of the Society, were by and large deeply religious men of Puritan background. The Charter of the Society instructs its members to pursue their studies "to the glory of God and the benefit of the human race." Both these terms were strongly emphasised in the Calvinistic-Puritan stream of thought, and, while not denying their use on a wider front, became within Calvinism of particular significance. A man like Robert Boyle was deeply religious far beyond the bounds of mere convention and clearly envisaged science as a religious task itself. (Cf.4.4.)

The connection between faith and science is well put by Gillespie - even if his conclusion can be questioned.

> "The correlation of Calvinist behaviour patterns - hostility to tradition, utilitarianism, calculating self-denial, a calling to work in this world, rationality and the individual interpretation of experience - the correlation of these qualities with practical business and science.......is a very general feature of Western cultural history. There can simply be no doubt that protestant and bourgeois milieux have encouraged talent and ambition to rise through science, and that catholic and aristocratic milieux have inhibited the development of scientists. Scotsmen and Dutchmen flock through the history of science; Irishmen and Spaniards are scarcely to be found." (1967, p.114.)

But then Gillespie dissociates all this from belief and claims that "the forces are sociological, not doctrinal." (ibid p.115.) Surely the very facets he has enumerated as the Calvinistic behaviour patterns cannot be dissociated from the theological doctrines from which they derived? Gillespie here follows a common tendency - to see the connection, and then assert that it is but the sociological forces of the time at work. This avoids the need to answer the question as to where these sociological forces originated; for do not they themselves depend on the philosophical, theological and cultural spirit of the age? And in times such as the 16th and 17th centuries, religion was a dominant, if not the dominant, cultural facet forming the world-spirit of the age.

3.3. MERTON'S THESIS

3.3.1. The Background to Merton's Thesis. The connection between Calvinism and western culture has been classically formulated by Weber (1905). He suggested that the Calvinistic stream of the Reformation was conducive to, and nourished, the spirit of capitalism. He did not suggest a causal relationship, but that Calvinism gave an intellectual and ethical backbone to a feature that existed long before the Reformation. In his thesis, Weber does not use the word 'capitalism' in any pejorative sense, but simply as a designation for a cultural and social movement that actively pursued a profit motive from work based on the rational organisation of free labour.

Thus while religious ethics influenced the cultural setting and the economic structure of society, the culture and economics in turn influenced the religious structures of the day. This two-way influence tends to militate against any simple analysis and the picture becomes difficult to untangle. The issue is a complex one involving economic, ecclesial, social, scientific and political factors. It is therefore difficult to come to concrete conclusions, quite apart from the personal bias that distorts investigation.

Investigations on this topic date from 1873 when Alphonse de Candolle published a statistical analysis of the historical development of science. (Cf. Kemsley 1968, pp.81-87) This classified leading scientists of international reputation who were members of the French Academy of Science between 1666 and 1869. He determined that 71 out of 92 foreign members of the Academy were non-Catholic, which he labelled Protestant; 16 were Catholic; and the remaining five Jewish or indeterminate. Of 22 British members, none were Catholic. These figures have to be set alongside the general population totals outside of France which in 1873 were 107 million Catholics and 68 million Protestants. So there were 3 Catholics for every 2 Protestants in the general population; while in science there were 4 Protestants for every 1 Catholic. These figures, however, take no account of French scientists and Candolle extended his studies to examine the background of foreign members of the Royal Society in 1829 and 1869 - years when French members in the Society were high. He found that in both years foreign members of the Society were roughly divided between Catholics and non-Catholics; yet the general population outside of the United Kingdom was 139 million Catholics and only 44 million Protestants. That is: while there was a 4:1 ratio of Catholics to Protestants in the general population, there was a 1:1 ratio in the Society.

J.Pelseneer (cf. Hall 1963/b, pp.69,70; Kemsley 1968, p.82.) in 'L'Origine Protestante de la Science Moderne' - published in 1946 - extended this study of religious affiliations back into the 16th century and showed that of 250 individuals responsible for over 300 important scientific publications (from 1521-1600) the majority were either Protestant or sympathetic to the Protestant movement. For the last 20 years of this period the ratio of Protestant to Catholic authors became as high as 6:1. Thus he concluded that modern science was born of the Reformation. [4]

3.3.2. Merton's Thesis. Merton writes:

> "It is the thesis of this study that the Puritan ethic, as an ideal-typical expression of the value-attitudes basic to ascetic Protestantism generally, so canalized the interests of seventeenth-century Englishmen as to constitute one important element in the enhanced cultivation of science. The deep-rooted religious interests of the day demanded in their forceful implications the systematic, rational, and empirical study of Nature for the glorification of God in His works and for the control of the corrupt world." (1957, pp.20,21.)

The basis of his thesis is the belief that the main influence of Puritanism for science was that the natural world should be studied in order to glorify God. Other features aiding this were the acceptance of Baconian rational empiricism, and hence the utility of inquiry; the quest to improve social welfare; the Puritan stress on methodical industry; the use of reason to curb the passions which led to rigorous thought conducive to science; and the belief that creation possessed an order which inquiry would reveal. These had existed before as isolated features, but the Puritans brought them together and gave them a new and forceful emphasis. Merton claims to have shown the close association between Puritanism and scientific inquiry; and while conceding that Puritanism and science were separate systems of development, argues that there were sets of values behind both which were congenial and supportive.

Like Weber, Merton does not posit a causal connection; he does not claim that Calvinism or Puritanism brought forth science, only that the spirit of both was congenial, so forming a favourable climate for them to interact. The thesis itself is amply supported by the factual basis on which it is built. There are two questions that have to be answered: (a) why did scientific progress occur in 17th

4. Interestingly a survey concerning the background of American scientists points to their coming predominantly from the small denominational colleges of the Middle West. Cf. Gillespie (1967) p.115; Knapp and Goodrich (1952) p.274.

century England?; and (b) why was this largely in the physical and astronomical sciences? The answer of Merton lies in the cross-fertilisation between science and ascetic Protestantism, and he establishes this from the statistics available along with the testimony of other writers from within that period. Thus his argument revolves round the provision of a change in values associated with Puritanism that was crucial for the development of modern science.

While the motives indicated by the virtuosi may be rationalisations, the list of names who provide testimony is formidable - Boyle; Ray; Willughby; John Wilkins, one of the leading personalities of the Invisible College, who married Cromwell's sister and later became an Anglican bishop; Wallis: Haak; Papin, a French Calvinist; Sydenham and Petty, both followers of Cromwell; and Sir Robert Moray (or Murray), described by Huygens as the 'Soul of the Royal Society', of whom it could be said "religion was the mainspring of his life, and amidst courts and camps he spent many hours a day in devotion." (Dictionary of National Biography , XIII, p.1299.) These men were religious in a religious age, but it would be tendencious to suggest that they were only so out of customary usage when they talk piously and worshipfully of the 'glory of God.'

> "On the contrary, it is more often necessary to remind ourselves that these words were then seldom used without their accompaniment of meaning, and that their use did generally imply a heightened intensity of feeling."
> (G.N.Clark 1929, p.323.)

It becomes clear that some element of Protestantism pervaded science and motitivated men to pursue the study of nature. There was a concern for social welfare, furthered as man, through science and technology, learned to have dominion over the rest of creation. Labour and diligence were features of Puritan life-style, and as Sprat indicated the 'Art of Experiment' was akin to this in the province of science. In the Puritan spirit there was a blending of reason and practical usefulness. The basic values of diligence in one's calling and systematic labour were combined with a rational approach cultivated in order to remove excess passion. So in a real way the values of rationality and empirical need were brought together.

The Puritan attitude to the church involved the negation of the divine right of kings; the validity of lay participation; and an appeal to Scripture rather than ecclesial authority. Parallel with this in science there was the rejection of ecclesial interference in a sphere that was not its concern; a call for the lower ranks of society to be involved in a blending of crafts and theory (cf. Ramus and Boyle); and an appeal to the book of nature rather than received doctrines. But perhaps over all there was the common rejection of authoritarianism - there was to be an equal priesthood before God and before nature (Hooke stresses this). In religion there was to be a return to the Book of Scripture; in science a return to the Book of Nature.

> "What was needed was a constant interest in searching for this order in nature in an empirico-rational fashion, that is, an active interest in this world and its occurrences plus a specific frame of mind. With Protestantism, religion provided this interest: it actually imposed obligations of intense concentration upon secular activity with an emphasis upon experience and reason as bases for action and belief." (Merton 1957, p.28.)

Merton (ibid p.37.) then turns to the more general consideration of the 'Value Integration of Pietism and Science', and notes that pietist leaders such as Francke and Comenius emphasised the new science. Francke and Thomasius built the foundations of the University of Halle, 'the first German university to introduce a thorough training in the sciences.' Likewise the universities of Konigsberg, Gottingen, Heidelberg and Altdorf all reflect the ascetic Protestant interest in scientific endeavour.

In his 1957 revision of his thesis Merton concludes with four points. (a) While Luther and Calvin were indifferent and ambivalent to science, nevertheless there was deriving from Calvin a religious ethic which produced a mentality and value-orientation congenial to the pursuit of science. (b) As time passed the value-orientation "develops some degree of functional autonomy." (ibid p.54.) (c) Ethic and mentality can be effective even when "below the threshold of awareness of many of those involved in it." (ibid p.54.) (d) The 19th century clash between science and religion tends to obscure the less visible, but perhaps more significant relationship outlined above.

Before turning to recent interpretations of Merton, several problems should be noted. The fact of a high number of religiously orientated people within the Royal Society does not indicate _per se_ that this involvement stemmed from a religious ethic. The question is blurred by the additional factor that the commercial and industrial classes tended to Protestantism and science; while the more resistant feudal sections of society tended to Catholicism.

3.4. RECENT ASSESSMENTS

3.4.1. Three Viewpoints. There is no general consensus concerning the relationship of Puritanism/Calvinism to science.

3.4.1.1. Perspectival. Scholars like Merton(1957), Hookyaas (1973) and Dillenberger (1961) point to some form of parallel spirit in the two enterprises but refrain from drawing causal inferences. They see the Puritan ethic (derived from Calvinism) creating a suitable environment for science and refrain from developing this point. (Cf. 3.3.) Certainly this adequately accounts for the number of Protestants involved in the sciences; the general lack of interest in the Lutheran stream of the Reformation; and the upsurge of interest in England, Scotland, the Netherlands and the Protestant sectors of France.

3.4.1.2. Causal.(Cf. 3.4.4. and 3.5.) Others, such as Mason (1953) go further and indicate a more causal influence stemming from Reformed theology. There was "a certain congruity between the more abstract elements of the Protestant theologies and the theories of modern science." (Mason 1953, p.101.) He points specifically to the coincidence of centres of European scientific activity being consistently centres of Calvinistic ecclesiastical reform - such as the Puritans in England, the Hugenots in France, and Dutch Calvinism.

3.4.1.3. Disjunctive. (Cf. 3.4.2. and 3.4.3.) The third position rejects any firm connection (cf. Singer 1926, p.122.). Rabb (Kemsley 1968, p.86.), for example, suggests that both elements - science and religion - stem from a 17th century spirit of revolution.

3.4.2. D.S.Kemsley (1968, pp.74-102.) Reviewing the evidence of Merton etc., he concedes that a general Protestant predilection for science seems incontrovertible. However he goes on to disengage any firm correlation and enumerate areas which undermine Merton.

(a) He argues that Mason is erroneous in attributing the principle of a non-literal approach to Scripture (necessary for compatibility of science and religion) as a mid-seventeenth century phenomenon. Kemsley admits this approach was used by Calvin, and previously by others like John Colet and John Chrysostom. He goes on:

"In general, it cannot be said that new scientific theories or discoveries were either retarded by one understanding of particular biblical texts referring to nature, or, conversely, enabled to develop through a supposed enlightenment and emancipation from the bible of 'scientifically-minded' men." (ibid pp.89,90.)

I note: (a) that Mason is correct that while this tradition of interpretation was under pressure from literal approaches it did continue into the 17th century (cf.3.5.6.); (b) Merton does not argue from textual materials but from the general spirit of Calvinism.

(b) Kemsley then points to the confusion of terms - between 'Protestant', 'Calvinistic' and 'Puritanism'. It is true that for Candolle 'protestant' is a general category to cover non-Catholics and in this way it is fairer to talk of Protestant and not Puritan involvement. But here he himself confuses the use of the word Puritan. He instances Sprat as the propounder of "quite definite anti-Puritan statements" and attacks Merton, Hookyaas and others because they "neither refer to nor discuss Sprat's remarks." (ibid p.92.) But Hookyaas does discuss Sprat and sees a quite different picture! (Hookyaas 1973, p.144f.) Kemsley is in fact guilty of a restrictive usage of the word 'Puritan' when, for the post-Restoration period he is discussing, he should be allowing a more general usage of the term. Perhaps the designation of Calvinism is more precise than Puritan. But the fact is that generally those involved stand in the non-Lutheran side of the Reformation. There is a distinctive Calvinistic culture, but no equally distinctive Lutheran culture.

(c) Next he attacks the weight placed on the twin formula of 'the glory of God' and 'the benefit of man'. Neither, he claims, is indicative of Protestantism or Puritanism! (Kemsley 1968, p.93.) From this I conclude that he either has not read, or read without any empathy, such works as Calvin's 'Institutes' or the writings of a Puritan like Boyle. The fact that he instances usage of these terms prior to the Reformation is irrelevant - it was after all a re-formation, which implies a going back to the original sources, namely the book of Scripture and the book of nature.

(d) He criticises the argument that draws on the volume of literature concerning science produced during the Puritan era. He quotes figures (ibid p.95.) which show a percentage drop of scientific works between 1490 and 1640. If this means anything it counts not only against Puritanism's impact on science, but militates against the rise of science itself.

(e) Kemsley then points out that Merton's thesis plays down the positive role of other aspects of the Christian faith - the role of the Catholic church up to Galileo - and the non-sectarian nature of science. But it does not alter the fact that it was not until the 17th century, and primarily in reformed areas of Europe, that modern science blossomed. These facts require adequate explanation, not explaining away by raising different and more nebulous factors. On the secular side he appeals to Gresham College, the Baconian influence and Sprat's history. But these features were themselves bound up with the general Puritan worldview (cf. 3.2.1.) They therefore hardly count as secular, as opposed to religious grounds. Kemsley notes the distinction by Bacon of a Book of Nature and a Book of Scripture, and suggests this reveals that religion has no interest in science. But to distinguish between the spheres of theology and the natural sciences is not to negate the guiding principles of faith over both spheres. Indeed Bacon could write:

> "The prerogative of God extendeth as well to the reason as to the will of man; so that as we are to obey his law, though we find a reluctation in our will, so we are to believe his word, though we find a reluctation in our reason. For if we believe only that which is agreeable to our sense, we give consent to the matter, and not to the author...."
> (1974, p.200.)

(f) The failure of the older sciences was the lack of empirical assessment of the primary evidence and it was the pursuit of this, he argues, that led to the new science. But this leaves the question of why there should be this emphasis at this time.

(g) Lastly he extensively utilises Sprat to show that there is a dichotomy between science and religion. He goes on to conclude that: "Religious denominational labels are simply not sufficient to explain all known aspects of the phenomenon." (op cit p.102.) But Merton, Hookyaas and Mason do not claim that such a label is the sole explanatory agent. It is a Zeitgeist engendered by specific worldviews that is crucial, not their denominational label.

Kemsley's arguments seem to reveal a predisposition against religion and are an inconclusive discrediting of the thesis under consideration. The choice is to accept the statistical approach conjoined with the testimony of the scientists themselves, or a more complicated argument which strives for a disjunctive view.

3.4.3. A.R.Hall. In 'Merton Revisited' (1963) he attacks Merton's thesis in a positive philosophical way. Perhaps it is indicative of the approach of Hall that in his book 'From Galile to Newton' (1970) he attributes only about five pages (pp.344-349) out of 379 to the topic of 'religion and science'. Clearly he does not consider religion a significant feature and this is in fact a necessary corollary of his 'internalistic' approach to the history of science (cf. 9.3.1.) Merton envisages science as a cultural artifact in need of sociological explanation. Hall, however, claims that while this 'externalistic' approach was popular in the 1920's and 1930's, it is not so today. "Clearly," he writes, "externalist explanations of the history of science have lost their interest as well as their interpretative capacity." (Hall 1963/b, p.71.) This is a sweeping generalisation flatly denied by the recent Open University course on 'Science and Belief' which followed an externalistic approach.

Hall, by virtue of his internalistic framework, finds little time for religious or other cultural features. With appeal to counter-instances to Protestant involvement (which involves claiming that Bacon and Boyle were not Puritan in any sense of the word!) he argues that the link proposed by Merton is not essential to the development of science. (ibid p.59.) But he fails to make distinction between an efficient/sufficient agency, and a necessary cause. Like Kemsley, he is intent on underpinning the thesis of Merton and does not seem to appreciate the role of over-all worldviews or paradigms as recepticles necessary to contain all facets of thought, and which must be conducive to the flourishing of particular lines of thought before they will develop in a comprehensive and coherent manner. Hall compartmentalises thought and criticises Merton for not doing so; but worldviews must be looked at on a broad front and not as exclusive to some discipline.

Hall claims that Merton summed up the era of the socio-economic historian and that Koyré opened that of the intellectual historian. In arguing for the validity of the internalistic approach, Hall notes that "the history of science is strictly analogous to the history of philosophy. It is no accident that Koyré himself is a philosopher." He continues: "modern science is of its own intellectual right fundamental and absolute; it is not derivative from some other displacement in civilisation as the reformation or the rise of capitalism." (ibid pp.68,69.) This is a philosophical premise I find unacceptable as it presupposes that philosophy itself is neutral to cultural forces and takes place within an intellectual vacuum. (Cf. 11.6; 12.5; 20.3.)

3.4.4. S.Mason (1953) argues for a positive appreciation of the role of religious belief in the rise of modern science. He notes the benefit of no Inquisition in Protestant circles, which removed fear of reprisal and opened the door to free speculation concerning scientific matters. More germane, however, was the congruence of Protestant theology and ethics with scientific activity; the utilising of science for religious ends; and the agreement between the cosmic theories of modern science and Protestant theology. For Mason both Luther and Calvin set the tone for a more rational experimental approach to reality in their rejection of authoritarianism. Priestly authority was rejected as were the received traditions in the field of science (Galen and Aristotle). The Puritans stressed the religious obligation of 'doing good works' and placed scientific activity in this category. Mason gives the example of John Cotton whom he quotes as writing: [5]

> "To study the nature, and course, and use of all God's works is a duty imposed by God on all sorts of men; from the King that sitteth upon the Throne to the Artificer..."
> (Cotton: In Mason 1953, p.103.)

So Mason contends that a religious orientation permeated the consciousness of those that comprised the Royal Society at its inception, and concludes a more causal implication than Merton.

> "The anti-authoritarianism and empirical individualism common to the early Protestant and modern scientist gave at best a relation of congruity, while the later Calvinist promotion of good works gave a positive impulse to scientific activity."
> (Mason 1953, p.103.)

3.5. TOWARDS A CAUSAL-PERSPECTIVAL INTERPRETATION

Much confusion abounds concerning this topic, but those who oppose the thesis of connection fail to provide adequate alternatives. (Cf. Hookyaas 1974/a, p.25.) Care has to be taken over terms like 'Puritan' and 'Calvinism', but in general it can be said that those of this disposition were inclined, more than others, to take an active interest in science. Further, it was an interest that saw in science

5. Cf. Dillenberger (1961) p.129. Here he envisages Cotton as opposed to science.

an added support to faith in God. But it had not yet become, as it would with Deism, a foundation for faith.

I wish to suggest that the connection between science and religion is more causal than Merton allows. It seems to me wrong to reduce the influence of the Reformation to a mere ethos, for there were positive elements in its theology that require to be given their place. To this theology we can certainly add the general spirit of freedom and individualism and deep love of nature as God's creation. Whatever the view from our century, there were those writing in the 17th century who saw a positive benefit accruing to science from the Reformation. Richard Bostocke could claim that the Reformation of religion was indispensible to the reformation of medicine; while John Cotton, a puritan divine, could see the study of nature as a positive Christian duty. (Cf. Mason 1953, pp.100,103.)

The followers of Calvin reveal a positive, if somewhat mixed attitude towards science. Zanche maintained that theology should not be separated from physics and defended the Ptolemaic system against Copernicus - this in 1597. But not all theologians were thus inclined and : "In the Netherlands the most influential Reformed theologian of the beginning of the seventeenth century, André Rivet, was favourably inclined towards Copernicanism." (Hookyaas 1973, p.131.) Van Lansbergen also propogated Copernican theories, pointing out that Scripture was not "according to the real situation but according to appearances." (ibid p.123.)[6] Scripture might be the text for instruction in doctrine and righteousness, but not geometry and astronomy. In this context Kepler commented that "our senses, too, have their own kind of truth." (Kepler 1609, p.21f.) There was a recognised modal diversity of truths, poetic and aesthetic as well as scientific and doctrinal. Today we seem to have lost this and become enmeshed in a net of Euclidean propositions - the enshrinement of rationalised scientific propositions of one form or another as the only possible truth.

There are diverse doctrines and attitudes flowing from Calvin which may be construed as giving positive impetus to science.

3.5.1. The Creatorship of God. (Cf chs.22 and 23) Firm belief in the

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6. Hookyaas (1973) p.133f points to: "The relatively strong position of Copernicanism and New Philosophy in general in the Protestant countries is emphasized by the tendency of Roman Catholics.....to identify Copernicanism and Protestantism...."

creatorship of God led to firm belief in natural physical law. No longer was nature against grace, or under it, as lower to higher. Nature was not the home of the demonic but the creature of God. There was under Calvin a restoration of the Medieval law-idea (minus any concept of autonomy). Perhaps the key was the new motive of 'creation, fall into sin, and redemption in Jesus Christ' which replaced the dualistic motives. (Cf.18.1.1.2; Appendix A.) Instead of reality viewed as split into realms of nature and grace there was one unified structure of nature which grace permeated and penetrated in the sustaining activity of the Creator. (Cf. Wolters 1975/b) Within this motive law was seen, in all aspects, as derivative from God. Even the fall into sin could not obliterate the law-structure of the cosmos within which man must live and work. Law was the basic foundation for the reality, and an understanding by man, of the unity and diversity that existed in the created cosmos. (Cf. Reid 1966, pp.60,64.)

3.5.2. The Glory of God. Some claim that this concept is not peculiar to Calvin (cf. Kemsley). Indeed it would be strange if it were; but that does not obviate the fact that Calvin took this concept and made it the fountainhead of his thought. The 'glory of God' was revealed in nature as well as Scripture. He writes: "Meanwhile, being placed in this most beautiful theatre, let us not decline to take a pious delight in the clear and manifest works of God." (Inst. 1.14.20 - 1560, p.83.) Man, by understanding this creation, was more able to praise and glorify God in this life.

The theme of the glory of God expressly revealed in nature was utilised by Kepler who was himself accused of crypto-Calvinism.

> "I am speaking of the Book of Nature, which is so highly esteemed in the Holy Scriptures. St. Paul admonished the Heathens to reflect on God within themselves as they would on the Sun in the water or in a mirror. Why then should we Christians delight the less in this reflection, seeing that it is our proper task to honour, to revere and to admire God in the true way? Our piety in this is the deeper the greater is our awareness of creation and of its grandeur. Truly, how many hymns of praise did not David, His faithful servant, sing to the Creator, who is none but God alone! In this his mind dwelled reverently on the contemplation of the Heavens. The Heavens, he sings, declare the glory of God.... Thus, in what follows, let us free the very tongues of the heavens and of nature so that their voices may resound all the louder; and when we do so let no one accuse us of vain and useless efforts." (Kepler 1596 , pp.7,8.)

So there were two books that revealed the glory of God - Scripture and nature.[7] Since God is Creator and Sustainer man can, and is called to, understand all the works of God. But Calvin clearly saw that man was never capable of exhaustive knowledge. The law of nature "because of its divine origin is never wholly subject to human rational analysis." (Reid 1966, pp.66,67.) (Cf. Institutes 1.5.9; 2.2.13ff.)

3.5.3. The Cultural Mandate. (Cf.24.2.2.) It is in this setting that the call to work is to be seen. The mythology foisted on Calvin and his followers is that they saw themselves elected to salvation and hence worked hard so as to prosper and gain reassurance. Nothing could display a more fundamental lack of understanding of Reformed theology. The very suggestion smacks of 'salvation by works' - a theme which Luther and Calvin were totally opposed to. To read their works, or any of the great Reformed confessions, is to find a different concept of work. Hookyaas, commenting on the 'Netherlands Confession', notes that what is there enshrined is the reality of works as a fruit, not an exercise in self-reassurance. "These are not the words of tortured souls, but of those that have achieved liberation." (Hookyaas 1973, p.104.) There was a positive attitude to work - all work. Knowledge and ability were gifts from God. In fact there was a strong utilitarian emphasis that created empathy with the crafts and also united with theoretical aspects. Here was a worldview that at last united theory and crafts (cf. 1.3.4; 1.5.4; 1.6; 1.7.) Whether minister or cobbler, preacher or magistrate, all were called by God to work within their own sphere of calling to the glory of God. (Cf. Institutes 3.10.6.) This is illustrated in the life of Calvin himself where there is a broad spectrum of cultural involvement.

> "He lent the acumen of his mind and legal training to a codification of the city's laws, and to the best adjustment of its taxes....The city's health was the better for his aid in construction of sewers and the erection of hospitals. He concerned himself with the methods of heating and protection against fire; through him the weaving industry was revived." (H.O.Taylor 1920, Vol.I pp.423,424.)

7. Note the repeated usage by a modern reformed thinker like Schaeffer of the Baconian statement that man "fell at the same time from his state of innocency and from his dominion over creation. Both these losses, can even in this life be in some part repaired; the former by religion and faith, the latter by arts and sciences." (This quotation from Kemsley 1968, p.97.)

Connected to the mythology of work is the mythology of predestination. This is interpreted as providing a determinative causality in the area of man's relationship with God that had parallels with the rising mechanistic causality in science. (Cf. Hookyaas 1973, pp.107–109; Mason 1962, p.181.) This will not do. For Calvin predestination was under the area of salvation, not providence. There was in fact little tendency to determinism in Calvin and in this he was closer to Scotism and Oresme. Nor can this be seen as a restoration of Greek atomism, for the mechanistic philosophy that was arising emphasised the clever machinery of God who controlled all – a basic belief that was diametrically opposed to the blind fate of the atomists. God, not fate, ruled. This rule was now seen as direct and absolute; gone were the older hierarchies of power by which a series of intermediaries (angels) stood between man and God.

<u>3.5.4. The Doctrine of Common Grace.</u> (Cf. 19.3.3; 24.2.1.) This doctrine saw truth and value in the works and thought of all men, Christian or not, at all levels of cultural life. The Fall was <u>extensive</u>, not <u>intensive</u>, in its effect. Here again one feels at times that Calvin's doctrine of the Fall is not fully understood. Calvin can write that men still have:

> "some residue of intelligence and judgement as well as will. ....To charge the intellect with perpetual blindness so as to leave it no intelligence of any description whatever, is repugnant not only to the Word of God, but to common experience....Therefore, in reading profane authors, the admirable light of truth displayed in them should remind us, that the human mind, however much fallen and perverted from its original integrity, is still adorned and invested with admirable gifts from its Creator." (Inst. 2.2.12f. –1560, pp.131–133.)

Thus Calvin was willing to learn from the pagan and had a remarkably open attitude to many phases of thought. [8]

<u>3.5.5. The Priesthood of All Believers.</u> This doctrine helped to further a spirit conducive to science, for here the individual was responsible for reading the Book of Scripture and the Book of Nature by himself. Each was to find the truth and not to rely on external authority of church or tradition. It was in the application of this that the unlearned began to be utilised in the collection of

8. Indeed John Donne praised him, for whereas Melanchthon would assert 'it can be no otherwise...', Calvin would say 'it seems to be thus...' (Hookyaas 1973, p.120.)

data for some of the botanical and zoological sciences. (Cf. Hookyaas 1973, p.110.) Aspects that do not square with the 'Protestant Ethic'.

3.5.6. Scripture. Many have claimed that the Reformers were tied to a literalistic view that demanded a trenchant defence against the new science. This could not be further from the truth. Indeed in the 17th century, Voetius recommended a Roman Catholic commentary on Genesis rather than Calvin's because he thought Calvin was too loose in his approach to Scripture via the principle of accommodation. The charge of literalism is "not borne out by the facts." (ibid p.115.) Typically Wilkins claimed in the 17th century that we can derive neither Aristotelianism nor Copernicanism from the Bible as it was written in ordinary language. He used Calvin's exegetical principles and quoted him extensively. The Bible was only infallible from the pre-theoretical viewpoint; the truths of which were not to be confused with the truths of theoretical thought. A typical example is Kepler's explanation of Joshua commanding the sun to be still - from the pre-theoretical viewpoint it is the sun that moves. (Kepler 1609, pp.21-25.) Calvin's approach was an empirical one centred on a simple grammatico-historical exegesis over against the tendencies to spiritualise and allegorise. (Cf. Packer 1974, p.95ff.) The Bible was to be taken as meaning simply what it said from the perspective of the ordinary person. So when Joshua talked of the sun standing still it was quite simple - what scientist refrains from talking of a sunset. Of importance, however, was Calvin's method which was essentially empirical and had therefore obvious affinities with the methods of the new science.

3.5.7. General Ethos.

3.5.7.1. A Love of Learning. Reformers like Calvin and Knox are renowned for their educational vision. An important connection between education and science can be traced through P.Ramus (cf. Reid 1966, p.62ff.), a Copernican, who claimed that the experience of the unlearned was worth more than the authority of the ancients; stressed the need to gather facts and not make speculative hypotheses; and noted that at Basle the interest in science was due to the Reformation, though he could point to economic factors (mining) in Germany. Ramus helped to further the unifying of head and hand, and this influence on the Puritans was crucial.

> "Gresham College in England, Edinburgh University in Scotland and Harvard College in Massachusetts all began their existence primarily as Ramist institutions. Added to this Ramus received much attention in the Netherlands and Germany." (Reid 1966, pp.76,77.)

3.5.7.2. A Love of Nature. Along with the spirit of freedom that prevailed there was awakened a love for nature in many Protestant scientists. This was a corollary of the doctrine that all should learn to read the book of nature. An example was when Bernard Palissy, a Huguenot, bacame angry with workmen because of their maltreatment of trees.

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From these seven aspects it seems wrong to charge Calvin(ism) with a negative or destructive attitude to science for both his own works and the spirit he advanced were conducive to the pursuit of science. Calvin's stress on the objectivity of nature and the need to acquire the facts pertaining to the world are indicative of the basic roles that the scientist was to assume. But if Calvin stressed the need to read the book of nature, he was also clear in pointing out that there was always a surd which was beyond analysis. "This does not result from some obduracy of nature, but rather from the mystery of God the creator and upholder of all things." (Reid 1966, p.75.) In other words, while true knowledge was possible for man and should be sought, it was nevertheless not exhaustive knowledge. Today it is important to see this emphasis that knowledge does not need to be exhaustive to be true. Theoretical thought is by nature an abstraction from reality and as such can never be exhaustive.

3.5.8. Basic Weaknesses. There were however weaknesses in the Calvinistic position which must not be glossed over. The essential thrust was that of teaching, not research, and the impetus to science was left to the individual genius with little encouragement coming from the church. This was compounded by a failure to utilise mathematics and an emphasis on the qualitative as opposed to the quantitative with respect to natural phenomena. These features meant that the latent potential of the Calvinistic worldview was never fully realised. Indeed as the Reformation became dissipated in the humanism of the age (involving a regression to Aristotelianism) Calvinism became a diluted force in society.

3.6. REVIEW

In conclusion of this brief review of the immediate importance of the Reformation to science it is worth noting that a modern scientist of the reputation of Oppenheimer can claim that without the Reformation worldview science, as we know it, would not have arisen; and he goes on to claim that the worldview of today could not have given birth to modern science. (Cf. Oppenheimer 1962.) At a fundamental philosophical level Calvin appealed to the "philosophically homeless students of nature" because of his basic rejection of Aristotle and scholastic dualism. (Reid 1966, p.58.) He was the first to really offer any change on a systematic basis and this could not be lost even when Beza, like Melanchthon, tried to reinstate Aristotle. Thus men like Ramus, Palissy, Pare, Kepler and Bacon, as well as the Puritans, transmitted a positive stimulus to scientific endeavour.

But the initial thrust was lost, the unified motive dissipated, and the scholastic dialectical motive of nature-grace reinstated. (Cf. Dooyeweerd 1969, Vol.I, p.511.) Thus I conclude that the influence of Calvinism on science is indirect if we are referring to specific scientific doctrines; but direct if we are referring to the general culture created which gave birth to modern science. (This indirect-direct tension is as it should be within the doctrine of sphere-sovereignty - cf. 23.4.3.1.) It is here with the emphasis on a law-giver (necessary for the concept of laws of nature - cf.1.1 and ch.23.); the divine calling to unfold creation; and the bringing together of head and hand, that we find the origins of modern science.

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CHAPTER 4

THE RISE OF THE NEWTONIAN WORLDVIEW

4.1. THE MECHANICAL PHILOSOPHY

The 17th century saw the establishment of mathematics and physics. It was a century of creative insight with Isaac Newton providing the crowning synthesis. But though Newton's achievement stands out, it does not detract from the genius of others such as Pascal, Hooke and Huygens. In fact Europe was clearly divided into two scientific and philosophical communities - Britain and the continent - the one under the influence of Bacon and the other of Descartes. On the continent scientific work was centred geographically in the countries of the Reformation - Alphonse Borelli being the last of the great Italian scientists of the period. In Holland and France the philosophy of Descartes held sway and was one of the reasons that the critical problem of gravity returned to England. Various scientific models for the structure of the universe were being put forward as serious challengers to the traditions of Plato and Aristotle. Descartes and Borelli tried to explain all animal activity, as well as physical, on the basis of mechanistic models; Paracelsus, van Helmont and Francis de la Boe thought the key lay in chemical aspects; while Stahl sought a solution in a form of vitalism. But the key was to be the mechanical philosophy.

However there was no easy transfer from the thought of the 16th to the 17th century. The hold of Aristotle and Pythagoras was still strong and existed in tension with the rising atomistic doctrines. Thus Gilbert, for example, could remain caught in an Aristotelian world of organic structures. Pierre Gassendi, a convinced Epicurean, held that nature was not completely transparent to reason, and promoted the old atomistic ideal. He brought Democritus and Epicurus before the 'Republic of Letters' and ensured its integration into the increasingly mechanical outlook. The mechanical approach was not confined to physics and astronomy but involved a general spirit of the age which spread across the disciplines. It was the greatness of Newton to resolve the tension between the Pythagorean tradition of mathematical description and the atomistic mechanical philosophy.

A great variety of reasons combined to facilitate the acceptance of the mechanical philosophy. (a) There was the rediscovery of

Lucretius' famous 'De Rerum Natura' in the previous century. Despite the atheistic tag that was attached to such speculations, it was readily adapted by Christian thinkers like Boyle and Charleton who harmonized it with their faith in a positive and creative manner. This new mechanical way of looking at things was simpler and clearer than the traditional 'sympathies' and 'harmonies' - it was easier to visualize and therefore easier to accept. The corpuscle could thus become, under someone like Boyle, a basic building block of matter, capable of explaining "all the phenomena of things corporeal." (Brooke 1974/a, p.70.) (b) Another facet was that western civilization was moving into a mechanical age. This was the period of rapid development of machines - clocks, waterworks, water and air-pumps, etc.. Here, too, was the invention of the telescope and microscope, both of which were to play important roles in reducing the observable world to mechanical constructs.

(c) But if the factors influencing the new philosophy were practical and speculative, they were also religious. The influence of Calvin mediated through Kepler, Bacon and Boyle was significant. (Cf. Butterfield 1973/b, p.120.) There was a quest to show the greatness and orderliness of the Creator's creation. Science for many was primarily a religious aspiration. Brooke claims: "It is impossible to discuss the establishment of the mechanical philosophy without reference to theological issues." (1974/a, p.50.) Boyle could picture the universe as analogous to the great clock at Strasbourg.

> "Influenced by the reformed theology of the Calvinists it was therefore possible for Boyle to present the mechanical philosophy as an expression of the Christian philosophy of nature which stressed the primacy of God's sovereign will." (Brooke 1974/a, p.50.)

Hence by 1665 when Hooke came to write his 'Micrographia' he could confidently assert that there was only one philosophy of nature which was based on experience and was self-evidently true. The mechanical philosophy had come to rule the thought and labour of men - and despite the breakdown of the Newtonian framework and the advent of the new physics, it still does.

The exact connotation of the mechanical philosophy is open to question. At least three positions were posited. (a) It was seen as a new concept of causality requiring the reality of mechanical contact and impact which ruled out occult concepts such as action-at-a-distance. This belief would be a stumbling block for Cartesians in their acceptance of Newton's concept of gravity which apparently necessitated action-at-a-distance. (b) It could be a new concept of matter. Boyle emphasised the corpuscularity of matter as the basic structure of the material world - thus negating the older 'forms', 'spirits' and 'principles'. (c) It could be viewed as a new scientific method: the search for plausible mechanical models by which to explain phenomena.

The problem of the mechanical philosophy was that it swiftly lost sight of its theoretical abstraction from the real world and became autonomous. Thus Leibniz, following and developing Descartes, could envisage the human body as equivalent to a watch. This particular line of thought finished up with the logical conclusion of Diderot that there was no essential difference between men, animals, plants and things. The old ways of thinking were disappearing and in their place there was "a structure of forces and masses rather than a hierarchy of purposes." (Barbour 1968/b, p.35.)

4.2. RENÉ DESCARTES (1596-1650) (Cf.4.5.1.)

Today philosophy has often become derivative of science, a reversal of roles from the time of Descartes. Gillespie claims: "Descartes was the last of the great systematic philosophers to make integral contributions to science directly out of metaphysics." [1] (1967, p.94.) Descartes was a convinced Copernican but, shocked by the Galileo affair, refused to publish his controversial 'Le Monde' [2] for fear of trouble with the church authorities - though significantly he did not seem to consider omitting the offending passages. He was not, however, a 'free thinker' standing over against the church, but a devout man who was deeply disturbed by the difference between the biblical and his own account of creation. This disagreement of sequence led him to conclude that Genesis could not be understood literally. At the heart of his mechanical philosophy was the principle of inertia. All phenomena, he maintained, were caused by

1. As shall be made clearer in Parts II and IV such a disjunction as this is open to debate - although the general sentiment Gillespie is voicing is valid.
2. Published in 1662.

particles in motion and this led him to examine the cause and maintainance of motion, and the study of impact. He derived, from the homogeneity of the straight line and the immutability of God, a valid principle of inertia (cf. Descartes 1970, p.216ff.) But even man began to be seen as functioning mechanically at the organic level, while animals became little more than complicated machines.

> "The only difference I can see between machines and natural objects is that the workings of machines are mostly carried out by apparatus large enough to be readily perceptible by the senses......, whereas natural processes almost always depend on parts so small that they utterly elude our sense." (Descartes: In Crosland 1971, p.70.)

Yet it was no simple mechanical picture. It was not atoms that Descartes believed in but a continuous, though infinitely divisible, form. (Cf. Crosland 1971, p.67ff.)

His method was essentially an application of analytical geometry framed in rectangular (Cartesian) co-ordinates - algebra applied to spatial relationships.[3] So Descartes formed his model of the universe as a series of connected vortices. But it was a theory that the intrusion of comets destroyed. Nevertheless his theory was held in general, along with his methods, by many continental thinkers right into the 18th century and vortices were defended as late as 1752 by Fontenelle.

Descartes, in his radical reduction of doubt, had been forced to introduce God into his thought via the ontological argument in order to avoid a solipsism. Employing the concept of an infinitely good and perfect God he endeavoured to eliminate any discussion concerning final causes from science - he would restrict himself to the question how? instead of the more general and fundamental why? While many saw in him incipient atheism, Boyle pointed out that God was at the foundation of his thought (cf. Goodman, D.C. 1974/b, p.37.) - even if not introduced into his argument in a satisfactory manner. It was immorality and unbelief that led to atheism, not mechanical philosophy. Descartes had in fact conceded that some of the purposes of God might be known by supernatural revelation and it was because of this that, in controversy with Cartesians, Boyle could argue on the basis of

3. Mathematics has, of course, been at the root of all styles of analysis. "In each case, the crucial step forward from Aristotle involved a mathematical idealization." (Toulmin & Goodfield 1961, p.248.)

Scripture - pointless if the source was not accepted by both sides.

Descartes supposed that God ruled the universe by means of 'laws of nature' laid down from the beginning. Whatever the sociological roots of this term (cf. 23.2.) it implicitly carried with it the concept of a divine Creator who was alone supreme and above nature. So Descartes could refuse to talk of 'infinity' except as applied to God and warn of the danger of underestimating God and overestimating self. (Cf. Goodman, D.C. 1974/b, p.20.) This rests uneasily on the shoulders of his atheistic followers. Perhaps in terms of strict logic he brought God in by the backdoor, but he still believed in Him.

The implications of Descartes' teaching were probably more critical than those of Copernicus, for here was a new worldview as opposed to merely a new world-picture. The world was reduced to a piece of machinery which left man, with his rational soul, isolated from the rest of creation. It was a worldview that would be attacked on scientific and theological grounds. Newton did both. (Cf. Koyré 1965, pp.93,94.) He attacked the whole vortex system of Descartes and demonstrated mathematically that the planets could not swirl in the vortices laid out as this would infringe Kepler's laws of planetary motion - though others such as Huygens held to the vortex theory.

4.3. FRANCIS BACON (1561-1626) (Cf. 4.5.2.)

If Descartes is considered as the founder of modern rationalism, it is not unreasonable to take Bacon as the founder of modern empiricism, even if he did little in the scientific field and performed few experiments (though ironically he died of a cold caught during one). He possessed prophetic power and laid out his vision of a new scientific method in 'Novum Organum' (1620). While his method centred on gathering data, from which should stand out the 'truths of nature', it is too glib to accuse him, as is often done, of a simple 'bucket' approach (cf. 9.3.2.1.) However he certainly helped to set forth the widening intellectual gulf between the Middle Ages and the new empirical scientific method. Yet he saw the difficulties of actually ascertaining the facts of nature and posited the need for critical discussion. Unfortunately he missed the necessity to tie observation and discussion together. Thus while he advocated an empirical approach, he did not escape the reality that empiricism must be guided by some motivation, must choose which facts to study, and must from these facts form some hypothesis which can be tested against phenomena. To be told simply to 'observe' is meaningless.

4.4. ROBERT BOYLE (1627-91)

Boyle is typical of the English preoccupation with an empirical approach which endeavoured to relate scientific and Christian thought in a creative and constructive manner. He made an important contribution to science and, though there is little in his work that is original, exercised an immediate influence on Newton concerning the structure of matter by espousing a thoroughly corpuscular concept. (Cf. Gillespie 1967, p.105.) This was an atomism free from the 'wild fancies' of the Greeks. Indeed in his most famous work - 'The Sceptical Chemist' (1661), which effectively opened the modern period for chemistry methodologically if not theoretically - he destroyed the old concepts of the four Aristotelian elements. He is, of course, noted for his famous law which states that if the temperature remains constant, the volume of a gas varies inversely with the pressure; while the vacuum produced by an air-pump bears his name - 'vacuum Boylianum'. His method was one of patient observation, careful manipulation and long exposition. We can safely claim that in him the experimental procedure came into its own, though ironically he was guilty of the very use of experiment-as-demonstration with which he charged others. (Cf Butterfield 1973/b, p.131.)

In Boyle we have a rigorous interaction of science and theology. His belief in God lay at the heart of all his scientific endeavour which he saw in a positive Christian light. The practising scientist was called to master the intricacies of God's universe and was actually best off, when he had done so, to appreciate and praise God's work. (Cf. Brooke 1974/a, p.77.) The contemplation of nature was an appropriate preparation for the contemplation of God, not a substitute. So he could agree, in part, with the mechanical philosophy of Descartes but criticised him for going to the opposite extreme of Aristotle in negating final purposive causes. (Cf. Goodman, D.C. 1974/b, p.36.) This was an important issue for Boyle.

> "First, there may be some grand and general ends of the whole world, such as the exercising and displaying the creator's immense power and admirable wisdom, the communication of his goodness, and the admiration and thanks due to him from his intelligent creatures, for these his divine excellencies, whose productions manifest his glory. And those ends, because they regard the creation of the whole universe, I

> call the universal ends of God or nature...."
> (Boyle 1688, p.106.)

Boyle's piety was no sop to ecclesial authority. To a man who liberally supported missionary causes; who, though no linguist, went to the trouble to learn the original languages of the Bible to understand it better; and who inaugurated the Boyle lecture - sermons for the propogation of Christian interest in science - to such a man faith was paramount, expediency was not.

Nor had Boyle time for those who tended to pantheism, for while nature may be viewed as a machine it was in no way to be identified with the God who created it. In this he offered prophetic warning, for nature was to be increasingly deified and even today in many books is seen as <u>N</u>ature. Nature was a machine, but for Boyle it was not autonomous and while he appealed to the analogy of the mechanical clock one feels that the analogy of an electric clock would have better suited his views. Boyle was not so simplistic to evince that every object in nature revealed design; nor that all had been created for the benefit of man alone; nor that man could plumb all the mysteries of God. But he was clear that there was design in the universe and that it pointed to God. (Cf. Boyle: In Crosland 1971, p.121.)

His work therefore reveals no division of science and theology such as in the Baconian tradition. (Bacon was not a Baconian.) The two books - scripture and nature - were intimately and harmoniously related for Boyle. "I am persuaded, that nature will be found very loyal to her author..." (Boyle 1690, p.125.) 4 Thus his faith stood at the heart of all his scientific speculations and experimentations as well as in his personal devotional life. All was for the final glory and praise of God.

> "I think it my duty to prefer an important truth before my respect to any man, how eminent soever, that opposes it, and to consider more the glory of the great Author of nature, than the reputation of any one of her interpreters."
> (Boyle 1688, p.109.)

But for all this Boyle had set problems which could not be easily

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4. The following quotation from Boyle is significant. I am unable to locate the source. "...if we lay aside all irrational opinions, that are unreasonably fathered on the Christian religion, and all erroneous conceits repugnant to Christianity, which have been groundlessly fathered upon Philosophy, the seeming contradictions betwixt Divinity and true Philosophy, will be but few, and the real ones none at all."

resolved. In a clockwork universe, what was left for God to do? What was happening to the immanence of God? He was slowly but surely being shut up to the transcendent.

4.5. SCIENTIFIC METHODOLOGY

From the foregoing it is readily noticeable that the 17th century was dominated by two conflicting philosophical-scientific approaches - the one inductive-empirical, based on 'veracitas naturae'; the other deductive-rational, based on 'veracitas dei'. [5] The former was British and Baconian, the latter European and Cartesian. The former led to a rash of experimentation (under the Royal Society) which was often frivilous and highly questionable; while the latter led to an austerity and economy of thought that did much to facilitate success.

4.5.1. Descartes (cf. 4.2.). He followed the Archimedian ideal of a deductive heirarchy of propositions combined with Pythagorean and atomistic elements. From this basis Descartes had a vision of a single universal science that would cover and explain all. Like Bacon, the knowledge he posited was conjectural and not certain; but, whereas for Bacon pure mind could correctly read the book of nature, for Descartes it was God alone that guaranteed such truth. God was the first mover. This inverted Baconian procedure and made experiment an aid to explanation rather than a way of discovery or testing of hypotheses. Descartes tried to derive basic physical laws from purely metaphysical principles. A hypothesis was validated by its ability to explain phenomena within the framework of the basic laws of the mechanical system.

4.5.2. Bacon (cf. 4.3.). His central thesis was that to acquire knowledge about the world one must interpret the particulars of sense experience. The method was that of discovery, investigation and explanation of the properties of substances by means of controlled experimentation, using tables of instances from which inductive generalisations could be made. Popper suggests that the thrust of interpretation here is that of "spelling out the book of Nature" which leads inductively, not to conjectures about reality, but to certainty. (Popper 1972/a, p.14.) We are to prepare our minds to read the book of nature by purging them from preconceived prejudices, guesses

5. Another popular method of the period which I shall not discuss was that of Ramus who advocated the study of nature via the best writers. (Cf. Butterfield 1973/b, p.98.)

or anticipations. This was the process for the philosophical foundation of knowledge. In this setting Bacon was critical of Aristotle as well as various false ideas which hindered true invetigation of nature.[6] The only true demonstrations were experimental. But not by careless or wearily repititious experiments, rather by controlled and planned experimentation. The man of science needed his mind 'washed clean of opinions' and freed to gather data. Though Bacon fell into a 'cataloguing of facts' methodology his was no dead empiricism that negated the place and use of hypotheses. He saw the need for direction and organisation in what was to be done and thus a modern commentator writes:

> "What we obtain by this process, however, is only the 'Commencement of Interpretation' or the 'First Vintage.' Bacon presumably means by this what present-day scientists would call a 'hypothesis'; that is, a tentative interpretation which we enjoy as a guide to the selection of further instances." (Magill ed. 1968, p.379.)

It is only this that makes his criticism of Aristotle (for an uncritical collection of data and overhasty generalisation) mean anything. (Cf. Losee 1972, p.63.)

<u>4.5.3. Newton.</u> He affirmed the Aristotelian method of 'Analysis and Synthesis' (ibid p.81f.) and stressed the need to be rooted in a careful examination of phenomena. He wrote, against Cartesianism:

> "....although the arguing from Experiments and Observations by Induction be no Demonstration of general Conclusions, yet it is the best way of arguing which the Nature of Things admits of." (Newton 1952, p.404.)

This fits roughly, as would be expected, into the Baconian tradition. He goes on to distinguish principles derived from experimentation and from intuition; and sets out to primarily explain what happens - to describe rather than explain. Thus in opposition to Descartes he specified that it was the observed effects and laws of mechanical motion that should be the starting point for mathematical demonstrations in science. He sets out his rules for reasoning:

> " I. We are to admit no more causes of natural things than such as are both true and sufficient to explain their appearances.

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6. The idol of the tribe: the dominance of emotion over reason.
The idol of the cave: the attitude due to cultural conditioning.
The idol of the market place: distortions due to abstract words.
The idol of the theatre: received dogmas and methods.

" II. Therefore to the same natural effects we must, as far as possible, assign the same causes.
III. The qualities of bodies, which admit neither intensification nor remission of degrees, and which are found to belong to all bodies within the reach of our experiments, are to be esteemed the universal qualities of all bodies whatsoever.
IV. In experimental philosophy we are to look upon propositions inferred by general induction from phenomena as accurately or very nearly true, notwithstanding any contrary hypotheses that may be imagined, till such time as other phenomena occur, by which they may either be made more accurate, or liable to exceptions."
(Newton 1962, Vol.II pp.398-400.)

4.6. ISAAC NEWTON (1642-1727)

Classical mechanics is often referred to as Newtonian mechanics, but this is only a portion of the contribution of Newton to the scientific world. He is extremely important in the fields of mathematics and optics. Today some theologians and philosophers talk as though Newton was old hat, now irrelevant and effectively replaced by the theories of Einstein. But this is a simplisitic view for as a standard contemporary textbook puts it:

> "Newton's laws are 'true' because they are consistent with experiment. They successfully describe the motions of objects as small as molecules...and as large as galaxies... Thus, newtonian mechanics has an enormous range of applicability. Only for the submicroscopic world of the atom and nucleus and for speeds approaching that of light must the classical laws of mechanics be supplanted by the more nearly correct mechanics of the quantum theory and the theory of relativity."
> (Weidner & Sells 1975, p.96.)

Newton formulated the differential and integral calculus, the binomial theorem, showed that colour was an intrinsic property of light and not of the refracting medium, invented the reflecting telescope, and observed the phenomenon known as Newton's Rings. He also did some work in the field of chemistry and though he has been accused of alchemy this does not seem proved. He did all this apart from his most well known contribution in the field of mechanics. In the pursuit of his mechanics - the laws of motion and gravity - we are faced by the majestic ability of Newton to invent casually as he goes along, mathematical tool after mathematical tool, in order to facilitate the ease and rapidity of his work. These tools of calculus have become the mathematical backbone of applied science.

As he himself remarked he was indebted to those who had gone before, breaking the new ground and indicating the paths to be followed. He drew on Galileo for the mathematising of kinematics, the law of acceleration and the concept of inertia; Kepler for the crucial laws of planetary motion; Descartes for many of his early speculations and his clear statement of rectilinear inertia (Koyré even argues that Newton derived from Descartes a theological impetus (cf. Goodman, D.C. 1974/b, p.23.).); Borelli for his theory of centripetal attraction between sun and planets; Bacon for his methodological distrust in natural philosophy that excluded experimentation; Hooke (though reluctant to acknowledge this) and others that the law of attraction was an inverse square one; and on Boyle for his conception of the structure of matter.

Crucially he followed Descartes in accepting the ideal of Euclidean straight line motion, as opposed to circular concepts, which posited that no object was to have a privileged place in the universe - no centre of the universe round which all else naturally circled. Thus he was able to take the hypothesis of attraction suggested by Borelli and Hooke, still in the form of a driven machine and mathematise it on the basis of the free spin of planets.

The laws he formulated were carefully derived from the phenomena by means of mathematical reasoning. But behind the mathematical generalisations it needed creative imagination to synthesise the differing aspects: to unite the abstract and continuous conception of space with the concrete and atomistic conception of matter; to bring together theory and experiment; physics and astronomy; physics and mathematics. (Cf. Hall 1970, p.289.)

Yet in the final analysis it was no simple mathematical synthesis, no mechanistic world that Newton postulated, for the ultimate forces were spiritual. Neither gravity nor matter were ultimately independent of the God who had created all things and whose sustaining power alone kept them in existence. This tied science and theology in an unacceptable way for many. [7] It is significant that the Cartesians found difficulties right into the 18th century in accepting the scientific theories of Newton because of their theological and philosophical premises and implications. Important figures like Leibniz and Huygens were implaccably opposed to the philosophy that was thus tied to the general theories of Newton.

7. However it should be noted that Newton said that "the laws of God and the laws of men, are to be kept distinct." (Newton 1950, p.49.)

However: "The mind of Sir Isaac Newton was one of the glories of the human race, and one of its mysteries." (Gillespie 1967, p.117.) This is even more forcefully brought home when we realise that he did most of his creative work in two periods (1665-66 and 1685-86) which together amounted to a mere three years (cf. Newton undated.) It was in these three years, linked by long years of study and reflection, that the knowledge of heaven and earth was united in the mathematical structure of classical physics. It was Lagrange who is supposed to have said; 'There could only be one Newton, there was only one world to discover.'

<u>4.6.1. The Principia.</u> It was 1687 when the world first saw the decisive 'Philosophiae Naturalis Principia Mathematica', normally referred to as 'the' Principia as if there were no other principles for physics. Gillespie notes that in a sense this is true. "For that book contains all that is classical in classical physics. There is no work in science with which it may be compared." (1967, p.137.) Remarkably, it was writeen in about 18 months. No other scientific work equals it in "originality and power of thought, or in the majesty of its achievement." (Hall 1970, p.306.) No other book so changed the whole edifice of science or approached its authority in justifying the mechanical picture of the universe. It was a synthesis that could only be wrought once in the history of science.

The crux of the problem revolved round the necessity to show that motion in an ellipse, with speed varying so that the instantaneous acceleration is at all times directed to one focus of the ellipse, necessitated an inverse-square law of acceleration as the determining condition. This was the stumbling block up to Newton. The older theories had simply held that bodies fell to the centre of the universe (the earth) or followed perfect circular motion - here gravity was considered to be a property of position as opposed to a property of matter. With the breakdown of the Aristotelian worldview the scene was open to new theories. <u>Gilbert</u> posited the magnetic attraction of the earth and attacked the concept of the geographical point of matter as significant, holding that gravity was indeed a characteristic of matter. <u>Kepler</u> turned the problem into one of attraction and posited his three laws round which any future explanation would have to be formed. His theories were revived in 1666 by <u>Alphonse Borelli</u> (the same date as Newton's first creative period) who suggested that the elliptical orbit of a planet was the resultant of a balance between opposing forces — the force of gravity between planet and sun, and a centrifugal force which tended to move a planet away from the sun. Huygens had already discovered in 1659 that a centrifugal force was needed to maintain a body in circular motion but failed to make the transfer from terrestrial to celestial mechanics. Huygens' work was not published until 1679, and Newton seems to have carried on his own work quite independently. Roberval was in fact the first to point to the theory of universal gravitation, but, like those other advocates who followed him, could not derive any proof for this theory — that had to await Newton.

Assuming Galileo's principle of inertia, that the unimpeded motion of a body is uniform speed in a straight line, the problem of explaining the heavenly movements in mechanical terminology resolved into: (a) the derivation of a law governing the centripetal force needed to bend linear motion under inertia into elliptical motions; and (b) the demonstration that gravity could provide the required force to constrain the planets in closed orbits. This whole problem of the interpretation of Kepler's laws had become the intense preoccupation of the Royal Society. Involved in depth were such giants as Wren, Hooke and Halley. Eventually in 1684 Hooke claimed to have a complete explanation but failed to bring forward proof to back this up. Part of the problem was that the ellipse seemed too neat an answer. Both Kepler and Hooke thought at first that the orbit would be more complex than that of a perfect ellipse. The first two laws of Kepler were however perfectly exact dynamically — not approximations as Hooke took them to be.

So Halley journeyed from London to Cambridge to consult Newton. Without mentioning his own, Hooke's or Wren's, speculation on the subject, he asked Newton what curve the planets should describe on the supposition that gravity diminished by the square of the distance. He was amazed when immediately told — an ellipse. Newton said he had worked it out, but could not find the necessary calculation in his papers. "While others were looking for the law of gravity, Newton had lost it." (Gillespie 1967, p.137.) But under the stimulus of Halley he reconstructed his proof and forwarded it to him in November. From here, under the goadings of Halley who ultimately provided the finance to publish, the 'Principia' began to be formulated.

In the controversy between Hooke and Newton over this topic, Hooke's scientific stature has risen during the last few years, though this in no way diminishes the achievement of Newton. Whereas Descartes claimed that the planets were pushed round by some form of corporeal impact, and Borelli claimed that the planets had a natural tendency to move round the sun; in Hooke the explanation of planetary motion became a problem of applied mechanics equivalent to the principles involved in terrestrial problems such as the pendulum and projectile. Therefore Hooke and Newton both made the important step of suggesting that the force drawing planets to the sun, and the moon to the earth, was the same as that which caused things to fall on earth.

Despite the insight of Hooke, the master stroke belonged exclusively to Newton. It was he who solved the fundamental problem concerning the force which keeps the planets in their elliptical orbits and derived the mathematical relationship between sun and planets which yielded the force of attraction varying as the inverse square of the distance between them. He showed that one universal force kept the planets in the orbits; held the satellites in their orbits (i.e. moon, satellites of Jupiter etc.); caused objects to fall as observed and also held objects on the earth; and finally caused the tides. This was the law of universal gravitation ($F = mm'/D^2$). Newton had succeeded in doing what his contemporaries could not - namely the provision of a mathematical deduction which pro ved the inverse square law. The break with Aristotle was complete. Instead of natural circular motion there was linear; instead of one law for the terrestrial and another for the celestial, both were brought under one universal set of laws; instead of force yielding constant speed it was seen to give constant acceleration. But: "There is no mathematics - whether algebra, geometry, or the calculus - to justify this bold step. One can say of it only that it is one of those triumphs that humble ordinary men in the presence of genius." (Cohen 1961, p.118.)

This was a tremendous advance in the range of explanation and the degree of prediction. Astronomical predictions became intelligent and led to the discovery of other planets such as Neptune (sought to account for what would otherwise have been irregularities). (Cf. Kuhn 1957, p262.) It explained the necessity to shorten the length of a pendulum nearer the equator in order for it to still beat seconds; and so to the prediction that the shape of the earth is an oblate spheroid.

It also affected other sciences giving new significance to the concept of weight which lay at the heart of chemistry. But as well as these 'technical' influences, his theory had the result of mechanising the world-picture and worldview with disastrous effect, opening the door to naturalism and deism in a way quite alien to his own beliefs.

But care in interpreting Newton is necessary and one feels that some have not exercised a requisite balance in presenting his views. Newton himself did not formulate an autonomous mechanical worldview. He cautiously refrained from mechanising his own gravitational force and this is crucial in understanding his theological perspective. For Newton, like Boyle under the Calvinian influence, the very concept of laws of nature presupposed a divine law-giver. Thus his development of a mechanical philosophy must be seen within the framework of Christian thought which stressed the primacy of the sovereign will of the Creator. Indeed aspects of Newton's thought were not in the first instance identifiable with mechanical philosophy. His concept of gravity seemed to posit the existence of some form of action-at-a-distance. This smacked of occult properties residing in matter and was taken this way and rejected because of this by Cartesians. There was also the problem of the vacuum or void which seemed to posit the philosophical problem of the existence of nothing! Newton in fact spoke very carefully of gravity and while at times positing the influence of some 'aether', in general tended to hesitate to make any positive statement as to its cause. He refrained from hypothesis where he had insufficient data. (Cf. Kubrin 1967, p.160f.)

<u>4.6.2. The Laws.</u> Turning to his famous laws, the statements he called 'Axiomata sive Legus Motus', we find the basic statements which are reproduced in the textbooks of today. These laws he saw, not as Newton's laws, but nature's or more correctly God's. The three statements should not however be divorced from the eight definitions with which he preceeded them in the original version of his work. (Cf. Hurd & Kipling 1964, Vol.I pp.180ff.)

> "Law 1. Everybody preserves in its state of rest, or of uniform motion in a right line, unless it is compelled to change that state by forces impressed thereon.
>
> Law 2. The alteration of motion is ever proportional to the motive force impressed; and is made in the direction of the right line in which that force is impressed.
>
> Law 3. To every action there is always opposed an equal reaction: or the mutual actions of two bodies upon each

other are always equal, and directed to contrary parts."
(Newton: In Hurd & Kipling 1964, Vol.I p.193.)

The first law is Galileo's law of inertia defining an inertial frame – a reference system in which an isolated body moves with constant velocity. The second law applies for observers in inertial frames and gives a procedure for measuring an unknown force. In other words: law 1 is the law of inertia; law 2 gives that acceleration is proportional to force. Law 3 is the principle of the equivalence of action and reaction. This raised the question of absolute and relative time and space of which Newton wrote:

> "I. Absolute, true, and mathematical time, of itself, and from its own nature flows equably without regard to anything external, and by another name is called duration: relative, apparent, and common time, is some sensible and external (whether accurate or unequable) measure of duration by the means of motion, which is commonly used instead of true time; such as an hour, a day, a month, a year.
>
> II. Absolute space, in its own nature, without regard to anything external, remains always similar and immovable. Relative space is some movable dimension or measure of the absolute spaces; which our senses determine by its position to bodies; and which is vulgarly taken for immovable space; such is the dimension of a subterraneous, an aereal, or celestial space, determined by its position in respect of the earth.... (ibid p.185f.)

This distinction between absolute and relative time and space would be the metaphysical chink into which later criticism would bore. The distinction between 'true motions' of bodies in absolute space and time from the 'sensible measures' of these motions suggests a separation of reality and appearance, which interestingly provided a bridge from Plato to Kant. But care must be taken not to derive from Newton claims of absolute certainty where he in fact makes careful reservations.

Thus, while he adduces theological and physical arguments for the existence of absolute space, he was uncertain of locating bodies in that space. His arguments stemmed from the concept of creation 'ex nihilo' which posited for him a recepticle within which created matter was distributed. (Cf. Torrance 1969/a.) On the physical side he advanced his famous 'bucket' experiment. But he "admitted that there may be no single body which is at rest with respect to Absolute Space, and which may serve as a reference point for measuring distances in this space." (Losee 1972, p.86.) Whatever his reservations he laid out space and time in some form of absolute grid and gave an unreal simplicity to our perceptions of things.[8] It would not be for another two hundred years that Newton's formulation would begin to go awry.

4.6.3. Atomic Theory. Newton's basic conception of matter was corpuscular. Galileo had made the distinction between primary and secondary properties; Descartes reduced matter to the equivalent of extended being. However Newton, making the distinction of primary and secondary, emphasised the concept of force as the key rather than matter, and saw matter as chiefly consisting of extension, mass, mobility, inertia, hardness and impenetrability. Again his starting premise was the existence of the Creator and hence matter depended, for him, as in all things, on God. God was the creator of matter in the first instance and His will was necessary for its continuance in existence (cf. Newton: In Crosland 1971, p.76.)

4.6.4. Hypotheses non fingo. Newton was not a Newtonian - his followers were. It is perhaps a feature of great thinkers that they do not conform neatly to the system-builders that follow them. The problem with Newton was that, while he started from God in his thought (as well as the free will of the human spirit), his method of mathematical-mechanical analysis swiftly became a metaphysical construct of reality. "A technique of investigation was on its way to becoming a total account of the world; a method was being turned into a metaphysics." (Barbour 1968/b, p.36.) Thus while Newton might say he did not deal with absolutes "many of his followers did not possess such modesty" as they carried his models and techniques into every conceivable sphere of study. (Reid 1966, pp.31,32.) Yet Newton's attempt to distinguish a body of definite objective science from the areas of speculative thought where he held reservations is difficult to maintain in practice. All thought must start from initial metaphysical presuppositions whether conscious or unconscious.

The change in method that was being introduced into the field of scientific work and extended through the whole range of theoretical thought is obscured by the use or misuse of certain phrases from Newton. Centring round his supposed claim to 'invent no hypothesis', it is claimed that he advocated a purely empirical approach and that,

8. As Bronowski comments, the prophetic words were left for Leibniz to utter: "I hold space to be something purely relative, as time is." (1973, p.241.)

whereas his forerunners tried to describe the motions of the heavens, he became the first to explain them. To a certain extent this is true, but the view is propogated without qualification by scholars who should know better. Bronowski, for instance, states that while Newton could speculate in private concerning the Bible he stuck to his theme of 'no hypotheses' in public. (1973, p.234.)

But if attention is given to the words of Newton the picture becomes somewhat different. Holton and Roller quote Newton's 'General Scholium' for the second edition of the 'Principia' - published in 1713.

> "But hitherto I have not been able to discover the cause of those properties of gravity from phenomena (observation and experimentation), and I frame no hypotheses....And to us it is enough that gravity does really exist and act according to the laws which we have explained, and abundantly serves to account for all the motions of the celestial bodies, and of our sea." (Newton: In Holton & Roller 1958, p.205.)

They rightly point out that Newton is here simply rejecting the introduction of additional speculation into a theory that already had a great deal of experimental and predictive corroboration. While agreeing that the fundamental cause of gravity might well plumb greater depths, they were no concern of Newton at that time for he had no ability or necessity to go deeper into the problem.

> "Nor did he feel that his theory suffered by this inability. The purpose of physical theory per se is not to find ultimate causes but to explain observables in terms of a consistent and fruitful scheme of concepts and derivations based on observation, and that he had done." (Holton & Roller 1958, p.205. cf. Gillespie 1967, p.126 and Crosland 1971, p.61f.)

It thus becomes nonsense to attribute 'hypotheses non fingo' as a vague generalisation to which Newton adhered in all situations. Indeed his usage of the term 'hypotheses' does not conform to modern usage. I.B. Cohen (1966, pp.138-140.) has suggested that he uses nine meanings of the term! Inter alia the 'hypotheses' as attacked by Newton are what might be considered 'occult qualities'. In an era rife with speculation Newton had no desire to tie his empirical and mathematical work to speculations for which there was no measurable procedure known. He seems to have particularly abhorred the use of ad hoc hypotheses. He saw Descartes' theory of vortices in such light. (Cf. Prosch 1966, p.75.)

In the famous phrase - 'I frame no hypotheses' - at the end of the

'Principia', Singer suggests that Newton was returning to the original meaning of the word (1962, p.295.) In Plato and Hippocrates it was used as a postulated scheme to be accepted in order for discussion to start (Gk: hypo-thesis - a thing placed under). Here hypotheses were merely fictions, examples of which are constantly used in legal circles, or 'convenient presentations of remote possibilities.' In fact Newton does not hesitate to use the term in a positive way - making nonsense of the charge against him. His use of hypotheses is hardly surprising in one of the great speculative thinkers of all time, he framed countless hypotheses.

Thus while his aphorism is quoted freely it should not be taken as an absolute statement that characterises his attitude. His own rules of reasoning (cf. 4.5.3.) were after all rules concerning how to form sufficient scientific hypotheses. Holten and Roller paraphrase the first rule: "Nature is simple, therefore we should not introduce any more hypotheses than are necessary to explain the observed phenomena." (1958, p.169.) In the final analysis the empiricists of the day knew that Newton feigned hypotheses and were unhappy about it.

4.6.5. Newton's Theology.

> "It would be a mistake to think of Newton as a brilliant scientist who happened to be a Christian, or who made extensive contributions to natural philosophy despite his eccentricity as a theologian......his Christian faith had a considerable bearing on the way in which he interpreted his scientific discoveries. He was even described by one bishop as 'knowing more of the Scriptures than them all'." (Brooke 1974/a, p.87.)

Newton spent a great deal of time studying and writing commentaries on Scripture, especially in apocalyptic areas. He did not keep his science and faith in separate compartments - they fertilised each other in a positive manner. [9] Some certainly (e.g. Biot and Laplace) tried to separate his science and theology but this cannot be done in any fair treatment of his writings. Newton actually tended to give primary place to his religious activities and looked on many of his scientific endeavours as a spare time occupation!

9. I am well aware that Newton also said: "That religion and Philosophy are to be preserved distinct. We are not to introduce divine revelation into Philosophy nor philosophical opinion into religion." (Newton 1950, p.58.)

The problem was that Newton called on God to solve what turned out to be scientifically solvable problems. But once again care is needed or we will misunderstand the true position of Newton. His stance was not simply a 'God-of-the-gaps' mentality, though this has often been foisted on him. Nevertheless the tendency to introduce into explanation the reality of God, led to suggestions that fall strangely on modern ears. Suggestions that if God had not given the planets their tangential velocity then their orbits would have been less harmonious than they were; or where (so it is claimed) God is the true Agent of gravity in the 'Principia' - though this viewpoint needs care for in a sense God as Creator is the sustaining agent and ultimate source of all for Newton.

While Newton was intensely interested in the realms of science and religion it is clear that he did not see the object and method of the two as similar. Although "for Newton in the last analysis, the realm of science was dependent on the God of religion." (Burtt 1932, p.131.) Thus behind the scientific phenomena the primary explanation for the order, simplicity and beauty in the world was a religious one. Even the 'Principia', in this light, was seen by him as having apologetic value.(Cf. Burtt 1932, p.135.)

Newton did not restrict empirical objectivity to science and see religion as an area for fruitful hypotheses concerning ultimate explanations. God was neither hypothesis nor object of science, but the ultimate ground of all. God was, as Creator, a necessity, not an interesting addition to science; and God, as the foundation of all in His creating and sustaining work, could not be reduced to a gap.

> "Newton's God was certainly not a <u>mere</u> god of the gaps; he was not defined by his scientific functions. He was the God of radical Christian theism. When there was a phenomenon like gravitational attraction which Newton could not explain, he knew that it must have its origins in God, since in the last analysis <u>everything</u> did." (Brooke 1974/a, p.93.)

It is therefore against this backcloth that Newton's remarks to Bentley should be read.

> "Why there is one Body in our System qualified to give Light and Heat to all the rest, I know no Reason, but because the Author of the System thought it convenient....the Motions which the Planets now have could not spring from any natural Cause alone, but were impressed by an intelligent Agent. (Newton 1756, p.133.)

In these letters to Bentley, Newton argued that the whole frame of nature implied the existence of God and his continual work in providence. For Newton nothing happened by chance, nothing was arbitrary, nothing was a law unto itself outside the control of God. Both the 'Principia' and the 'Opticks' insist that, despite the apparent diversity of nature, all was traceable to a few fundamental laws of nature. But these laws were not innate in nature for they were only so because God had willed them. Thus: "The perfection of the laws implied for him a lawgiver, as the perfection of the architecture of the universe implied a cosmic design." (Hall 1970, p.308.) Like Descartes and Boyle, he saw the mechanical structure of the universe as an argument against atheism, not for it. The universe was not the result of blind unreasoning evolutionary chance but "the Effect of Choice rather than Chance." (Newton 1756, p.136.)

Here was where philosophic and theological controversy were joined, especially with the Cartesians. For Descartes, Boyle, More, and Newton, God was seen to work in creation <u>and</u> providence; it was not a question of God setting the machine in motion and then leaving it to run itself. Interestingly, to guard against a loss of providence Boyle even objected to the term 'laws of nature' as this implied some sort of autonomy in nature. But others, like Huygens and Leibniz, saw the work of God only in creation. Leibniz argued that the need for God to interfere implied that he had not done a good enough job in the first place. Newton's position was that the world was in a state of decay, a theme which he tied to his cosmogony that the world was not eternal. It was probably in part to counter the accusation of Leibniz and for fear of incipient atheism that he went on to talk of the periodic reform of God in ordering the universe. Thus while acts of free creation and continuing providence were a structural whole for Newton, it was not easy to set this out in a neat and logical fashion.

The conclusion is that whatever else Newton was he was not a mechanical philosopher <u>per se</u>. If Leibniz pointed to a choice between every event as 'mechanically caused' or a 'perpetual miracle', Newton rejected this as a pseudo-antithesis. His world went far beyond the simple materialism of a mechanical universe.

> "One often reads in intellectual histories about the 'Newtonian World-Machine'. The world-machine was no such thing. It was Cartesian. It was only the science of mechanics, a far more restricted topic, which was Newtonian."

(Gillespie 1967, p.92.)

But if this was so of Newton it was not so of his followers. Many (e.g. Bentley, Ray, Derham) held to the reality of God in His works of creation, but as thought developed there was a boomerang effect on Newton who came to be seen as the champion and founder of the mechanical world, reducing all to mathematically understandable laws. His followers "began to milk a simple materialism" out of him, and banished any ghosts from the intricacies of the machinery of the universe. (Prosch 1966, p.63.) The fact that Newton had pointedly drawn differing inferences was ignored. In time God would be banished entirely from the universe and the soul of man. (Cf. 5.4.1.)

4.6.6. Problems. Newton's success and achievement were considerable but not without problems. By and large his theories rest on the 'ideal' case. Take the pendulum. The law here states that the period of swing is proportional to the square root of the length. If the weight of the bob is unevenly displaced round its centre the law breaks down. The law in fact assumes a homogeneous bob, weight symmetrically distributed along all axes; that the pendulum swings on a tensionless string; and that there is a frictionless axis. In reality there is no pendulum that conforms to the mathematical requisites. If there are no instances - what does a verification mean? Is it a verification of the motion or of how we define a force? Whatever position is held the door is open to philosophy and moves away from any simply empirical reduction. It is interesting to remember that in each case "the crucial step forward from Aristotle involved a mathematical idealization." (Toulmin & Goodfield 1961, p.248.)[10] But this is not equatable with reality. It may be a mode of reality, but mathematics is not the integrated wholeness of reality. Feather (1970, p.104f.) points out the very definitions from which Newton starts are misleading for they are not, as appears, independent statements. His technical critique is beyond my scope here, but note that as an example Law 1 is simply a special case of Law 2.

4.7. REVIEW

Newton set science on its modern footing of empirical inquiry.

10. "In this sense, classical physics was an application of Euclidean geometry to space, general relativity a spatialization of Riemann's curvilinear geometry, and quantum mechanics a naturalization of statistical probability." (Gillespie 1967, p.87.)

Here he typifies the critical scientific tradition of the 17th century where to quote authority was by itself useless in scientific matters. 'Nullius in verba' ('On the words of no man') stands on the crest of the Royal Society. Abstract deductions divorced from practical observations and experiment were no longer to be tolerated.

Undoubtedly this laid the seeds for determinism and materialism, even if in the first instance the quest for law stemmed from a religious motivation. Philosophically the atomists had triumphed over the Aristotelians, but it was not without significance that the atomists of old had been deemed atheistic and materialistic. This was the very trend that history would see once more as men lost sight of the religious foundation on which modern science was built. Newton's followers would eventually abdicate faith to the supremacy of the mechanical. The scene was being set for the coming opposition of science to faith, but the clash did not yet exist.

In concluding this chapter let it once more be noted that we live today primarily in the world-picture of Newtonian mechanics, not that of Einsteinian relativity. Today Newton is still relevant, and our very consciousness has been shaped by his legacy. While the structure of the Newtonian model is questioned, much remains. It is a testimony to his stature, and the 'Principia', that though much has altered and improved, the problems of celestial mechanics and gross bodies are still solved essentially as he did in the 17th century. A high point of our technology was the landing of men on the moon - it was Newtonian mechanics that engineered that feat.

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CHAPTER 5

CONSOLIDATION AND TRANSITION

5.1. SCIENCE AND BELIEF IN THE 18th CENTURY

> "One might have expected, after Newton, a great burst of discoveries. What came was a long period of slightly stunned assimilation." (Pledge 1966, p.100.)

Following the scientific breakthrough of the 17th century there was a period of consolidation in which science grew internally by specialism and concentration of study, and externally through the growth of periodicals and learned societies. Science was also popularised (cf. Fontenelle's 'Science for the Ladies' in 1686). The Enlightenment, with its faith in reason and increasing scepticism towards religion, was not essentially scientific but literary and, like the Renaissance, tried to recapture the glories of the ancient world. (Cf. Gay 1973/a; Gay 1973/b; Harris 1968.) The science of the 18th century could only be Newtonian but, transformed by the varying ideologies of the Enlightenment, it was generally inclusive of something more than Newton's views. Newton was reinterpreted through the eyes of either Bacon or Descartes. There was also the attempt to extrapolate from the realm of physical law into social science (cf. Bentham's 'An Introduction to the Principles of Morals and Legislation' in 1789). This caused fundamental confusion between declarative and normative aspects of law, between 'is' and 'ought'.

There was change from the worldview of the virtuosi as God and revelation came increasingly under attack from Deism, Materialism and Atheism - though not from science <u>per se</u>. The correlation of science and belief still held firm. "Switzerland became an important centre of scientific activity during the eighteenth century, probably because it was the refuge of so many Protestant scientists who had left Catholic lands." (Mason 1962, p.283.) Many of the leading figures were devout men - Joseph Priestly a Unitarian; John Dalton a Quaker; Michael Faraday, who continued Dalton's work into the next century, was a Sandemanian; Thomas Young, who revived the wave theory of light, was a Quaker. This was the period of strength for the dissenting academies and many Anglicans choose to go there rather than the universities as more modern subjects, especially science, were taught. Though in Scotland the universities were noted for the teaching of the sciences, with Edinburgh becoming famous for her medical school.

The virtuosi were in fact the exemplars of religious orthodoxy. They had opposed Hobbes in contending for the creation of the universe by an intelligent purpose instead of the random production of chaos; Leibniz in stressing creation out of the free will of God and not from rational necessity, creation was contingent on the will of God not a necessary consequence of first principles; Spinoza in stressing the transcendence of God as well as His ability to work into creation. The doctrine of creation at the same time provided the mandate for the investigation of nature. Scripture was clearly seen to affirm nature, but it certainly did not deify it, or identify it with God.

While the 17th century saw a reorientation in the concept of motion, the first scientific thrust of the next century saw an attempted return in chemistry to communion with nature - an attempt to deepen man's concept of matter that is "rightly forgotten." (Gillespie 1967, p.174.) Combustion was still associated with spirits and respiration and most chemists of the early 18th century had little or no conception of the change that had been wrought in physics. (Cf. Pledge 1966, p.107.) Not till Black (1728-99) would craft and chemical theory come together giving birth to the doctrine of the latent heat of freezing and vapourisation - a coalition brought about in part by the booming distillery industry of Scotland. Not until Priestly unmasked the phlogiston mystery, and his discovery of oxygen was developed by Lavoisier, would chemistry be put on a firm basis.

Generally there was little theoretical interaction between science and industry in specific details. But the transfer from science to industry of a scientific method was important - the assumption to the crafts of a systematic description, classification and study of processes and principles. The metal industries, for instance, did not change to any great extent but came to be understood. Spinning off from this was the automation of machinery and the primacy of invention over discovery.

On the religious front there was growing estrangement between autonomous man and revelation. The study of nature came to replace historical truths as the key to understanding God and the quest for rational order in nature became the preoccupying force in man's encounter with the mysterious. But while this divorce was propounded by many the distinction was not so evident among scientists. "Nothing is easier than to amass evidence for this continuing association of science and religion, both in Britain and on the Continent." (Gay 1973/a, p.315.) Perhaps so, but this is all too often ignored in accounts of the history of ideas.

5.2. NATURAL THEOLOGY

In the late 17th century it became fashionable to demonstrate the reasonableness of Christianity and hence natural theology came to the fore. Natural theology can be simply defined as theology based on what may be rationally demonstrated, though this definition is by no means the sole one and debate will obviously exist as to what is, and what is not, rationally demonstrable. Locke's 'Reasonableness of Christianity' and Blount's 'The Oracles of Reason' are typical works. But the difference between natural theology in its early format and its end product is considerable. With Boyle, Newton and Ray a close alliance was forged between natural theology and natural philosophy which was productive and creative, as well as integral and basic to their thought. (Indeed it was often closer to a theology of nature than natural theology.) However by the 19th century natural theology had developed into an autonomous province of study and someone like Baden Powell could separate the physical and moral, assigning the former to science and the latter to theology. (Cf. Brooke 1974/b, p.52.)

As natural theology developed it implicitly assumed an area of religious concern autonomous from revelation. This was its distinctive feature. There is a discernible historical flow from (a) revelation over reason; to (b) the two complementary and interacting; to (c) independence of each other; until finally (d) reason came to lord it over revelation. Thus reason/natural theology moved from a persuasive prelude to revealed theology to a substitute for it. For men like Derham, Burnet, Ray and Paley natural theology, though made much of and seen as independent, was essentially a prelude to the study of revelation. The orthodox apologists in their approach simply deferred their appeal to revelation to a later point in their argument; but the Deists allowed natural religion to take over and displace revelation.

5.2.1. Why Did It Develop? The exact reasons for the rise of natural theology are varied and complex. Brooke (ibid p.14.) suggests seven - the need for some natural theology for those who lived before Christ; to reconcile the latest scientific theories with

Scripture; a conviction that non-believers had to be shown as 'foolish'; the increasing emphasis on the design(er) of the universe that science now unfolded; to defend the reasonableness of belief; the quest for a universal religion which was compelling to all and which would unite all men (re. the recent geographical discoveries); and finally the need to justify science in religious terms as a means of worship, duty, and a method of cultivating virtue.

The upsurge of natural theology was not without biblical support. Passages such as Romans 1,vv.18-21, and the Nature Psalms seemed to point to the possibility of a natural knowledge of God apart from revelation.(Cf. Berkouwer 1971, chs.6,7.) Under Aquinas reason and revelation had been dualistically assigned their respective spheres of investigation. On the other hand Calvin had maintained that such passages suggested that man, by himself, had a clear enough knowledge to condemn him, enough knowledge to be inexcusable before God, while the biblical revelation was absolutely necessary for salvation. But the general drift of thought was to see natural theology as a necessary aid for revelation instead of complementary - to see the Bible as merely magnifying the truths known to reason. A move from God the Redeemer to God the Creator and the installment of His works over His word.

But the root problem was that, in emphasising the creatorship of God and the goodness of His creation, sight was lost of the reality that the world was fallen. The strong motive of Calvin (creation, fall and redemption) was overcome by the religioo-humanistic dualism of nature-grace. It was against this dualistic motive that the paradigms of this age must be seen, changing as they did into a motive of nature-freedom (Kant). So it is in the loss of the Fall that Stubbe (tendenciously?) accuses Sprat of reducing the Fall to merely a failure to cultivate the Garden of Eden! (Brooke 1974/b, p.15.)

5.2.2. The Question of Design. The argument from design has a long and controversial history. Despite its obvious limitations it was, and is, one of the most persuassive arguments for the reality and existence of God (cf.16.5.3.1.) - though it can never logically be a proof. Boyle argued that as science advanced it furthered the eloquence of the argument for here was revealed a world of mathematical law and harmony, of macroscopic and microscopic beauty and simplicity. Further, the works of nature were seen under the rigours of scientific investigation to be far superior to the artifacts of man. Thus the transcendent design of the Creator, along with the principles of a fixed creation and the sufficiency of reason (cf.5.2.3.), became cornerstones in the apologetics of the virtuosi and other theologians.

Design was seen with respect to four categories. It was seen in living things; in the laws that governed natural phenomena; in those facets that seemed scientifically inexplicable without God's activity; and in the inconsistencies of those who rejected design. Some reason had to be given for the design of the world around, it could not just be ignored and it was here that the last point was forcefully utilised. But natural theology and design were unwisely used as means of explaining gaps in the scientific account. Newton faced with certain irregularities in the heavens could (seemingly) appeal to God for their adjustment to keep things going, but then Laplace worked out that these irregularities, instead of accumulating, cancelled out and therefore excluded God. Again with respect to the orderliness of nature, Newton had appealed to God as the reason for the co-planar orbits of the planets which apparently defied explanation. This was seen as God's creative activity until Laplace came along with his nebular hypothesis (22.1.5.) and provided a reasonable explanation as to why the planets went round in the same direction. Thus God's activity was increasingly removed from acting into history to that of the divine legislator, reduced to preserving the cosmic order. As natural theology developed even this would come under pressure.

<u>5.2.2.1. Robert Boyle (1627-91).</u> Paley is probably the best known propounder of design, though his presentation is pedestrian alongside that of Ray's. Boyle is famous for his analogy of creation with that of a clock and the design of the eye. The clock analogy left questions against the sustaining activity of God in creation, but this was for Boyle small price to pay against the objective of securing the reality of the Creator and the mandate to research into the workings of creation. Thus as far as he was concerned the analogy between nature and a human contrivance was justifiable in coming to the emphasis on the wisdom and beneficence of God. The paradoxes of providence were of no immediate concern for him. It was not the individual parts as such but the whole that pointed to the goodness of God and there were within the parts levels of truth that had to be

distinguished. Boyle claimed it was presumptuous to seek knowledge of a purpose for each and every facet of nature; that it was likewise presumptuous to claim knowledge of all the purposes of any one facet; and that it was presumptuous to see all as designed solely for the benefit of man. Yet he goes beyond Descartes in stressing the need to seek divine ends in nature. Descartes argued that we only know such ends if God chooses to reveal them to us, but for Boyle this was not so and final ends could be derived from investigation of the world.

5.2.2.2. Isaac Newton (1642-1727). Like Boyle he gave a positive impetus to 'Physico-theology'. In his work, and in his criticism of Descartes, his faith was always present.

> "Whereas Descartes had postulated the development of solar systems of matter in motion, Newton had to deny the sufficiency of such an account. The only satisfying explanation for the present structure of our solar system was that God created it more or less as it now is.... This was one of Newton's most cherished assumptions and it was shared by almost all who expounded his scientific works in defence of their faith." (Brooke 1974/b, p.20.)

For Newton the emphasis was on the general physical laws rather than the question of biological adaptions (cf. Boyle). In this he was followed by Bentley, while Boyle was followed by Ray, though both streams could readily utilise arguments from either position. Thus Newton in his 'Opticks' appealed to the design of the eye.

But in fostering the argument from design controversy arose as to its benefits to religion. In the Clarke-Leibniz debate, Clarke saw gravitational forces evincing the activity of God while Leibniz protested that non-mechanical forces were unintelligent; Clarke affirmed, and Leibniz denied, that space could be seen as analogous with the sensorium of God; Clarke saw constant preservation by God, while Leibniz maintained constant production by the Deity. Thus while for many in England Newton furthered religion in his scientific work and the arguments he presented, Leibniz contended that Newton had fostered the decay of natural religion. (ibid p.25.)

5.2.2.3. John Ray (1627-1705). Perhaps the best exponent of biological design was Ray. Ordained in 1660, he resigned his fellowship at Trinity College Cambridge in 1662 because of his opposition to the Act of Uniformity. He is regarded as the founder of modern botany and his work is full of reference to biological design.

Characteristic of his thought was the idea of a full and perfect universe and a pervading optimism whereby the Fall was virtually inconsequential. But basically there was the assumption of transcendent design. Ray was influenced by the Cambridge Platonists and it was part of his strategy to stress biological facets which could not readily be explained on a mechanical basis. It should be noted that this was an assumption, not a proof - as is generally the case with the argument from design. He pointed to the vast difference between the works of men and the superior works of nature. But there was a problem here for if the difference between the works of man and nature was stressed, how did the analogy bear up, and how could extrapolation be made to the absolute properties of God? (Cf. Ray 1691; Ray 1693.)

5.2.2.4. William Paley (1743-1805). The most famous work in this area is by Paley. In his 'A View of the Evidences of Christianity' he argued that either no religion was true or Christianity was true and superior. He contended that, granted the assumption of God, miracles were credible and that the revelation of the Bible was such a miracle which made known the will of God. He argued from the historical evidence contained in both pagan and Christian writings to the truth of Christianity. Auxiliary evidences were sought in the prophecies of the Old and New Testaments, the morality of the gospels, and the rapid growth of the faith. This was a typical apologetical reaction to the Enlightenment and Deism. Eight years later he argued in his 'Natural Theology' that by examining such diverse things as teeth and watches we could arrive at the Creator God. (Paley 1802, p.319f.)

5.2.3. Two Further Ideas.

5.2.3.1. The Idea of a Fixed Creation. This held that the world was now substantially the world as it had always been, the world in fact which God created. This had several advantages from the point of the inner consistency of the argument: animals were seen as pre-adapted to pre-adapted conditions; this extended readily to the cycles of nature; it entailed that no species had ever become extinct thus revealing the excellence of the provision of God for all creatures. But there were serious disadvantages - species were being discovered which were extinct (cf. Buffon) and therefore either conditions changed or creatures were not properly adapted. Also arising at this time was the question of the dynamic relationship between creatures and their environment.

5.2.3.2. The Principle of Sufficient Reason. Basically this asserted that God neither did or omitted anything except for some rational and good reason - even if man could not understand it. Thus Derham utilised Paul to point out that man was not to question the doings of God, though this tacitly undercut the design argument as a rational proof. Here, as elsewhere, he was assuming God's existence and then pointing to design, rather than arguing from design to God. For Ray the principle meant that all was perfect in the world; instead of the later concept of 'red in tooth and claw' his worldview was that there was perfection in tooth and claw. Pain and suffering were negotiated by various means - rattlesnakes gave warning before they struck (Derham); disease reconciled man to death (Paley). (Cf. Dillenberger 1961, p.152.) At this point, of course, the arguments became tenuous plugging of holes in the idea of design. Also there was the problem of the uselessness of the stars which were not visible to the naked eye - though the answer given was the plurality of worlds.

5.2.4. Deism. While many contained this predilection for natural theology within a conventional Christian framework others did not. Deism arose and substituted natural theology for revelation. Typically, Toland in his 'Christianity not Mysterious' (a revealing title) noted the past assent to God's word and then went on to strip Christianity of all revelation, leaving only that which was solidly based on rationalistic thought. (Cf. Gay 1973/a, p.376.) Utilising the argument of design he rejected the Epicurean atomism of Lucretius but kept the Epicurean concept of eternally moving matter. Tindal - in 'Christianity as Old as the Creation, or the Gospel as a Republication of the Religion of Nature' - saw revelation adding nothing to reason. This demotion of revelation departed a long way from orthodoxy, especially when in the pursuit of scientific reason they attacked the concepts of the Trinity, clergy, ceremonies, the doctrine of the resurrection etc.. (Cf. Goodman, D.C. 1974/c, p.42.)

5.2.5. The Orthodox Reply. Paley provides a basic outline of the apologetical approach of orthodoxy to the deistic challenge. Four points were concentrated on - miracles, prophecy, creation, and the analogy of the two books. The first two areas were subject to empirical confirmation. Miracles were to be confirmed by the senses; they had to be public to be allowed as real; customs had to flow from them and men were on their behalf to suffer for their faith. Hume was sceptical of miracles but allowed faith in their non-event to over-rule any possibility of empirical evidence. Thus he finished up getting rid of science and the laws of nature at the same time. The Deists presented the most consistent attack on miracles as contrary to reason. While most theologians (and scientists) accepted the laws of nature and the fact of miracles, the Deists accepted only the order of nature in a quite materialistic and humanistic manner. Prophecy in a sense is a special case of miracle. It was stressed by a man like Ralph Cudworth. (Cf. Dillenberger 1961, p.145.)

The wisdom of God in creation tended to revolve around some presentation of design, though not necessarily as a 'proof' of God. God was to be better understood by unravelling the depths and mysteries of nature - rightly seen as resting on a firm biblical foundation. Creation was argued against concepts of fate and chance (which could be affirmed by the same person). Cudworth contended against any mechanical interpretation of the world. Recalling that Anaxagoras had commented that man merely 'chanced' to have hands he suggested this was sheer nonsense and devoid of meaning for hands were obviously designed with specific purposes in mind. Similarly, Ray pointed to the immense size of the universe and the smallness of certain species; Derham pointed to astronomical immensity; while Paley, doubting the usefulness of astronomy, pointed to the watch and biology. Even the more unpleasant aspects of life were included in the overall purposes of God as worked out in natural theology - insects spread disease but were also the source of medicine, while locusts were often used by God to bring judgement.

Lastly there was the analogy of the two books (cf. Bacon, Boyle). This was developed by Butler who pointed out that nature, like Scripture, had depths which man could not hope to plumb. Dillenberger is rather harsh on Butler at this juncture for his analogy was not in fact between nature and Scripture per se, but between our common experience of nature and the Bible. (ibid p.154.) Thus he constructed his analogy, moving from the authority of nature to the authority of Scripture. But the problem arising was that as the author of Scripture came into question, so also did the author of nature.

In the elevation of reason over revelation, the problem for natural theology was that it did not develop any real biblical view of nature (cf. ch.23.) The Bible clearly has much to teach on the Christian attitude to the world but this was neglected in favour of untutored reason. No reading of Genesis 1-3 or Romans 1-2 can fail to realise that crucial to the Christian approach is the reality of a fallen world. But this was neglected in favour of an optimistic-progressive view of nature. Men like Derham and Paley failed to sense the reality of a 'broken globe' or the 'pangs of sorrow' in this present condition. (Cf. Brooke 1974/b, p.36.)

But the rise of reason within orthodoxy must be placed in context, for although the rejection of revelation came from unorthodox quarters there was within the main stream of Christian thought a strong emphasis on the reasonableness of the faith. This was inevitable when the charge began to be made that religion was a mystical, irrational belief, beneath the dignity of enlightened men. The only answer to such a charge was to show that the faith was perfectly reasonable within Christian parameters. So the response of natural theology was correct in principle (as an attempt to stand for the rationality of the faith) if wrong methodologically (in accepting the ground of the opposition). A presuppositional critique may have been more fruitful.

There was also inevitably an orthodox response that endeavoured to balance reason and revelation in harmonious relationship within a dualistic motive. Such response was found in men like Buddeus, Mosheim, Baumgaten and Pfaff who maintained that revelation did not contradict the light of reason. These thinkers tended to move towards a position of 'philosophia ancilla theologiae'; their defence of revelation being an attempt to reinstate grace over nature. Certainly Buddeus saw natural theology in an intermediate position somewhere between reason and revelation. Natural theology was neither independent nor bound to revelation. Baumgaten distinguished between revelation and the Bible, arguing that the two were not equatable; while Michaelis contended that physics was quite independent of theology. (Cf. Dillenberger 1961, p.179.) Butler saw revelation as indispensible for several reasons: it was necessary to make plain what was only dimly discernible in nature; as giving the dispensation of providence; and for setting forth the conditions necessary for salvation. The general drift was however to enthrone reason as lord of all, and this was clearly seen in the Enlightenment.

5.3. THE ENLIGHTENMENT

The irony of the Enlightenment, with its radically anti-Christian worldview, was that it was often forwarded by Christian involvement in science. (Cf. Gay 1973/a, pp.22,23; Gay 1973/b,pp.140ff.) Often called the 'Age of Reason' this appellation has to be treated with care, for while this was certainly a dominant thread in the spirit of the age it cannot be an unqualified description.

> "The philosophes' glorification of criticism and their qualified repudiation of metaphysics make it obvious that the Enlightenment was not an Age of Reason but a Revolt against Rationalism. This revolt took two closely related forms: it rejected the assertion that reason is the sole, or even dominant, spring of action; and it denied that all mysteries in the world can be penetrated by inquiry." (Gay 1973/a, p.141.)

Old values and beliefs were up for question. God may have been an assumption of basic importance for Newton, but for the philosophes He was merely a debatable hypothesis. Likewise with Scripture: Descartes may have set limits to reason and granted revealed religion a province only accessible to faith, but for men like Condorcet and Spinoza the text of Scripture was to be fully exposed and subjected to the light of rational criticism. The theme of the Enlightenment was that 'You shall know the truth and the truth shall set you free', but it was the truths of reason enlightened, at least in the early 18th century, by science. But dogma based on science had its problems and it was manifestly absurd to set forth a rational position as the final absolute truth even if it had scientific backing. In the early half of the century Descartes and Newton both reigned - giving two opposing scientific worldviews. The problem was to choose - but how? In the end the Newtonian view prevailed and the perfection of man embraced within that framework. Turgot writes in 1750:

> "At last all the clouds are dissipated. What a glorious light is cast on all sides! What a crowd of great men on all paths of knowledge! What perfection of human reason! One man, Newton, has submitted the infinite to the calculus; has unveiled the nature and properties of light, which, while revealing to us everything else, had concealed itself; he has placed in his balance the stars, the earth, and all the forces of Nature." (1750, p.219.)

Yet Turgot could still see this within the context of orthodoxy. (ibid p.220.)

5.3.1. Baruch Spinoza (1632-77). He foreshadowed the Enlightenment. For him, God was identifiable with nature and could therefore be known apart from Scripture if man was intelligent enough. The Scriptures were merely a facility for controlling the ignorant masses of the unlearned, while, on the other hand, the learned who arrived at 'true conceptions' by reason were 'altogether more blessed.' (Cf. Goodman, D.C. 1974/c, pp.38-40.) Laws of nature were viewed as autonomous and necessitated the impossibility of miracles if they in any way transgressed these laws. Thus his unprecedented criticism of the Bible, his rejection of ceremonial, his free-thinking philosophy, and pantheism all influenced the philosophes. [1]

<u>5.3.2. Bernard le Bovier de Fontenelle (1657-1757)</u>: though secretary of the 'Académie des Sciences' from 1699 to 1741, was essentially a man of letters. While he wrote some mathematical works, his importance lies in forging a link between the scientific 'revolution' and philosophy. It was he who helped to formulate the new scientific worldview. "As a man of the world he saw what was fashionable and produced what was wanted." (Butterfield 1973/b, p.165.) He produced his popular 'The Plurality of the Worlds' in 1686, two years before the 'Principia'. But it would be thoughtless to see him as a philosopher unaware of the sciences around him, for in fact as secretary of the Académie he was in touch with all the differing fields and had a better general knowledge than many of the front-running specialists. For any worldview to grip its culture it is essential that it have its popularisers and Fontenelle performed this function for the new scientific outlook. The claim can be made that the new worldview was forged basically, not by the scientists, but by the writers and philosophers of the time.

<u>5.3.3. Francois Marie Arouet (Voltaire) (1694-1778)</u>. A French Deist who drew heavily on the thought of Newton, as well as John Locke, Voltaire was in fact the continental populariser of Newton through his 'Elements of the Philosophy of Newton' - 1738. He started where Newton left off. In no sense did he take up the cudgels of science and reason in blind opposition to belief; rather, like Newton but against Descartes, he began with the liberty of God to create as He saw fit. Rejecting Epicurean atomism, he contended that Newton led men closer to God while Descartes led men away from the Creator. (Cf.

1. Part IV of this thesis shall draw heavily on H.Dooyeweerd. It has been said of him by one who does not share his viewpoint that he "can be called the most original philosopher Holland has ever produced, even Spinoza not excepted." (Langemeijer 1964, p.10.)

Gay 1973/a, p.158.) Newton, Locke and Bacon were thus seen as the precursors of the Enlightenment through their stress on careful experimentation instead of wild conjecture. Hence Voltaire's 'Candide' (1966) is a dramatised reconstruction of the Newtonian approach to the world - though it goes beyond what Newton himself held. (Cf. Gay 1973/a, p.200.) In common with the period Voltaire utilised the idea of design, claiming that Newton's intelligence could only come from a higher intelligence. (Cf. Goodman, D.C. 1974/c p.43.) He was no upholder of orthodox religion, however, and unequivocably enthroned philosophy and reason above all else. But he carefully delimited boundaries beyond which reason could not go, for there was a mysterious residue in life which could not be plumbed and which limited any search for ultimate causes. True wisdom lay in recognising the ignorance of man. He could look at the milky way and the 'atom', but he did not know what matter was; he saw by the aid of light, but he knew not what light was. On all sides he was limited by his ignorance. (ibid p.46.) Thus far and no further (Job 38;11.) was the calling of reason.

5.3.4. Denis Diderot (1713-84) : encyclopaedist, materialistic philosopher, novelist, satirist, dramatist, art critic and scientist; he is most famous for having, along with d'Alembert and others, compiled and edited the 'Encyclopédie ou Dictionnaire raisonné des sciences, des arts et des metiérs.' Many strands of the Enlightenment come to a head in Diderot, who in 1746 was still deistic in outlook, but by 1749 had clearly moved to a more radical materialism (ibid p.60.) His position changed from a deistic outlook, from looking at God in nature, to excluding God and confining his discussion to matter and motion, finally portraying an active and sensitive matter as the cause of all things (re. spontaneous generation and huge time scales in nature). (ibid p.65.) In his 'Pensees Philosophiques' the Deist had triumphed over the atheist, but he moved on to the failure of a blind man (Nicholas Saunderson?) to be convinced by the wonders of nature. (ibid p.64.)

All was to be equally subject to the criticism of reason. (Cf. Gay 1973/a, p.149.) But his position was not as scientific as might be expected. He rejected mathematics and his rejection was a fundamental critique of the unreal idealization of the discipline. (Cf. Gillespie 1967, p.187.) But Diderot was no fool at mathematics and could readily utilise it at a secondary level; his indictment was against a science of finite intelligence which endeavoured to plumb the infinite. His approach was a more earthy one than that of the pure rationalist and he actually reversed the Cartesian procedure (of studying self to know nature) by studying nature to know himself. It was a study through the craft tradition rather than abstract theory; matter rather than form was the key. (Cf. Gillespie 1967, p.191.)

5.3.5. The Marquis de Condorcet (1743-94) : philosophe and mathematician, he advocated the "infinite perfectibility" of man in his 'Esquisse D'un tableau historique des progrès de l'esprit humain' (cf. Condorcet 1794, p.235.) Here he traced the development of mankind through nine epochs and foretold that man would become perfect in the tenth. He confidently asserted the supremacy of the laws of nature, the perfectibility of man and the reality of science as opposed to the illusion of religion. From the 'Tenth Stage' he writes:

> "...we shall find in the experience of the past, in the observation of the progress that the sciences and civilization have already made, in the analysis of the progress of the human mind and of the development of its faculties, the strongest reasons for believing that nature has set no limit to the realization of our hopes....The time will therefore come when the sun will shine only on free men who know no other master but their reason;..." (ibid pp.223,226.)

5.3.6. Pierre Simon Laplace (1749-1827) : is famous for his remark to Napoleon that he had no need of the hypothesis of God. Having determined that the planetary irregularities cancelled out, and that the co-planar orbits could be explained by the nebular hypothesis, God became redundant as a 'stuffer of holes.' Thus he developed the Newtonian world into one that was self-sufficient and impersonally mechanical, subject only to a strictly deterministic sequence of cause and effect. It is Laplace who formulates the Newtonian world-machine.

> "We ought then to regard the present state of the universe as the effect of its anterior state and as the cause of the one which is to follow. Given for one instant an intelligence which could comprehend all the forces by which nature is animated and the respective situation of the beings who compose it - an intelligence sufficiently vast to submit these data to analysis - it would embrace in the same foundation the movements of the greatest bodies of the universe and those of the lightest atom; for it, nothing would be uncertain and the future, as the past, would be present to its eyes." (Laplace 1961, p.4.)

This is reductionism on two levels: epistemologically in the conviction that all will ultimately be capable of explanation on the basis of physical laws; and metaphysically in the idea that matter-in-motion constitutes reality.

* * *

Space forbids details of the classification methodology of Condillac, extended by Linnaeus; or of Goethe, who despite "making a fool of himself" (Gillespie 1967, p.196.) was nevertheless an important figure. But enough has been given to indicate the drift of this period as a movement for reason against the concepts of revealed religion. The Enlightenment gave the first real and serious evidence of a divergence between science and belief, though the picture is confused by the ambivalent attitude to science by many of the philosophes. Like the Renaissance it tended to be a movement back to the pristine clarity of the ancients. They could therefore tie reason to science, but equally reason could be against science, or indifferent to it. In this the formulation of reason and philosophy were quite at variance with Newton and the other virtuosi.

5.4. OTHER REACTIONS

5.4.1. Materialism. La Mettrie caused a scandal with his uncompromising materialism in the middle of the 18th century - 'L'Homme Machine'. Baron Pierre-Henri d'Holbach, unlike many of the others mentioned in this chapter, readily adopted an Epicurean position concerning the state of motion; all was in flux and there was no rest anywhere in the universe. But nature was ultimately governed by determinism, not chance, by the inevitable chain of cause and effect. Holding this, he contended that creation was unreasonable as a doctrine and spontaneous generation quite feasible! In the 1740's there had been reported the observed regeneration of the polyp or hydra by Abraham Trembley, subsequently confirmed by Reaumur. This was of tremendous significance, especially when coupled with the apparent spontaneous generation of life in the sealed flasks of J.T.Needham. The latter was an erroneous conclusion as the preparations of Needham were not sterile, but it would be nearly a century before they were disproved. The point was that both these incidents pointed to 'active matter', the ability to regenerate and bring forth life from that which was dead and inanimate. Thus materialism was furthered in excluding God. But with these early pioneers of strict materialism it should be noted that they were not necessarily denying the existence of God - some did, some did not. The point was the thorough exclusion of God from participation in the processes of nature. (Cf. Goodman, D.C. 1974/c, p.49f.)

5.4.2. David Hume (1711-76) : embodied a sceptical approach to all of reality and brought everything into question - religion, science and even the principle of cause and effect. Descartes, Leibniz and Spinoza had argued for the innate qualities of the mind, and Locke for the 'tabula rasa'. For the former, true knowledge consisted in the mind's grasp of innate ideas, with mathematics as a prototype of knowledge, its reasoning certain, universal and *a priori*; for Locke, ideas were empirical in origin and were built up from sense impression and therefore not universal in form or structure. Hume clearly held to the view that the only reliable knowledge man can possess was based on *discrete* sense-impressions.

The idea of discreteness of sense-impressions led to Hume's radical view of causality. He refused to accept any *a priori* idea of a rational order which was *imposed* on the natural world, and causality was therefore viewed primarily as something necessitating constant conjunction. Our ideas of cause and effect were, he maintained, habits of expectation and no cause could be known from its effect alone. The idea of constant conjunction was obviously inadequate and he had to reinforce it with two additional concepts: (a) that 'A' would only produce 'B' if 'B' could not occur without 'A'; and (b) that spatio-temporal contiguity was necessary. This still left him with serious problems as gravity clearly violated the latter point.

Hume ranged himself implaccably against the argument from design and gave one of the classical critiques of it. He argued that no man had witnessed creations, and there was therefore nothing in the way of proof that could be extrapolated from the observed creative acts of man to the unobserved acts of God; there were evils in the world, therefore God could not be the benevolent God that He was claimed to be; that to argue to a first cause only logically allowed us to say 'It is a cause'; that all effects are finite and therefore fail lamentably in establishing an infinitely good, wise and loving God; and finally that the analogy of a seed or egg would provide an equally valid analogy for the argument of design. The first point is significant for he employed the scientific *a posteriori*. But

God cannot be thus dealt with; while design is an a priori argument. However his critique exposed the basic fact that the argument was essentially not a proof of God, but followed on from the assumption that God had created. If we try to deduce the nature of God from the characteristics of the universe, viewed as His created order, Hume declared that He must then be finite, imperfect and incompetent.

It would be wrong to see Hume as a champion of science against religion - as has been suggested. Indeed such was the close tie between science and orthodox belief that for Hume to attack the religious beliefs of his time he had also to "impeach the rationality of their science" as well. (Brooke 1974/b, p.45f.)

There were various responses to Hume for his arguments were incisive, although in the immediate context not treated as seriously as they warranted. Priestly dismissed Hume as irresponsible, claiming that his analysis of causality was defective - for Priestly, the practising scientist, causality was a real phenomena. At another level there was the common-sense philosophy of Thomas Reid who suggested that Hume's analysis was insufficient as an explanation of efficient causality - such as in the moving of a limb by an exercise of will. A third response can be seen in Hugh Miller, evangelical preacher and distinguished geologist, who argued that the progress of geology refuted Hume in that the discontinuity of the differing strata (creations) overturned the basis of the first point of his critique of design. Miller's position would, of course, soon be challenged by Darwin who undercut the idea of discontinuity in the development of the species.

5.4.3. Immanuel Kant (1724-1804) : is a landmark in western thought in his attempt to precisely define the domain of rational understanding. He rejected Hume's scepticism and challenged the Enlightenment's faith in the unlimited scope of reason. His thought was caught however in the dualistic formulation of the science-ideal and personality-ideal. (Cf. Dooyeweerd 1969, Vol.I, p.386.) On the one hand there was determinism, the autonomous machine which was the province of science and theoretical thought; and on the other hand there was a certain quality of freedom inherent in the idea of ethics. (Cf. Appendix E) Thus science was limited and room made for religious faith. There is really a tri-ism in his thought, for in the lower storey (cf. Appendix A) of the science-ideal there were 'things-in-themselves.' Newton had suggested that things could never be known by themselves in isolation. This construct of Kant of a realm of deterministic science and a realm of moral obligation was one in which the two realms of science and belief could not clash, for they were contained in separate compartments of reality. But the question must be asked if his philosophical system is true to reality, and if science and religion are independent in this way? It is the contention of this study that they do interact, that there is a foundation of belief in science that requires explanation - not explained away.

Knowledge, for Kant, was the combination of sensory material with the structure of consciousness which organises and interprets data by its own forms of comprehension. Among these forms of sensibility were the basic ones of space and time; seen as 'ideal' as opposed to real, they were the spectacles through which we perceive. Only in the experience of duration do we have an idea of time, and only in the encounter with 'things' do we recognise the existence of spatial possibilities. "Space must, therefore, be a pure (a priori) form of our intuition, making the experience of externability possible." (Prosch 1966, p.117) Similarly, causality was seen as a form of understanding by which the mind unified the chaos of discrete data.

<u>5.4.4. Romanticism.</u> Inevitably there arose a movement back to primitive nature as a reaction against the deterministic abstractions of scientists and philosophers. (Cf. Harris 1968.) It was seen more in the art and literature of the period, than in the sciences: though it was here that Goethe got his science and romanticism mixed up. In art and literature there was an exaltation of freedom, the individual and wholeness over against the unchanging laws of nature, universals, abstractions and atomising tendencies of the scientists. Inevitably perhaps the movement, wishing to reinstate the glories of nature, tended to pantheism. (Cf. Gillespie 1967, p.198f.) So it tended to replace physics with biology (note the comparison with the move from physics to the human science after 1945 - e.g. Bronowski); from mechanical models to organic; from objective and rigorous research to "pathetic subjectivism." (ibid p.199.) Under this the philosophes could turn imprecision into a virtue - a thought well illustrated when Rousseau, in the winter of 1750, threw away his watch. (Cf. Gay 1973/a, p.245.) With this act he had overthrown the tyranny of absolute, objective Newtonian time. It was no doubt

a rebellious romantic mood, but nevertheless it was deemed necessary to escape the claustrophobic oppression of a science which denied freedom to man.

Certain streams of pietistic thought will obviously fit into the general mood of this reaction. Though men like Wesley and Edwards "had a sense for the central christological core in Christianity but also for the new science." (Dillenberger 1961, p.161; cf. p.156f.)

5.5. REVIEW

The 16th and 17th centuries were unquestionably dominated by Christian belief. The popular beliefs were Christian, while the great scientists were consciously Christian both in their pious devotion and scientific work. The 18th century, which saw the establishment of the mechanical worldview, was a period of transition away from the traditional Christian beliefs by a free-thinking speculation that led ultimately to the extremes of existentialism and positivism. This was a period for assimilating the deterministic structure of science that would rule substantially down to the present, despite the intrusion of its theoretical disintegration.

Natural theology, once a positive impetus to science, gradually became an embarrassment to science and theology as it developed through Deism and critiqued by Hume and the philosophes. Internally within theology there was the theological shift of Schliermacher which insisted that theological language should be concerned with the experience of Divine activity, not the concept of it. Discussion of the evidences for Christianity was on the way out and new paths would have to be trod. (cf. Chalmers 1833.)

Perhaps the period is summed up in its swing away from religion and revelation in the phrase which Voltaire, according to Gay, set great store by: "Reason and conscience are perfectly adequate for man's conduct." (Voltaire: In Gay 1973/a, p.384.) This stood in opposition to the traditional acceptance of revelation as found in the virtuosi, and tersely put, if I remember correctly, by Kierkegaard: "There is only one relation to revealed truth: believing it." Or, we might well add, disbelieving it!

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CHAPTER 6

INDUSTRIALISATION

This chapter follows a more practical outworking of the mechanical worldview - parallel, if slightly later, to the previous chapter. The Enlightenment was paralleled by the rising confidence man began to have in his powers - science, technics and organisation. Thus Joseph Wright (1734-97) painted a whole series of pictures in the late 18th century that depicted scientific activity after the classical manner of nativity scenes. Science was the new messiah.

6.1. FORCES IN INDUSTRIALISATION

The early impetus in industrialisation, as in science, came from lands that were predominantly Calvinistic. Thus Christopher Hill, a former self-confessed communist, can write: [1]

> "Calvinism liberated those who believed themselves to be the elect from a sense of sin, of helplessness; it encouraged effort, industry, study, a sense of purpose. It prepared the way for modern science.." (Hill 1961, p.92.)

While the religious stimulus is undeniable, the period was nevertheless characterised by an increasing secularisation that saw a decline of religious influence and a rise of material self-interest. Science may have been the awaited messiah for mankind; but the gospel of salvation was work conjoined to material progress; and the religious dogma of the age revolved round the increasing wants which would lead to a multiplication of the powers of production and a necessity to increase the capacity for consumption. It is of interest to note that in Goethe's 'Faust', Faust is tempted in Part I (1808) by the classical temptations of knowledge and woman's beauty while in Part II (1832) he is caught in a increasing tempo of work. The period can only be seen in relation to the new spirit of industrialisation, an increasing mechanical efficiency that paradoxically provided the possibility for the romantics and middle classes to turn their backs on the machine and escape into the fantasy of nature and Victoriana.

6.1.1. Factors of Growth. It would be quite wrong to think only technological innovations and their impact need be considered - there were wider and deeper influences at work stemming from the Newtonian

1. One of the best accounts of the dignity and degradation of work in this period which I have read is E.L.H.Taylor (1970) - ch. 2: 'The Degradation of Work in Modern Society.'

worlview of the Enlightenment. The growth of technology can therefore be a misleading concept if considered in isolation for there were bound up with technical development a complex of social and economic changes that were not reducible to the technical. (Cf. Coley, Lawless & Roberts 1974, p.74.) In our century it is undoubtedly true that science has increasingly come under the dominance of technical capability, but in the 19th century, and earlier, science was more determinate of technical progress. It is therefore fair to say that most 'neat' explanations are simplistic/reductionistic.

Ellul's 'La Technique' (1964) gets behind the neat lines of development and continuity and points to the spirit of technique which motivated the technical revolution. This spirit of technique on which the mechanical age rested was active in many spheres of life. Inter alia: it was found at the heart of the military campaigns of Frederick the Great and Napoleon as they worked out their strategies, organisations and logistics; it was found in the rationalising of economic structures; and it was found in the provision of integrated police forces. Ellul argues: "This systematization, unification and clarification was applied to everything." (1964, p.43.) He goes on to show the affinity of techniques with the Enlightenment.

> "....it might be said that technique is the translation into action of man's concern to master things by means of reason, to account for what is subconscious, make quantitative what is qualitative, make clear and precise the outlines of nature, take hold of chaos and put order into it." (ibid p.43.)

Though of course not all the philosophes would agree (e.g. Voltaire). Though I disagree with the unresolved dialectic which Ellul thus posits between man and his powers (cf. 26.3.2. and 26.5.), it must be conceded that this is an appropriate warning of simplistic explanations that fail to account for the prevailing Zeitgeist.

There is, then, a complex of factors that constitute the Industrial Revolution. There were the materialistic, utilitarian and pragmatic spirits that pervaded the period and confined life to the material. The optimistic atmosphere engendered in the 18th century provided the general climate for man's drive to produce and dominate his environment - a domination that often included men. There were the forces of rising population, of war, and of availability of capital. Another aspect was the 'Enclosure Act' of the 17th and 18th centuries when landlords, with the approval of Parliament, began to enclose their landholdings and re-divide their property into a few huge farms.

As a result peasants became landless and penniless, and drifted to the towns and cities in search of work, providing a cheap labour pool.

6.1.2. Why Britain? Why should Britain have led the Industrial Revolution? French techniques were superior; Sweden and Russia were smelting more iron ore; and Holland was the main creditor nation. The supremacy of France is easily seen - her ships were considered far advanced on their British counterparts; in the modern control of machines by punched cards as divised by J.M.Jacquard about 1804 for the silk weaving looms of Lyons. But supremacy had to be cashed in on, and Britain emphasised the immediate usefulness of technologies while the Continent tended to restrict technical capabilities to making toys and intricacies for the rich and royals.

But again: why Britain when the basic established educational system was not geared to a technical society? There was in England nothing to compare with the German institute of technical training - the 'Bergakademie' - or with the educational revision following the French revolution which saw the birth of the 'Ecole Polytechnique' (established in 1795) and a revived Academy. The Polytechnique was swiftly copied in Prague, Vienna, Stockholm, and other Continental countries - but not in England. Hobsbawm, pointing to this, gives part of the answer in the strong Calvinistic emphasis on a general and practical education in the Non-Conformist tradition.

> "English education was a joke in poor taste, though its deficiencies were somewhat offset by the dour village schools and the austere, turbulent, democratic universities of Calvinist Scotland which sent a stream of brilliant, hard-working, career-seeking, and rationalist young men into the south country..." (Hobsbawm 1962, p.47.)

Industry was empirical and Britain was the empirical centre of Europe. There was also the contributory features of its unique island geography which facilitated easy and cheap water transport; the ready supply of water power and mineral resources (90% of world output of coal in 1800); and a maritime policy involving overseas domination.

6.2. RELIGIOUS INFLUENCES

In the midst of changes what part did religious belief play? Whatever explanation is given the fact remains that many deeply committed Christians, especially Non-Conformists, were bound up in the activities of the Industrial Revolution. The Non-Conformists had been banned from holding municipal office by the Corporation Act of

1661; from clerical office by the Act of Uniformity in 1662; and barred from taking degrees at Oxford and Cambridge by the Tests Act of 1673. The social consequence of these obstructions was to direct some of the talents of Non-Conformists into areas of industry and commerce. The Non-Conformists were not, of course, a unified body within themselves, being composed of differing streams of Protestant thought - Presbyterians, Independants, Baptists, Quakers, Unitarians and Methodists. But despite differing theological emphases they had in common a general belief in the freedom and responsibility of the individual before God - a belief shared by many in the established church as well.

<u>6.2.1. How Interpret?</u> As with Protestant involvement in the theoretical scientific re-orientation, so also there was a relationship with technological developments. Technology and non-conformity expanded and spread through England together. This, by itself, tells nothing of the relationship between the two. (Cf. 3.1.1.; 3.4.1; and 9.4.)

(a) It could be argued that technology spurred the growth of non-conformity through the manifest weakness of the established church in the industrial areas; or that it looked for a justificatory area for its emphases and found this in the sphere of non-conformity.

(b) Perhaps a third factor lay behind technological growth and religious involvement, in that both relied heavily on a socio-psychological ability of individuals to innovate - the one to forge new paths in religion, the other in practical inventions. There are many possible combinations of socio-cultural influences and it would be foolish to say that any one was an adequate explanation by itself. (Cf. Robertson 1970, p.178.)

(c) There is another possibility - that non-conformity did in fact spur the development of technical growth - which does not negate divergent factors. There was the positive thrust of a doctrine that accepted the cultural mandate to subdue the earth; but there were also the social conditions already noted which must have facilitated, without doctrinal impulse, a non-conforming interest in this area. The Non-Conformists were obviously at serious disadvantage in the arena of politics and church life and would find natural outlet for their abilities in the fields that science and technology were opening up

The social structure in which the Non-Conformists lived was conducive to the advance of commerce and industry. It had a strong emphasis on modern education which, when joined with a desire for achievement and knowledge, was highly akin to the scientific spirit. To this can be added their democratic outlook which gave scope to the individual and stimulated innovation. Again they were closely knit communities, tending to intermarry, which led to social and business networks at national level. Thus when the Quaker banker Samuel Pease wanted to promote the Stockton and Darlington railway in the early 1820's he was able to call on 'Friends' in Norwich and London for financial assistance.

This Non-Conformist involvement in industry is no small matter for their contribution was quite out of proportion to their strength in the general population (cf.3.3.1.).

> "The most striking contribution to the number of entrepreneurs .....is that of the English Nonconformists. In contrast to their 7 per cent of the population of England and Wales, they contributed 41 per cent of the English and Welsh entrepreneurs whose religion is known, while the Anglicans, who constituted almost all of the remaining population, contributed only 58 per cent. The Nonconformists contributed about nine times as many entrepreneurs, relative to their total number in the population, as did the Anglicans." (Hagen 1962, p.297.)

6.2.2. The Quakers. The Quaker contribution to 18th century technology is a good example of the positive impetus given to industrialisation from such sources. George Fox (1624-91), born the son of a weaver, taught that it was essential to bring all of life, including trade, under the influence and standards of the spiritual life. There was an intrinsic need to practice a strict, personal religious code in daily life. The Quaker ethic centred round the 'inner light' that each person had within, and the tenet that all men were equal before God. The early Quakers were drawn largely from the fields of agriculture, crafts and trades, and it was not until later in the 18th century that the proportion of professional and self-employed began to show significant increase. By the end of the century, however, they were tending to become middle class - largely due to their success in business and their emphases on the importance of education and self-improvement. Education had played an important role from the beginning and from the 1680's onwards there were small schools for Quaker children which stressed subjects of obvious utility or which had forseeable potential in the light of developing society.

These schools take their place alongside the Dissenting Academies as an important factor in shaping industrial England.[2] It was religious belief that led to separation from the establishment by the dissenters, and it was within that framework of belief that they found the incentive to pursue educational, commercial, and industrial interests. It was not education that was crucial but belief.

> "Why was it that many of the most important contributions to English medicine and science in the 18th century came from a rather restricted geographical district in and about the county of Lancashire? .... I believe that the secret lies not in the Warrington Academy, but in the great wave of religious unrest that brought it into being." (Fulton 1933, pp.51,52.)

The Quakers fitted in well with the scientific ethic. Their religious motivation to seek after truth (inner light) by means of reason was analogous to the scientific mentality; their integrity and honesty, even when distasteful, was a necessary feature in the objective reporting of scientific observations; in both fields there was the prerequisite emphasis on primary sources; and their roots from artisan stock meant a high respect for practical elements. Their conscientiousness and precision led to prominence in many fields. In clock-making they were noted for their careful workmanship and the accuracy of their instruments - features which were the key to experimental science. Many of the famous clockmakers were Quakers: men like Thomas Tomion (1638-1713) who was commissioned to build two clocks for the Royal Observatory in 1675; Daniel Quare (1648-1724) whom the King wanted to appoint as his personal watchmaker in 1714 at a salary of £300 per annum; George Graham (1673-1751) who also made important steps forward in astronomy and navigation, constructing the mural arc at Greenwich in 1725 which recorded star positions with great accuracy, and developing the transit telescope and zenith sector. Graham actually advised J.Harrison, the first to design a truly accurate chronometer, and even supplied the finance for the construction of the first model.

Quakers, while often not in the front rank, were influential on

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2. The Dissenting Academies were critical in educating many in the ways of science. A study of them and their timetables is revelatory of a wide interest - wider than the universities. Unfortunately space precludes any examination of them.

those who were – such as Harrison. There were also the influences of S. Alexander on Priestly; and that of the blind Quaker J.Gough and the mathematician E.Robinson on the life and work of J.Dalton who constructed the first truly modern theory of the atomic structure of matter. (Cf. Coley 1974, pp.73–109.)

6.3. THE INDUSTRIAL REVOLUTION

The Industrial Revolution is difficult to date but can be taken as that period between 1750 and 1900 – though there were important changes and forming influences prior to 1750. It has been claimed that the Industrial Revolution was in fact the British equivalent of the French and American revolutions (e.g. Bronowski 1973, p.259.), but though there may be elements of truth in this it should not be pressed too far.[3] Political revolutions were relatively short and traumatic experiences in the lives of their respective countries; while the industrialisation of Britain was much more diffuse and lacked precise form or focus. It also occured in those countries which had political revolutions! No doubt in Britain there were sudden changes in life-style, but in general before 1760 most work was taken to the villagers in their homes, while after about 1820 workers began to be brought into factories and have their work supervised.

What did the Industrial Revolution basically mean? Essentially it meant that the shackles were taken off the productive power of human societies and led to the constant, rapid and apparently limitless multiplication of men, goods and services. The key was not in the first instance automation or technologies, though these played their part, but production – the submission of men to an apparently autonomous power that stood over against them in domination.

6.3.1. Background Phenomena. In looking at the Industrial Revolution several phenomena need to be borne in mind.

6.3.1.1. Technical Experience. The developments that occured in production were the fruit of long technical experience. Technological change does not occur overnight, even today, and "every invention has its roots in a preceding technical period." (Ellul 1964, p.47.) There is 'collective incubation' where every new technique

3. Perhaps the same misapplication of the term 'revolution' is made here as in the 'Copernican Revolution'. The non-scientific denotation of revolution is political – not industrial or Copernican.

grows out of the experiments and failures of the past. Now, while the technological inventions of the Industrial Revolution were modest compared with our century, industrialisation only became possible through a number of remarkable inventions. The development of water power and communications by a man like James Brindley; the water frame - 1769; the spinning jenny - 1770; Crompton's mule - 1779; the self-acting mule - 1792; the power loom - 1785; and of course the steam engine. From these it can be readily seen that the main thrust of the early period was in the textile industry - the important cotton industry being a by-product of overseas trading. The steam engine was largely confined to mining at first and this was where its early development took place. Interestingly the steam engine required no more knowledge of physics than had been available for many years - an indication of a time lag between science and technology.

<u>6.3.1.2. Population Expansion.</u> A second phenomenon was the population expansion which led to the growth of needs, as well as providing cheap labour. The rising population was not, as sometimes thought, the result of the Industrial Revolution. This would not explain the large population increase in a country like Ireland which had subsequently to shed much of this increase abroad. But the increase of population did have significant effects - it meant improved agriculture in order to feed the growing masses, as well as added incentive to industries in terms of labour resources and home markets. Hungry mouths could only be fed if hands were employed in manufactures which, through improved technologies, could be exchanged abroad for adequate supplies of raw materials and foodstuffs.

<u>6.3.1.3. Fluidity of Social Milieu.</u> Economically there is in times of change a need for a stable situation as well as potential for development. Stability is necessary for primary technical research, while openmindedness is required if that research is going to be translated into reality. Economically there was throughout this period the accumulation and international availability of capital as never before. This was furthered by the improved methods of transport and communication systems. War, too, was an important factor, necessitating the increased production of certain key markets. At a more mundane level, the patent laws helped promote innovations and further technical mastery in industry. In general there was a spirit of freedom (political and personal) in Britian as a result of its religico-political heritage.

6.3.1.4. Technical Intent. Lastly there was a clear technical intent - an overruling search for the 'one best way' which when found became self-directing. This had the unfortunate result of putting many entrepreneurs in the position where they put the interests of technique above that of employees, leading in turn to a reaction against the age of the machine. A reaction championed by General Ludd and 'Captain Swing' in textiles and agriculture respectively.

There has been furious debate as to which factors were the crucial ones. Not unnaturally Hobsbawm (1962), a Marxist, stresses the productive elements, war and the rightness of the social conditions. On the other hand Ashton (1968) looks to the rates of interest on government stocks, the stimulus to economic growth stemming from non-political factors such as the nonconformists, and individual contributions in the face of little direct government interference in industry. (Cf. Harvie 1972, pp.8ff.)

6.3.2. Industrial Development. This was neither linear nor simple to analyse. Derry and Williams (1970, ch.10.) depict three basic divisions within the period which are as good as any. From 1750-1815, a period which encompassed two revolutions and three wars, and saw the impact of men like Arkwright, Wedgewood, Boulton and Watt; from 1815-1870, a period characterised by the explosion of the railway system; and from 1870-1900, a period when power began to shift from Britain.

6.3.2.1. 1750 - 1815. There was a basic increasing tempo of industrialisation from 1750 to 1792 which saw the development of spinning and the improvement of the steam engine by Watt. But the impact of the steam engine, though significant, must not be over-estimated in the 18th century. The first - in 1774 - was used to drain a colliery, and the second, built the same year, was used to work a blast furnace. Yet by the end of the century less than 500 had been built under Watt's patent.

From 1792 to 1815 the history of Europe was dominated by the French Wars and it should be noted that not all the suffering attributed to industrialisation is justified. Suffering abounded, but often because of war and not because of technological changes. However, the Industrial Revolution was oppressive and trade unions were suppressed in 1799, being outlawed until 1825 when the Combination Act was repealed; though even this did not mean unions were recognised in the way they are today. At the end of the wars the industrial scene was marked by the Luddite response.

6.3.2.2. 1815 – 1870. The period following the wars up to the Great Exhibition of 1851 saw Britain excell – she was foremost in agriculture, in the expansion of railways, and in her cotton trade. Here too was the rapid growth of the machine-making industry based on the development of machine-tools. By the middle of the century France was producing an approximate total of 67,000 h.p. of steam power – less than was being used in Britain for cotton alone. But other countries were coming to the fore. A notable student of Britain's steel production in 1838 was Alfred Krupp, heir to a small ironworks in Essen – it was an empire that would not remain small for long. By the 1840's Germany was beginning to forge ahead in the art, design and application of fabrics, as well as establishing her reputation for fine metal-work and a broad educational system. At the Great Exhibition the young America captured the technological imagination with machines like McCormacks labour saving reaper, the sewing machine and the colt revolver. But Britain still dominated both in trade and skill, and indeed many of the skilled workers on the continent and in America were British.

From the Exhibition to the end of the century there was a period of nationalistic wars and the increasing dominance of a materialistic outlook. Interestingly by the end of the 1860's the acreage under plough (and in wheat) in Britain reached new maximums, a testimony to high efficiences. Thus the 1850's often saw workers better off than before.

> "....from the 1850's onwards, with sustained employment and with wages rising faster than prices, it became demonstrably true that the industrial worker in Britain was a gainer by the industrial revolution. He could afford to eat meat and wheaten bread produced by the improved agriculture..... a great increase in the cleanliness of his person, clothes, and home." (Derry & Williams 1970, p.300.)

The picture was not one of simple oppression, of unrelieved gloom. It was at this time that the Saturday half-holiday became a feature of life in English factory districts – known abroad as the 'semaine anglaise.'

6.3.2.3. 1870 – 1900. Britain began to lose her lead. She had developed the steam engine and was stuck with it when others changed more rapidly to electrical power and the internal combustion engine.

6.3.3. The Industrialist : The Darby-Reynolds Empire. The entrepreneurs were not all hard, intolerant businessmen in the ruthless pursuit of maximum profit. Despite the evils and injustices that abounded it is fallacious to generalise and claim that all the leaders of the commercial and industrial fields trampled workers into the ground.

> "The men who made the Industrial Revolution are usually pictured as hardfaced businessmen with no other motive than self-interest. That is certainly wrong. For one thing, many of them were inventors who had come into business that way. And for another, a majority of them were not members of the Church of England but belonged to a Puritan tradition in the Unitarian and similar movements." (Bronowski 1973, p.274.)

Something of the positive influence of religion on industry can be seen in the fields of iron and steel. The field of iron was perhaps the area of most significance in the Quaker contribution in the 18th century when they constituted the mainstay of that industry. (Cf. Coley 1974, p.85.)

Abraham Darby (1678-1717) formed the Bristol Wire Company about 1702 and soon began experimenting with the substitution of cast iron for brass. In the pursuit of this a small iron-works was added to the plant and out of the integrated plant, and over the next century, the Darby empire contributed significantly to the iron industry. From it flowed many important innovations such as using coke for smelting; linking processes by iron-railed wagon-ways; and social measures for the welfare of workers. In 1701 Darby went to Holland to study methods and brought back new procedures and some Dutch workmen. By 1707 he had discovered that he could replace charcoal with coke which led to more continuous production runs. He developed new processes of casting iron articles. There was, in fact, great outlet in the domestic market for iron pots and pans, but the new processes would play an important role in the production of parts for steam engines. In 1709 he took over, with two partners, a lease on the iron furnace at Coalbrookdale which was to become the classical centre of the iron industry for many years.

In 1742 Abraham Darby II introduced a steam engine to improve the efficiency of the works and replaced the old bellows by wooden blowing machines which provided a more uniform blast. But it was the next in line, another Quaker, Richard Reynolds who introduced the most overall startling innovations. Married to the daughter of Darby II, he became a partner in the firm in 1756 and assissted in the programme of expansion until 1763 when he himself became manager. He introduced the conversion of pig-iron to wrought iron without charcoal in a reverberatory furnace. In the pursuit of this Reynolds displayed a considerable knowledge of chemistry and of the actual iron-making process, and at the same time a willingness to learn from his workers from whom several important ideas stemmed. Again he allowed experimentation to take place using up the companies' resources. In 1749 wooden rails had been introduced to facilitate the movement of materials within the integrated plant, and these Reynolds replaced with superior iron rails.

Social concern was high on Reynolds priorities. All the materials coming into the plant were brought via the Severn in barges towed by gangs of men. This Reynolds held to be demeaning and degrading and worked hard to obtain land by the river side in order to provide tow paths for horses. That an interest in social welfare should occur is not surprising when it is remembered that the Quaker integrated the whole of life before God and held human equality dear to his heart.

> "From the beginning the Darbys were concerned that their workpeople should be properly housed and the works estate contained workmen's cottages as well as the Darby's own house. The latter included offices and a large room where meetings could be held, although a separate Meeting House was soon built as part of the general plan. The unification of the religious and business aspects of life were well exemplified in the Darby family. They maintained a true Quaker home with simplicity and sincerity and the same spirit pervaded the works, where there was to be found little or no evidence of trouble over wages or prices. The furnaces were always shut down on Sundays, despite losses arising from cooling the melt and the technical difficulties this caused. The company preferred to lose something in order to give their workpeople a free day for recreation and worship." (Coley 1974, p.89.)

Continuing in this tradition Reynolds purchased land and laid out walks for his employees so that they could enjoy the woods and surrounding beauty spots; he built schools; and in time of food shortages bought in bulk in Liverpool and sold in turn to the work-people at cost price or less.

6.4. SCIENTIFIC AND TECHNICAL ASPECTS.

6.4.1. The Steam Engine. Perhaps the two most dramatic innovations were the advent of the steam engine and subsequently the railway.

The steam engine was the most sophisticated product of the earlier period and has been seen as the pivot of the whole period (Toynbee). But its initial impact was largely confined to the mining industry where it was first developed. Nevertheless it soon spread to other areas and possessed an intoxicating and dramatic effect on the life of Britain. The steam engine symbolised the new drives for power and domination, and Boulton could remark that he sold what all the world desired - power! (Cf. Bronowski 1973, p.280.) Power could be seen tangibly in the railway. It was Richard Trevithick who turned the steam engine into a mobile power pack, though the main development lies in the hands of Watt and Stephenson. The railway was matched by no other invention of the period in terms of public impact. It alone displayed for all to see the power and speed of the new age - the early engines were soon capable of 60 miles per hour (by 1830). Thus it was this aspect of the revolution that came home to the layman in dramatic fashion - witness the literature and poetry stemming from the railway. Yet the domination of steam in industry itself was not so dramatic. The largest Boulton and Watt steam engine built by 1800 was capable of only about 80 h.p., whereas large water wheels could easily produce anything up to 150 h.p..

<u>6.4.2. Electricity.</u> Despite the technical changes it is essential to realise that there was no basic shift in the scientific world comparable with the change from Medieval to Newtonian worldviews (at least in the physical sciences.) But there was an intensification and extension of the mechanical outlook. It was a time when science and technology moved closer together and industrial innovation and scientific theory began to be integrated. There was an interaction that occured in both directions: thus the new science of electricity led to a corresponding industry; while the industry associated with the development of the steam engine led back to the theory and development of thermodynamics. (Cf. Pledge 1966, p.149.)

If there was no shift in perspective there were new fields being opened up in electricity, thermodynamics, chemistry and mathematics. Electricity was important in forming our modern society and life today is unthinkable without the benefits of our electric technology. But it was developed largely abroad due to the strangling influence of steam on the British situation - though British scientists played crucial roles in its development. The basic steps of the new field of electromagnetism were in 1786 when Galvani discovered the electric current; 1799 when Volta constructed the first battery; 1800 when electrolysis was discovered; 1820 when Oerstad saw the connection between electricity and magnetism, thus opening vast new possibilities and reshaping the theory of the new science; and finally in 1831 when the devoutly motivated Faraday provided the necessary synthesis to bring the various facets of theory together and set forth an integrated and consistent theory.

6.4.3. Thermodynamics. Electricity would revolutionise the life-style of man and so too would the new science of thermodynamics. The two laws of thermodynamics became the most important theoretical discoveries of the period and are still regarded by many as the most 'certain' of all scientific laws. By 1824 the steam engine had led Sidi Carnot to the fundamental insights necessary to construct the two laws - which subsequently received various formulations. The first law is that of the conservation of energy; and the second states that: "Heat cannot be converted completely and continuously into work." (Montgomery, S.R. 1966, p.106.) The key is not the first but the second law which deals with direction, and utilises the analytical concept of reversibility abstracted from the caloric theory of heat flow. The first law is historically attributable to the notion of heat as a substance, and depended on the demonstration of convertibility of heat to power. But conversion is not the same as reversibility and here Carnot was wrong - heat does not just flow, it is degraded in any conversion. What is conserved is energy. This concept of reversibility was the essential parameter which led Clausius on to the theory of entropy. (Cf. Appendix B.)

It is interesting to note the basic Christian framework in which most of these scientists still operated. A framework in which mechanical models predominated but still found a reference point in the Creator. So Gillespie tells of J.P.Joule, who experimented to try and find the mechanical equivalent of heat, and who could write, after a failure at the Chamonix waterfall - an experiment conducted on his honeymoon: "I shall lose no time in repeating and extending these experiments, being satisifed that the grand agents of nature are by the Creator's fiat indestructible..." (Joule: In Gillespie 1967, p.371.)

6.4.4. Chemistry. This was often the closest of the sciences to industry in practical terms in the bleaching and dyeing processes of the textile industries. Again religious figures such as Priestly and Dalton were prominent; Priestly in turn advising the Christian industrialist, Josiah Wedgewood.

6.4.5. The Lunar Society. Many of those so far mentioned - Priestly, Wedgewood, Boulton and Watt and others such as Wilkinson and E. Darwin belonged to the Lunar Society which evidenced the social awareness of scientists and industrialists. This society, like others of its kind, was based on the simple belief that life was much more than material success and decency, but that material decency was a base on which the spiritual should rest.

6.4.6. Mathematics. This was another important area of development, though it did not filter through to the general consciousness as readily as other facets. (Cf. Pledge 1966, chs. 12 & 13.) But this area did have revolutionary impact in the theoretical world. Here was the theory of functions of complex variables as developed by Gauss, Cauchy, Abel and Jacobi; the theory of groups by Gauss and Cauchy; and the conceptual overthrow of Euclidean geometry in the work of Lobachevsky and Bolyai (Cf. Boyer 1968, ch.23.) No longer did parallels never meet, and the world as a globe in fact conforms to Riemannian and not Euclidean geometry. But to make these assumptions in the early 19th century was the theoretical daring that had put the sun at the centre of the universe and developed the laws of planetary motion.

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But it was not all progressive in the world of the sciences and technology. There was a swing away from the mechanical monster into the arms of nature and romanticism, a rebound from the machine to biological interests. Here was the rise of Schelling's 'Naturphilosophie' from 1779 on; and the rise of the human and social sciences - sociology coming out of Comte's critique of capitalism. Further, there was creeping into life an element of philosophical irrationality under the dominance of the machine age. "Technicism leads directly to irrationality " claims Mumford (1973, p.375.) in a sentiment echoed by such diverse writers as Ellul, Fromm and Kierkegaard.

6.5. THE IMPACT OF INDUSTRIALISATION : SECULARISATION

Adam Smith in his 'Wealth of Nations' gave prophetic warning concerning the issues that would arise out of the industrial process.

Long before the phrase 'industrial revolution' came into common usage, the process was described by continental commentators as the 'English System', as they discussed the new forces of legal individualism and economism. But crucial to the force of impact is the question as to whether the changes in society were slow or abrupt. Hobsbawm (1962, p.46.) maintains that the changes were sudden, qualitative and fundamental; and Nisbet writes that "to intellectuals of that age, radical and conservative alike, the changes were of almost millenial abruptness." (1970, p.22.) However it seems to me that there is a fallacy stemming from an equation of the 'French Revolution' with industrial processes. Technical changes were no doubt traumatic in the life of the nations, but it can hardly be compared with the political revolutions in France or America. I contend that British society was much more mixed than is often suggested. It was not just a question of capitalistic oppression, for as we have seen this was mixed with positive religious doctrines. The folly of advocating an abrupt change seems to me evident when we consider the debate as to when the Industrial Revolution in fact began, and that to talk sensibly of it we require to consider some 150 years.

Yet the period was transforming in a radical way, and a new vocabularly itself indicates this. Among the words invented or given their present meaning were -- industry, democracy, class, ideology, humanitarian, masses, commercialism, proletariat, liberal, collectivism, conservative, scientist, capitalism and bureaucracy. (Nisbet 1970, p.23.) At another level, words which were increasingly descriptive of the times were 'mechanical', 'disintegrated' and 'amorphous' -- key words as Williams (R. 1961, p.201.) points out in describing the effect of industrial priorities over individuals and society.

The basic impact was the increasing and unprecedented secularisation of the masses. The 19th century, with increasing industry and urbanisation, created a situation where the established churches could no longer cope -- the parish system fell apart at the seams. The result was an upturn in the fortunes of Protestant sects -- a feature not unconnected with their more relevant stance vis a vis society, as even the Marxist Hobsbawm notes (1962, p.264f.) By 1851 approximately half of the Protestant worshippers in England and Wales were outwith the established church. But despite the expansion of the Non-Conformists in England and the desperate attempt at consolidation by the church in Scotland, the working classes were increasingly cut off from religious influences. A trend not significantly altered by the many revivals of the 19th century which tended to a pietistic withdrawal from the 'world'.

Interestingly, the Protestant Non-Conformists were found attractive to the rising entrepreneurs who found there an emphasis on exclusivism, individual communication between man and God, and a moral austerity that equated well with their outlook on life. It meant a blurring of the religious influences and a move to a much more justificatory position from the motivatory one of the earlier scientists and industrialists - such as the virtuosi and Quakers.

If secularism was the basic impact, the forces leading to it were not so much from industry qua industry, as from the attendant urbanisation and the conditions imposed on labour. The Industrial Revolution saw the rise of what Germans have designated the 'Grosstadt' (the city which is purely a product of industry) as opposed to the ancient centres of commerce and the modern megalopolis which was founded on the knowledge worker. (Cf. Drucker 1969, p.51f.) Yet this was often urbanisation without community; agglomeration without integration.

Much of course has been said about the evils of working conditions and the domination by the pace of the machine. Domination by machinery first in the areas of dexterity and skill, and apparently extending into the very ability of intelligence. This is where we find the pungent criticisms of Cobbett and Ruskin and of the validity of this there can be little question. (Cf. Harvie, Martin & Scharf 1970, pp.110,111,115; Williams, R. 1961; Nisbet 1970, p.25.)

Yet having taken note of this it would be wrong to envisage a universal mass oppression. Indeed as late as 1860 the majority of workers were still employed in concerns of seven or less; a feature which sits uneasily with the tendency to view a rapid and traumatic massification of life and industry at the onset of the industrial revolution. (Cf. Harvie 1972, p.89.) It can thus be contended that working conditions rose in general along with the standard of living. Recent scholarship has suggested that the conditions of the working classes in the early period of industrialisation was better than in the immediate past of our century. (Cf. Harvie, Martin & Scharf 1970, p.118.)

6.6. RESPONSES TO INDUSTRIALISATION

There was in the early stages of industrialisation almost a messianic hope in the new technologies. This is echoed in the phrase of William Blake that 'Energy is Eternal Delight' (In Bronowski 1973, p.285.), and in the thought of Erasmus Darwin who found in the machine an intriguing and ingenious artifact which had not yet become a driving obsession. (Cf. Harvie, Martin & Scharf 1970, p.46.) But by and large there arose an intellectual opposition to the new machine age. The conservatives distrusted the factory and its artificial division of labour, seeing therein that which was calculated to destroy the peasant, the artisan, the family and the community. It was easy to read into the workings of the machine that which was degrading for creatures made in the image of God. So from the satirical Butler in 'Erewhon' (1872) to the criticism of Carlyle, a whole literature arose which saw the latent potential for destroying all that had been held dear to man - his uniqueness in creation, his individual value and role in society. All that was left was dominion and that was turning out to be domination without responsibility or stewardship. Matthew Arnold writes:

> "Faith in machinery is, I said, our besetting danger; often in machinery most absurdly disproportioned to the end which this machinery if it is to do any good at all, is to serve; but always in machinery, as if it had a value in and for itself. What is freedom but machinery? what is population but machinery? what is coal but machinery? what are railroads but machinery? what is wealth but machinery? what are, even, religious organisations but machinery?" (1869, p.174.)

The problem was that industrialisation was taking over the whole of life, all else was being subjected to the rhythym of the machine and the consequences would be profound. Perhaps the greatest criticism came from the pen of Carlyle, especially in his essay 'Signs of the Times' where he clearly foresaw the dangerous consequences of the new era, the domination of mechanism and the spiritual emptiness this engendered.

> "Were we required to characterise this age of ours by any single epithet, we should be tempted to call it, not an Heroical, Devotional, Philosophical, or Moral Age, but, above all others, the Mechanical Age. It is the Age of Machinery, in every outward and inward sense of that word; the age which, with its whole undivided might, forwards, teaches and practises the great art of adapting means to ends. Nothing is now done directly, or by hand; all is by rule and calculated contrivance. " (1829, p.21.)

Such criticism did not deter others projecting the mechanical philosophy into other realms in an affirmative manner. T.H.Huxley argued that animals were only machines, and from there it was but a short step to humans. "It is quite true," he writes, "that, to the best of my judgement, the argumentation which applies to brutes holds equally good of men... We are conscious automata.." (1874, p.212.) Likewise Clifford posited man as a dualistic being under the impetus of mechanism. "Thus we are to regard the body as a physical machine, which goes by itself according to a physical law, that is to say, is automatic." (1874, p.217.) He continues in the same essay:

> "It is idle to set bounds to the purifying and organising work of Science. Without mercy and without resentment she ploughs up weed and briar; from her footsteps behind her grow up corn and healing flowers; and no corner is far enough to escape her furrow. Provided only that we take as our motto and our rule of action, Man speed the plough." (ibid p.222f.)

This was undiluted technological romanticism!

6.7. REVIEW

In drawing this brief survey of industrialisation to a close it should be borne in mind that we are still, in a real sense, in the middle of the industrial revolution, or at least its immediate developments.[4] But the industrialisation of society was not itself the cause of crisis, rather it was the misappropriation of power by the rising entrepreneurs, the evils of a system that necessitated either conformity or exclusion. So while there was no basic clash between technological development and religious belief, it must be said that the failure of Christians to develop intellectual structures, within which to contain the new powers of mankind (science, technics and organisation) would lead to an apparently unsolvable dialectic between man and his powers. As Hobsbawm concludes: "The gods and kings of the past were powerless before the businessmen and steam engines of the present." (1962, p.73.) But this is, as we shall see, a pseudo-dialectic.

4. This chapter is in a sense continued directly in chapter 26.

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CHAPTER 7

THE 19th CENTURY EVOLUTIONARY CONTROVERSY

7.1. THE PRE-DARWINIAN SCENE IN BIOLOGY AND GEOLOGY

To understand the debate over Darwin's 'Origin of Species' it is necessary to examine the history of geology and biology prior to 1859. There was little consensus of opinion concerning basic thinking in these fields, and several conceptual frameworks were firmly adhered to before, during, and after 1859.

7.1.1. Mechanism v. Vitalism. The former was traditionally strong in France, the latter in Germany. The 'mechanist' believed that biology would eventually be reduced to the physical sciences so that there would be no mystery to be faced in life. The 'vitalist' held to the belief of an organic residue in the constituence of life which required some non-physical organising power or force. It has been suggested that in time there was a gradual triumph of 'mechanistic' views over 'vitalistic'; but this is not clear cut as there has always been proponents of both views, while the actual dominance swings from one to the other. (Cf. Brooke 1974/c, p.11.)

7.1.2. The System-Builders v. The Nomenclateurs. This is a further division on a methodological level. Following Newton the construction of tight and elaborate systems was in the air. Voltaire complained that science was being bedeviled by a 'mass of systems', while Buffon saw this as nothing but flights of fancy. The alternative to systems was to embark on classification into families rather than into rigorous hierarchical systems. This latter view was developed by Linnaeus in botony, Lavoisier in chemistry, and Romé de Lisle in crystallography. Both approaches have histories going back to the Greeks. Indeed Aristotle posited both - arranging organic species in a hierarchy with large discontinuities; and seeing creatures in a great continuous linking chain of being. The division into discontinuous groups has been categorised as an 'artificial' method, while the arranging of diverse species within families as a 'natural' method. (Cf. Mason 1962, pp.331-335.)

7.1.3. The Neptunist - Vulcanist Debate. This was a great issue from 1790 to 1820 and the basic positions were that the rock strata had been suddenly formed (Neptunist) or that they had been gradually developed

(Vulcanist). The former view was readily facilitated by studying the sedimentary rocks, while the latter was enhanced by the study of volcanoes and basalt rock structures.

Of patriarchal stature for Neptunists was the German geologist Abraham Werner (1749-1817) who unfortunately built his theories on the basis of his local knowledge and did not consider other evidence such as the overthrust formations which exhibited older strata above the younger. Such objections were bypassed and adherence given to the precipitation of rock forms, either by chemical or mechanical processes, from some aqueous solution. But despite the apparent problems this view was deeply entrenched and respectable in scientific circles for it possessed great explanatory power. Many noted geologists supported the view such as Kirwin, Deluc and Jameson; it was accepted by other scientists like Davy and Watt; and it reigned in the universities of Scotland. (Cf. Gillespie 1959, p.68.) Kirwin violently opposed the alternative view being postulated by Hutton, but his views tended to degenerate into wild polemic. Firmly adhering to the Mosaic account he attacked anyone who seemed to stray from this, including Deluc. For Kirwin science was closely integrated with religion and he displays more the language of natural theology than objective science. Deluc, on the other hand, was much more restrained though advocating a similar view. Moses was still firmly seen as a reliable scientific authority.[1] (Cf. ibid p.50f.)

Robert Jameson (1774-1854), professor of natural history at Edinburgh, led the Wernerian forces in their almost religious adulation of the founder of their school. On the opposing side was another Scottish scientist, James Hutton (1726-97), who was perhaps the chief proponent of the Vulcanist view, as well as the principle of uniformity. The whole conflict came to a head in the Scottish setting and the story is recounted of a play written by an ardent Huttonian being hissed off the boards of an Edinburgh theatre by a house apparently packed by Neptunists!

Hutton was restrained in speculation and under the influence of Deism. He stressed the geological activity of the internal heat of the earth, though also accepting the formative power of water. His

1. One of the delightfully naive characteristics of this debate was the manner in which everyone seemed able to accuse others of forcing the facts to fit their theories, while they themselves were free from such subjective delusions.

views were largely based on the assumption of the constancy of the forces of nature and a general picture of stability, which was in effect uniformitarianism being utilised to account for the past events in the structuration of the earth's crust. However he divorced this from the question of origins. Hutton was ably assisted by Sir James Hall and John Playfair, two more Edinburgh men. (Cf. Mason 1962, p.404.)

7.1.4. The Uniformitarian - Catastrophe Debate. This debate interacted with the above controversy, though by no means followed parallel lines. These debates were of intense general interest and this is indicated in the high popular standing of geology - which was one of the first sciences thought suitable for ladies. This popularity is seen, for example, in the mass gathering in the Dudley Caverns near Birmingham in 1839 - an episode recounted by a rather bewildered German chemist, Herr Schonbein who had had more than enough after first Buckland, then Murchison, spoke for over an hour each. (Cf Gillespie 1959, p.200.)

It was in this era that geology developed the principle of uniformity to interpret the past in the light of the present. The principle has several senses. (Cf. Rudwick 1973, p.206.) (a) There was a general sense of uniformity without which science became impossible. (b) There was what Hookyaas termed 'Actualism' (1974/b, p.74f.), the view that the agencies responsible for past events can be evidenced today. (c) Strict 'Uniformitarianism' went beyond (b) to claim that these agencies possess the same intensity in the present as in the past.

This debate never engendered the bitter invective of the Neptunist-Vilcanist debate, mainly because it was contained within the confines of the Geological Society of London. (Cf. Gillespie 1959, p. 122.) There was, however, a certain affinity between the Neptunist and Catastrophist positions. The Catastrophic viewpoint, as opposed to the Uniformitarian, held that present causes were not sufficient to explain the past. But confusing this picture was the feature that by application of the 'actualistic' method one could arrive at the Catastrophic system; whereas by holding to Uniformitarianism as an implied method one could arrive, via an actualistic principle, at an Uniformitarian system.

Non-uniformitarian views held that great irreversible changes had occured in the earth's crust and in the organic world, and this basic catastrophic position centred on the universities where men like Buckland (Oxford) and Sedgwick (Cambridge) held chairs. It must be noted that, though the uniformitarian views would ultimately triumph in the 19th century, catastrophists did more to extend the frontiers of knowledge. They held their views because of the evidence of mechanical violence on a large scale, and because of the complete changes in living things - both of which appeared amply testified to by the evidence. Indeed there was strong support in palaeontology for the sudden appearance of higher animal forms in the younger strata.

The basic creed of Uniformitarianism was the explanation of the past in terms of present causes and processes which obviated the need of any sudden transformations; the explanation of the past without the need to refer to any divine activity - such as an appeal to the Flood; and an explanation of the past as uniform like the present, thus involving no progressively upward changes. Lyell, for instance, originally claimed that the fosil record gave no evidence for directional change. (Cf Hookyaas 1974/c, p.13.) The Uniformitarian view was carried to extremes by Lyell who posited that as well as the same causes being operative, they also possessed the same energy today as in the past. So he applied the actualistic view as true of primary physical causes as well as true of secondary geological ones. Uniformitarianism of this type was derivative from the extreme application of the Actualistic principle, involving the same physical causes plus the same intensity of force. As time passed numerous compromises had to be made in this extreme view which undercut Uniformitarianism as a system, and actualism, as a method, became limited. Therefore Uniformitarianism tended to pass to a view involving a 'coming-to-be' rather than a 'steady-state', or the reversal from uniformitarianism as a system to a methodology. (ibid p.32.)

7.1.4.1. Georges Cuvier (1769-1832) - was an important figure in the formulation of the catastrophist position and provided the scientific 'bible' for those that followed - such as Agassiz and Owen.

7.1.4.2. William Buckland (1784-1856) - was, from 1820 onwards, the foremost English geologist. A Neptunist, he exploited and extended Cuvier's method (of the correlation of parts) and put natural history once more at the service of religious truth. In 1821 miners discovered a large cavern at Kirkdale in Yorkshire in which were deposited a large number of bones (hyena). This led Buckland to produce his magnum opus in 1823 - 'Reliquiae Diluvianae; or, Observations on the Organic Remains contained in Caves, Fissures, and Diluvial Gravel, and on other geological phenomena, attesting the action of an Universal Deluge' (1823, p.371.) Here was the opening blast of the catastrophic controversy which firmly reinstated the Mosaic interpretation. Geological structures were the result of violent convulsions and their cause was not blind chance but the intervention of the Divinity. In his inaugural lecture at Oxford, published as 'Vindiciae Geologicae; or, the Connexion of Geology with Religion Explained', he clearly states his objective:

> ".....to shew that the study of geology has a tendency to confirm the evidences of natural religion; and that the facts developed by it are consistent with the accounts of the creation and deluge recorded in the Mosaic writings." (1820, p.352.)

7.1.4.3. Adam Sedgwick (1785-1873). Following Buckland, Sedgwick and his collaborator Roderick Murchison did much to advance the catastrophic position. Between them they identified the Cambrian and Silurian systems of the Paleozoic period, and correctly fixed them in the geological succession. Sedgwick, a Neptunist as well as a Catastrophist, became professor of geology at Cambridge in 1818. His basic view was that geology clearly indicated that God had not created the universe and left it to run itself.

In 1829 Sedgwick was forced to abandon the views of Werner and accept the Vulcanist position of Hutton - though in 1831 he could still point out that the basic problem of Lyell's theory was that it implied an evolution of species. He might recant the Flood as the explanation of all, but not the catastrophic position. The underpining of the Flood only deprived the catastrophists of their most spectacular catastrophe.

7.1.4.4. Assessment.[2] It is worth noting that this debate is still an open question. "It is impossible to say, even with the advantage of hindsight, that either catastrophism or uniformitarianism was 'right'." (Rudwick 1973, p.206.) This applies to the question of a universal Flood; there may be insufficient evidence to point to such a flood as outlined in Genesis, but equally there is no evidence to rule it out.

2. Space precludes details of others such as William Smith, Joseph Townsend and John MacCulloch (Cf. Hookyaas 1974/b for background details of several leading individuals.)

Uniformity may have become the scientific orthodoxy of the present, but it has had to be qualified under the coercion of facts. Indeed some modern geologists posit a 'pulse of the earth' cyclical concept which rules out the application of strict uniformitarian principles with respect to the early geological epochs. One of the basic problems here is the philosophical reality that once the principle of progressive uniformity is admitted it becomes determinative as to how the evidence will be interpreted. In other words, it is a paradigm lying behind the theories themselves. (Cf. 7.5.)

> "In other words the principle was transferred to other areas of investigation on the unsupported assumption that it applied, the evidence as it was found was arranged in the pattern dictated by the principle and so was shown to support the principle! The example of the tools of prehistoric man is the most telling one....their arrangement in ascending order was made on the assumption that man must have progressed, on the basis of an actualistic reconstruction of how these tools would have been developed by modern man in primitive conditions." (Lawless: ref. Hookyaas & Lawless 1974/c, p.33.)

In the 1830's, even for Uniformitarianists, the Creator was still an important explanatory concept, covering areas that would later be explained by evolutionary theories. As Gillespie comments, "geology had nothing to do with the Bible, this does not seem to have meant that science had no religious implications. All it meant was that Scripture had no scientific implications." (1959, p.139 - cf. pp.105, 218.)

<u>7.1.5. The Development Hypothesis.</u> It is wrong to envisage Darwin's theory of evolution as something new for there was a general move by many scientists to postulate a long, slow development of the earth and its species. In looking back, however, at those who went before Darwin, care has to be taken not to read them in the light of Darwin as this would be unfair to their views. They were predecessors, not precursors.

<u>7.1.5.1. Georges Buffon (1707-88)</u> - had no clear cut theory of evolution as some claim. The choice before him was not simply one of evolution or creation. There was a third choice residing in the firm, and new, belief in spontaneous generation. Hence even if he could envisage one species exterminating another it would be false to picture this in his thought as a competition of species, an element in some causal process underlying evolution. The simple case is , that while Buffon is looked on as one of the early modern forerunners

of evolution, he was not interested in that question as such, but rather in the problem of classification (at least in his early work.)

7.1.5.2. Jean Baptiste Lamark (1742-1829) - is perhaps the most influential figure amongst the French thinkers. Indeed when evolution became established, Lamarkianism would provide a rival viewpoint within the evolutionary camp. He was by no means atheistic in outlook, being under the influence of Deism. He clearly articulated a development hypothesis of the species as opposed to a degenerative sequence (Buffon), and as a skilled taxonomist can be regarded as one of the principal founders of modern biology.

Lamark was committed to the idea of the 'Chain of Being' which led him to posit a linear evolution which he tended to cling to even after such a schemata became untenable. Here he drew on the work of Robinet, and while he could envisage the 'Chain' as not fully continuous, he, like Robinet, suggested it possessed an inner force of self-improvement. He saw creation as that which was rational, ordered and intelligible, and thence as a corollary to this that species could not become extinct. At the same time his natural optimism precluded the concept of a struggle in nature such as Darwin would suggest.

In his work he did not clearly distinguish between what he could prove and what was speculation, and this meant that he could present a ranging and consistent theory of evolution "unhampered by any too nice an attention to evidence." (Wilkie 1965, p.264.) Thus, though he accepted evolution as a general progressive principle, he did so without tying himself irrevocably to any one mechanism to produce such development.

The method of Lamark was in effect the obverse of Buffon's, for he required in principle a linear classification of animals upwards. This led him to postulate three versions of his development theory. (a) His earliest view - 1801 - suggested the agency of inherited acquired characteristics (the so-called Lamarkian mechanism); a schemata in which the 'Chain of Being' was limited to providing a scalar classification on an artificial level and possessed little relation to the mode of origin. (b) The second view - 1809 - is contained in his 'Philosophie Zoologique', and here he posited a natural tendency to increasing complexity in organisms. The 1801 primary theory of acquired characteristics had been reduced to a subordinate role and he could present his thesis as a law of nature resulting in a single linear development. The idea of a 'chain' was exerting its attraction, but unlike the earlier concepts of one unified chain, Lamark suggested two chains - one for the animal kingdom and one for the plant kingdom. (c) Lamark's third view appeared posthumously in 1835 in 'Animaux san Vertebres' where he rejected any single chain of being and saw no gradation from living to non-living. Here the two earlier accounts achieved a synthesis which runs through his thought in a sort of complementary tension. The only conclusion is that there was not one mechanism for Lamark, but two - the inheritance of acquired characteristics, and an innate tendency to increasing complexity, with man the highest complexity. (Cf. Wilkie 1965, pp.267,268.)

Lamark was attacked for his views by scientists and theologians and the two are not always easy to distinguish. On the scientific front there was obviously problems with a theory postulating increasing complexity just when physics was coming to the conclusion that the reverse was the case. In England his theories were associated with the theories of nebular hypothesis which led to cosmic evolution and thence, for the social critics, to revolutionary desires (cf. 1789). But despite the apparently atheistic tone of much of Lamark, he could, as a Deist, slip into teleological arguments as well as in sincerity appealing to the divine plan for the world.

<u>7.1.5.3. Charles Lyell (1797-1875)</u> - gave the basic English response to Lamark in his 'Principles of Geology'. Lyell, a pupil of Buckland, departed from the views of his teacher and pushed uniformitarianism through to an extreme position. He rejected Lamark's theory of the continuous progress and transformation of the species; and also refuted Linnaeus because for him life had a number of foci of creation and not just one divine incubation area. (Cf. Gillespie 1959, p.130.) So Lyell, faced by the apparently increasing difficulty to refer the commencement of all the so-called alluvial deposits to only one event or period, turned to a strict uniformitarianism which posited that the gaps in the 'Chain of Being' were filled through the intervention of intermediate causes - not by some first cause. Change was going on in the present as it had always done in the past, and it was only these same forces which had been at work in previous periods. A pathway was being prepared for Darwin.

Lyell claimed to derive his theory from the appearances, but what he really did was to abstract the general idea of uniformity from Hutton and Playfair and universalise it as a basic principle. Having got his principle all the data was arranged to fit. (Cf. Gillespie 1959, p.128.) For Lyell the fossil record was far too imperfect to indicate a progression in the history of life as expounded by Lamark and he rejected evolution in the 1820's; later he revised his views for if the succession of fossils in the strata implied a geological evolution, then there also had to be an evolution of the organic species.

Interestingly he maintained the dignity of man in relation to the rest of the created order and appears to have had Unitarian sympathies. (Cf. Brooke 1974/c, p.37.) His work on geological forces, however, eventually led him to examine the distribution, dispersal and extinction of species, and from thence to a sympathetic approach to evolution. But to begin with he could see pairs created at different times and places as a requisite of natural uniformity and distinctiveness of species. In a peculiar prefiguration of Wallace, Lyell added intellectual and moral faculties to his basic 'system of nature', for any movement from animal to man involved an "interruption to the ordinary course of nature." (Hookyaas 1974/b, p.70.) However, he recognised that natural selection could be combined with a belief that events follow from forces communicated by some intermittent divine intervention.

In the final analysis the origin of the universe was not a scientific but a metaphysical question. Science and religion had their appropriate spheres and they should be restricted to them in the light of this. Lyell did not question the Pentateuch in terms of history and religion, but it had nothing to do with science. Despite his tempered views on evolution he recognised that his 'Principles' were contrary to accepted opinion and had a bad case of literary nerves while his book was going through the press. He was eventually elected to a chair at King's College, London, and as these appointments were in the hands of the bishops the only conclusion is that, if the bishops were uneasy about his theories, they did not think it serious enough to prevent his election.

<u>7.1.5.4. Robert Chambers (1802-71).</u> Two other important figures who featured prominently at this time were Chambers and Hugh Miller - both

Scottish; both to a large extent self-taught naturalists; and both more interested in the meaning of science than science itself, and in popularly communicating that meaning. Chambers, and his brother, founded the famous publishing firm and had a quite remarkable output of books themselves. But as an amateur in the field of geology he would be criticised as such. However when his 'Vestiges of the Natural History of Creation' appeared in 1844 it was anonymous. But the outcry it brought forth effectively prepared the way for Darwin and helped draw the sting from the later controversy.

Chambers, more uniformitarian than catastrophic, criticised Lamark's mechanism. But his own view was little better or clearer, and relied heavily upon the biological theory of recapitulation. He seemed to suggest that every individual literally went through embryonic stages of being an invertebrate, fish, reptile and so on. Despite this blatant espousal of a radical evolutionary view, his chief aim was really in the field of natural theology where he was trying to set out the beneficent rule of God. His central thesis was that the dominion of natural law testified to its divine source. Hence he suggested that Genesis chapter one resulted from the commands and expressions of the will of God and not from his direct acts. He could therefore quote the biblical material in such a way that it all sounded like a process of development.

The response to this was an outburst of horrified rejection. The theory of development was by no means in the ascendancy, and Gillespie can write, if somewhat sweepingly, that:

> "....around 1850 few scientists of any note in Britain had a good word to say for development or a kind one for the author of the 'Vestiges'. Catastrophist and uniformitarian, astronomer and biologist, joined in repudiation. Even to quote a sentence or so from each of the leading figures would require pages - they all spoke out: Herschel, Whewell, Forbes, Owen, Pritchard, Huxley, Lyell, Sedgwick, Murchison, Buckland, Agassiz, Miller and others." (1959, p.162.)

It was claimed that the 'Vestiges' was contrary to Scripture with respect to the uniqueness of man in the image of God; that it destroyed the physical and moral distinction between man and animals; and that it was a work of rank materialism. To conceive that biblical fundamentalism was the chief problem would be quite wrong, for the social, moral and materialistic problems were shared by Christian and non-Christian alike. (ibid p.167f.)

7.1.5.5. Hugh Miller (1802-56) - was a key figure in the arena of skilled, yet popular, reaction to the new theories of uniformitarianism and development. He was an unequivocable evangelical and a respected scientist. His attitude to God's world was that of a romantic lover of nature and though his original contributions to the field of geology were sound and important, they are not of first importance. Essentially he was a populariser and interpreter.[3] He firmly believed that science revealed the wonder of God's creation; that it was therefore of the greatest educational value; and that a profound knowledge of geology should enoble the Christian mind. Thus his task of popularising science was a religious duty. At the same time he was no literalist, holding that the six days of creation were six epochs/exertions of creative activity. He was, in effect, a progressive evolutionist who saw the creative power of God unleashed at the start of each new epoch. But development as expounded by Lamark and Chambers was a figment of the imagination with no basis in reality for Miller, and he invoked the fossil Coelacanth to confound the development thesis.

Unlike others, Miller achieved a real harmony of his faith and his science. It has been said of him that "he performed the unique feat of blending science and religion together instead of bending them together." (Gillespie 1959, p.175.) His reasoning was quite simple: if man came from the lower animals then either animals had immortal souls or men did not. Indeed he reverted to the doctrine of degradation and pictured each epoch as a regression from higher to lower forms - although the existence of man could be a problem here.

He was a damaging critic of the 'Vestiges' and his critique was particularly penetrating for, unlike many, Miller knew exactly where he stood. He was an evangelical not a deist, and as a result placed no final stress on design. The basic problems were ethical, not abstract, and he required "a divinity rather than a landscape gardener." (ibid p.177.) His God was a God of love and redemption who held out

3. The first ten editions of the 'Vestiges' ran to some 25,000 copies; Lyell, in two editions, managed toreach a circulation of only 4,000; but Miller's 'Testimony of the Rocks' quickly reached a circulation of 42,000, while his 'Footprints of the Creator' swiftly ran to 17 editions, and the 'Old Red Sandstone' to 20 editions. In the last of these works he spent an entire chapter refuting Lamark.

the hope of everlasting life and salvation to the individual soul.

7.2. THE DARWINIAN CONTRIBUTION

The years preceding Darwin had laid the stage for the publication in 1859 of 'On the Origin of Species by means of Natural Selection, or the Preservation of Favoured Races in the Struggle for Life.' The stage was set, for example, in the concept of the struggle for existence which was gaining favour in Britain (Malthus, Spencer) and in the developing work in the fields of palaeontology from France and the new biogenetic laws emanating from Germany. (Cf. Pledge 1966, p.156.)

7.2.1. General Concept and Problem. In the early 19th century the word 'evolution' had a narrow, specialised meaning that referred to the development that went on in the foetus. Pre-Darwin the word simply meant the development from egg to offspring. In the light of this it was perhaps not surprising that Darwin rarely used the term.

In the general concept of evolution there was an utilising of the theory in the rising study of anthropology. This new area, remote from the rigours of experimental science, did not bother over much with data, but relied on imaginative speculation. "Their conclusions sometimes outran the evidence." (Chadwick 1966, p.291.) The basic problem with evolutionary philosophy as applied to a field such as anthropology was that the basic axioms used to posit evolution were, and are, unverifiable/unfalsifiable. Anthropologists, for instance, held firmly to the view that all societies developed through parallel stages and that all development was for the better. Therefore the more primitive a society the earlier it was deemed to be. But many of today's so-called 'primitives' are in fact the degenerate remains of what were once high civilisations - such as the descendants of the Incas in Peru, or the survivors of the Mayan empire in Central America. But despite such apparent falsifications of the basic general theory of evolution it has not led to any significant revision in the views of those still working within an evolutionary grid of reference. This indicates that the general theory is not a scientific theory but a metaphysical commitment which provides a paradigm within which theories and related data are placed.

It is important, as Hookyaas points out in an incisive essay (1974/c, pp.10-29.), that evolution be seen to apply only to biological phenomena; it is wrong to read off from biological theory into other modes of being. Thus it is linguistical nonsense to talk of the evolution of history, motor car or science. Yet for the past hundred years this has been done. Such was the general application of the concept of evolution in the latter half of the 19th century that J.Y.Simpson could talk of the "evolution of the theory of evolution." (1925, p.164.) Here the first 'evolution' refers to an undefined general philosophy, while the second 'evolution' pertains to the biological theory!

In various concepts - evolution itself, history, man, species, and the possibility of transformation and reproduction (epigenesis and preformation) - there was no consensus of scientific opinion. It is not surprising that Darwin's thesis found no universal scientific acceptance even if popular mythology suggests that it did. Indeed Darwin did not even expect to convince the scientific world and indicates this at the end of the 'Origins'.

7.2.2. Darwin, Wallace, and the 'Origin of Species'. Darwin in effect inverted the actualistic method and used the evidence of the past to interpret the present. In doing this he managed to claim to be a true Baconian and collect facts on a wholesale manner. But this claim is open to question if it was meant as a claim to scientific rigour. The gods of Darwin as a student were Linnaeus and Cuvier as he passed from medicine through divinity to the fields of geology and biology. His voyage in the Beagle (1831-36) is well known and it was during this period that he was influenced by Lyell's book. He also acknowledges the crucial influence of Malthus' 'Essay on the Principle of Population' which he read in October 1838. On the voyage he noted the extinction of many species, especially around the coast of Argentina. Here too, he noted the existence of primitive people and compared them with the advanced civilisations of Europe, but fell into the trap of seeing them as primitive with a latent potential to rise, not even entertaining the idea that they might be degeneratives. This is important for it indicates that the concept of a philosophy of development was firmly adhered to before he in fact set out on the voyage. This is a point often missed by commentators who suggest that, while Wallace had his theory and set out to prove it, Darwin arrived at his theory only after the collection of data. To believe, however, that Darwin devised his theory to explain the 'facts' would be naive. Facts are not given as such, but must always be gathered within a conceptual framework. (Cf. Parts II and IV.) Indeed Darwin was worried if he was gathering the 'right' facts - the right facts being those that would fit his conceptual pre-formed metaphysical grid.

In 1855 Wallace brought out a paper entitled 'On the Law Which has Regulated the Introduction of New Species.' This had a twofold effect. It induced Lyell and Darwin to look again at the species problem with a new vigour; and it stimulated Darwin to write under_{nder} fear of having his 'scientific priority' stolen.[4]

7.2.3. Basic Assumptions. In the construction of his evolutionary mechanism Darwin became involved in a number of assumptions that were distinct from any facts derived from observation or experiment. At root there was the presupposition of a struggle for existence, and within this the occurence of favourable variations which advanced over the normal or inferior members of a species. This was an assumption based in turn on a metaphysical premise that (a) wholes were explicable by analyzing parts, and (b) that events were explicable by preceding events which were their causes. This principle of continuity leading to development was a basic faith-stance that must be seen as stemming from outwith science. Darwin himself wrote:

> "The noble science of Geology loses glory from the extreme imperfection of the record. The crust of the earth with its embedded remains must not be looked at as a well filled museum, but as a poor collection made at hazard and at rare intervals." (1859, p.453.)

We therefore find in his work an assumption of the principle of continuity and uniformity overriding any evidence to the contrary; the assumption of gradations and variations within organs and the struggle for existence; the admission of a lack of evidence and no scientific expectancy of links in this chain, and therefore a concession to the philosophical nature of the theory.

7.2.4. Basic Concept. The essential argument of the 'Origin of Species' looks simple: that no two specimens of any species are alike; no two survive their environment in exactly the same way; hence (assuming variations are inherited) cumulative changes in the race will always be going on. The general theory of biological evolution is therefore that theory which states that all living species have arisen by gradual modification of pre-existing species, and which

4. Darwin writes (In F.Darwin 1887, Vol.II, p.49.): "I rather hate the idea of writing for priority, yet I certainly should be vexed if any one were to publish my doctrines before me."

generalises this concept of the origin of species to incorporate fossils. Thus it postulates that species have arisen from only one, or perhaps a few, primitive types. It will be noticed that this concept says nothing concerning the actual mechanisms of evolution. The question of a mechanism was a separate conceptual area, though Darwin bound it together with the general theory in "one long argument." (Darwin 1859, p.439.)

Basically Darwin relied on two lines of argument – the distribution of extinct species through time, and the geographical distribution of living species through space. For these he drew extensively on his experience gathered on the voyage of the Beagle and to some degree on the embryology of von Baer (cf. Mason 1962, p. 417.) whom he interpreted as positing that an individual organism in its growth from a single cell to an adult animal passed through the total history of its species. So Darwin was led to suggest that the evolutionary series of organisms was a genealogical tree of descent, with branching lines from common parents, some to end in extinction and others surviving.

In presenting his theories Darwin was not making a personal attack on religious belief. There might be atheistic elements in what he was saying, but he himself did not in the first instance understand his work in that light. Rather the acceptance by him of the natural laws and the continuity of secondary causes was seen as consistent with a belief in a Creator who had impressed natural laws on the universe.

<u>7.2.5. Basic Mechanism: Natural Selection.</u> Darwin tied his general theory of evolution to the causal mechanism of natural selection out of the struggle for survival. Actually this theory contains several concepts. There was the necessity for random variations to occur which, when recognised, would fit in with his mechanism, though this does not explain the actual occurence of these variations; and there was the concept of the struggle for survival which flowed out of the fact that more offspring were born than survived, as well as the competition between species. This led to the idea of the survival of the fittest where those having advantage would live longer.

The evident wastage in nature was the motor that a process of evolution required to provide a causal mechanism, and Darwin siezed on this and developed it in conjunction with the concept of small variations. He recognised, however, that to argue as he did from isolation (relying on his experience of the Galapagos Islands) for these variations was a difficult concept, only acceptable to those who already accepted his conceptual framework. This led him to experiment and argue his case from the arena of domestic breeding. This was an original approach in this field of science and he went the length of joining several pigeon-fancying clubs. Thus he argued from the inbred variations by human selection to the variation in the wild from natural selection.

This was quite separate from any discussion of man which Darwin did not enter into in the 'Origin'. However, in the 'Descent of Man' - 1871 - he saw man in no way intrinsically different from the rest of the animal kingdom. He argued that the moral and mental faculties of man were only different in degree and not in kind from other animals. Wallace failed to agree on this point.

The theory of natural selection was a controversial analogy and raised much criticism. This was confused by Darwin's use of the analogy which appeared to vary from place to place. It has been suggested (Brooke 1974/d, p.74.) that his presentation of natural selection takes the form of a rhetorical device where it is seen as "incessantly ready for action"; as assuming an illustrative role where it refers to cattle to show that the severest competition occurs between variants and their closest roots; it has the form of an explanatory theory when it refers to breeders tending to "like extremes"; and it has a constitutive role when it is seen as making "unconscious" selection come through the breeder's selection. There were serious difficulties as to whether it was valid to argue from the domestic to the wild with all the attendant problems of reversion and regression from crossing with inferior animals. In domestic breeding man's benefit rules, while in nature the benefit must be for the animal. Darwin was aware of these problems but did not allow them to count against his theory. But it is clear that his own presentation presented a goal-directed nature which was unconscious! To posit 'selection' in any shape or form was to present the need for someone or something that selected.

In the end, Darwin was forced by criticism into: "Documented qualification and nagging doubt." (ibid p.79.) Thus nature became seen as much more a complex of interacting forces in organic interdependance and in interaction with their environment. The whole concept of 'nature red in tooth and claw' has been greatly modified under the weight of evidence to the contrary. "Today greater attention is given to the sources of coordination and organisation within the body and the structures of internal stability and harmony, which were neglected in Darwin's day." (Barbour 1968/b, p.87.)

Today the concept of natural selection is in decline and even for Darwin the basic argument became attenuated in later editions of his work. "The primacy of natural selection, which was later incorporated within neo-Darwinian orthodoxy, was effectively sacrificed by Darwin himself."(Brooke 1974/d, p.79.) Brooke goes on to note that: "This is of course an aspect of the evolutionary debate which is quietly ignored or lamented by those who like to record the linear triumph of truth." (ibid p.79.) There is today more emphasis on the balance and cooperation evidenced in nature and Pledge claims that "natural selection turned out to be not a law but a litany." (1966, p.158.)

7.2.6. Review. I believe it is important to distinguish between three ideas of evolution: (a) the general theory across disciplines; (b) the general biological theory; and (c) the special theory which posits a mechanism. Confusion arises if these are not distinguished. With particular reference to Darwin it is to be noted that he claimed to present 'one long argument' where all stood and fell together. This is especially pertinent under the reality that he attenuated his argument under pressure of criticism and his own additional researches. Where then the long argument?

7.3. THE CHALLENGE OF DARWIN

7.3.1. To Scripture. Under pressure were the 'days' of Genesis; questions were being asked about the biblical sequences of creation; questions were being raised concerning man as a special creation; and the question of inter-species relationships. But the Scriptural problem, though real, was neither crucial nor new. Time scales were thoroughly argued out in the pre-Darwinian controversies and this ground was well trodden. The question of man and species could only be attacked by arguing from what Scripture did not say, and was not a serious difficulty. Even granting that man had evolved from lower species, it would still be perfectly valid to refer to him as ultimately from the 'dust of the earth'; and men as special creations could be, and were, seen in the light of the guiding hand of God in evolution. Another avenue of reply to this challenge was the principle of accommodation which removed the difficulties of absolute literalism.

7.3.2. To Design. Natural selection seemed to replace the need for a conscious designer in nature. But Darwin retreated in later life from his extreme anti-teleological views (cf. Russell, C.A. 1974/b, p. 46.) even though he evinced an increasing loss of awareness of the design which others assured him was there. In 1862 he published a work on the fertilisation of orchids that was seen as an interesting piece of natural theology in that it talked about 'purpose' and 'beautiful contrivance'. Darwin admitted that here was an example of purposive design which thrust itself upon him, though at other times it receded from his consciousness. This ambivalence to design comes out in the very title of the 'Origins' where Darwin speaks of the 'Preservation of Favoured Races' - but how do we know that races are favoured? - by their preservation! Thus his very title involved a teleological metaphor. (Cf. Singer 1962, p.510.)

It has been said that teleology was given a death blow by Darwin, but this is an exaggerated claim. Many undoubtedly claimed this, but equally many could point to an overall design that encompassed a broader field than that of natural selection, while yet others claimed that design was built into evolution.

> "Darwin did not destroy the argument from design. He destroyed only the watchmaker and the watch....Darwin had delivered a death blow to a simple, a naively simple, form of the design argument, but as Huxley himself came to realize, it is still possible to argue for directivity in the process of life." (Eisley 1958, p.198.)

7.3.3. To The Identity of Man. For Darwinians man was not unique, but essentially just an animal, even if slightly more advanced than other animals. In opposition to this there was the theological objection that man was intrinsically distinct and unique. This was a real problem in the 19th century and even Lyell was worried over the loss of dignity to man. There arose a disagreement between Wallace and Darwin. For Wallace the body had developed through the process of natural selection, but the intellectual and moral faculties had not thus developed. He writes that: "Natural Selection could only have endowed savage man with a brain a little superior to that of an ape, whereas he actually possessesone very little inferior to that of a philosopher." (1871, p.329.) This is a god-of-the-gaps explanation, bringing in teleology in an area which could not otherwise be explained. So there was a deep and fundamental cleavage between two views of man. The one saw man purely in reductionistic terms and led to a concept of progressing mankind; the other saw a wider canvas and pointed to the predicament of man as well as his uniqueness.

7.3.4. To Society and Ethics. Huxley suggested that ethical norms could not be derived from evolution in contradiction to the views of Darwin and Spencer. Spencer saw evolution as the unifying key underlying all knowledge. Concomitant to the challenge to man's identity there was seen a possible sociological implication that negated ethics. The consequent danger of the disintegration of society was countered by Sedgwick and others.

7.4. THE RESPONSE TO DARWIN'S 'ORIGIN OF SPECIES' [5]

7.4.1. The General Response. Prior to Darwin there were various theories of evolution - the environmental adaption and acquired characteristic theories of Lamark; the germ-plasm theory of Weismann; and the chance combination of chemicals view of Haeckel. To this Darwin added his theory of natural selection - but evolution itself was not new.

Internationally the reaction depended on the strength of the current theories in different countries. On the Continent there was little enthusiasm for Darwin at first as they were influenced more directly by Lamark (France was hostile to Darwinianism) and Haeckel. But in time Darwin found that the ground had been prepared for him and the world was ready to accept his theory. In Britain the credit for popularising him has gone to T.H.Huxley, but it should not be forgotten that Spencer played an important role in advocating the philosophy of evolution before Darwin, and so paved the way for its scientific formulation.

The controversy was polarised in the infamous debate between Huxley and Wilberforce. Huxley, through better manners and more intelligently marshalled arguments, won the day - though this has unfortunately been taken as the establishment of the veracity of evolutionary theory and the victory of science over religion. But in the years that followed it was often the scientist who opposed the

5. There is an excellent analysis of this response in the Open University course on 'Science and Belief' (Russell, C.A. 1974/b).

new theories while theologians were prepared to accept them. In fact Darwin expected scientific opposition.

Huxley, then, swiftly supported the new theory of Darwin and wrote a favourable review in the 'Times' of 26 December 1859, and throughout the controversy played a leading role in defending evolutionary thought. Interestingly enough the 'Daily News' thought it had all been said before (cf. Brown, C. 1969, p.148.)! Not all reaction was however as favourable. The reaction of the father of Canon J.M.Wilson is typical when the former was given a present of Darwin's book at Christmas. Simpson records the words of the father, a country clergyman:

> "'I cannot conceive', said the older gentleman to his son, 'how a book can be written on the subject. We know all there is to be known about it. God created plants and animals out of the ground.'" (1925, pp.176,177.)

Despite a surge of public opinion against evolution in particular and science in general in the late 19th century, the new theory was relatively swiftly absorbed into the thought of the age. Darwin was welcomed, with minor modifications, by men such as the Rev. Charles Kingsley, and Asa Gray, a keen evangelical American. Evolution was seen by them, if not by Darwin, to point to design in nature. In other fields D.F.Strauss used evolution to justify an optimistic theology of man in deviation from the traditional concept of the Fall; Summer used it to justify the Protestant Ethic and a capitalistic society; while Josiah Strong used it to justify racism. (Cf. Brooke 1974/d, pp.96,97.)

The attitude of Huxley owed a great deal, not to scientific objectivity, but to deep-rooted anti-clericalism. He was ever eager to attack the religious establishment and Darwin provided an excellent opportunity which he seized with both hands, pointing to the deification of chance in Darwin's theory, the harm that it did to teleology, and the general anti-theistic tendency of evolution - though he did note that the abolition of teleology was not a necessary consequence of evolution (cf. Huxley, T.H. 1887, p.479f.). This attack on religion via evolution looks rather peculiar when set alongside the remark he made that Darwin's work in fact transcended theism and had in reality nothing to do with it! (Cf. Brooke 1974/d, p.86.) Essentially Huxley merely used the situation to his advantage while realising that there was nothing new being said of philosophical importance. For Huxley, Darwin epitomized the scientific enterprise in its struggle against the obscurantism of religion (cf. Huxley, T.H. 1887, pp.457,459.). Ironically neither he, nor Darwin, were following scientifically verified data, but as Huxley himself notes, a "pious conviction that evolution is true." (ibid p.468.)

7.4.2. The Scientific Response. This is a sector of the debate which has been lost sight of in popular mythology which sees a relatively clear division between science and religion. But only when the scientific reaction and climate is put in perspective can the theological reaction be truly assessed. (Cf.2.2.3.) If there was no consensus of acceptance within scientific circles it hardly seems just criticism to attack theologians for a failure to go overboard for Darwinian theories.

There was a basic barrier between the life and physical sciences that has not yet been satisfactorily resolved. Physicists tend(ed) on the whole to refrain from speculation beyond a core of tested data, and Darwin's approximate 800 'we may suppose's' did not compare very well with the rigour of the physical sciences. Therefore, while physical sciences operated on the level of sufficient data in terms of the acceptability of a given theory, evolutionists were faced with a methodological difference that they could not produce sufficient conclusive evidence for transmutations of any sort.

7.4.2.1. Various Views. Some scientists, of course, accepted the theory, though generally with reservations. Albrecht Kolliker (1817-1905), for example, accepted Darwin in part and pointed to several weaknesses in his work - namely that there was no experience of species formation; that there was evidence that a union between different varieties was relatively more sterile than between the same; that there was a rarity, if not a total lack, of intermediate forms, whether living or fossil; and that Darwin had formulated a non-testable theory.

> "In Kolliker's view, Darwin was dealing with the 'might' and 'may be' and not with any theory that could be tested by experience. Evolution was perhaps unique among major scientific theories in that the appeal for its acceptance was not the evidence for it, but that any other proposed interpretation of the data seemed wholly incredible." (Singer 1962, p.514.)

Many of the scientists of the era were strongly Christian in their views - such as Brewster, Joule, Maxwell, Kelvin, Faraday and Rayleigh - but opposition to Darwin must not be attributed to them on the basis of religious belief. They had powerful scientific reasons for their opposition. The issue is complex for Christian influences were not the only ones on such scientists and other opponents of Darwin, such as Owen and Agassiz, seemed to have been influenced by the German 'Naturphilosophie'. Richard Owen (1804-92) was perhaps the foremost student of comparative anatomy and fossil bones in Britain and was resolutely set against the new theory; Agassiz, on the other side of the Atlantic, was likewise a forerunner in science and unhappy with evolutionary theory.[6]

7.4.2.2. Lord Kelvin (1824-1907). Of considerable scientific stature, more open to natural theology and even more specific in his rejection of evolution, was Sir William Thomson, later Lord Kelvin. He is important because he did not oppose evolution per se, seeing it as compatible with the divine benevolence. His objections were strictly of a scientific nature and not from theological conviction. He saw a challenge lying in thermodynamics which raised problems on two levels - the time scale, and the basic process of nature involved. Accepting the evidence of physical science he dismissed Darwin's theories as 'futile'. (Cf. Russell, C.A. 1974/b, p.62.) The first problem was the time scale Darwin required for evolution. Kelvin worked out, on the basis of the loss of heat from the earth and sun, that the time required by uniformitarian geology and evolutionary biology was simply a scientific non-starter. The time was not available. Now it is of little importance that the figures of Kelvin were wrong - that was not realised until much later - for this was a serious scientific objection and had to be acknowledged as such. (Cf. ibid p.64.) The second problem (still unsolved) resided in the second law of thermodynamics. (Cf. Appendix B.) This implied a running down of any closed system, while the degree of entropy or

6. Another lacking enthusiasm for evolution was Michael Faraday (1791-1867). Faraday was perhaps the greatest figure in physics between Newton and Einstein, and his significance for science goes far beyond that of Darwin. Ironically in the 20th century most people are familiar with Darwin; few know much about Faraday. His achievements were numerous - liquefying chlorine, isolating benzine, formulating the two laws of electrolysis and the phenomenon of electromagnetic induction (this being the basis of the dynamo). A devout Christian of evangelical theology, Faraday had a deep sense of the unity, as well as of the diversity, of nature and the natural forces, which led him to posit his Field Theory - and thus revolutionise the whole physical sciences. Here was what led up to the prediction and discovery of radio waves.

disorder increased. Now this law is perhaps the most universally validated of all natural scientific laws and therefore to transgress it a serious matter. Thus it was used to attack evolution - for example 'The Unseen Universe' in 1875 by Stewart and Tait. More recently J.H.Rush claims that "a living species embodies a unique accumulation of genetic individuality and adaptive wisdom. It is one more insurrection against the Second Law of Thermodynamics." (1957, p.240.) But a standard textbook tells us that: "The law itself is applicable to every type of process..." (Montgomery, S.R. 1966, p.7.) Thus evolution and entropy are in tension, the one building up and the other breaking down and disintegrating. Many attempts have been made to evade this - though even Julian Huxley could admit to it as the greatest single scientific objection to evolution. (Cf. Wilson 1966, p.128f.; Koestler 1971, ch.14.) 7

The problem for evolution was that the whole tide of the physical sciences was flowing in the opposite direction to evolutionary thought. Atomic theory seemed to be pointing to the fixity of species - for instance the fixity of elements as enumerated in Dalton's atomic theory was in marked contrast to the gradations of evolutionary thought.

Thus is revealed the importance of the philosophy which undergirded the theory, for if this had not been strong then evolution may well have collapsed as a scientific theory. (Cf. More 1925, pp.117,304.) Whatever the scientific arguments for or against, it would seem that the whole question ultimately resolves itself back into the philosophical. It is in the light of these scientific objections that the debate of the 19th century should be seen, and in awareness of this that the theological reaction assessed.

7.4.3. The Theological Response. As might be expected from the above, Darwin's supporters in 1860 were "numerically extremely insignificant." (Huxley, T.H. 1887, p.464.) Only in this light can the hesitancy of the church be measured in accepting the theory of evolution, for there was little reason to go overboard for a theory which had not yet gained scientific respectability and which had failed to answer serious scientific objections. This does not mean that many within the church were not willing to accept evolution and indeed Darwin could claim by February 1860 that many clergy went far with him.

7. Another important critic was Lord Rayleigh who, as late as 1906, when asked if natural selection was adequate to explain evolution replied in the negative. (Cf. Russell, C.A. 1974/b, p.62.)

The debate in theological circles was an open one and in fact is still with us in muted form. The relative importance attributed to evolution varied greatly, and while Charles Gore could accept evolution in 1883 he considered it as a matter of no great controversy. In 1885, however, Bishop Magee accepted evolution and thought the matter newsworthy. So in general it is difficult to sustain the idea of consistent persecution of Darwin by the churches.

Theologians were divided on the issue, and predilection for or against appears to originate in more basic metaphysical and philosophical stances. A general division of theologians can be made - Liberal or Modernistic divines were more ready to accept evolution as it obviously correlated to their ideas of progress; fundamentalists tended to oppose; while moderates merely held judgement in suspense. This latter position would seem, in the light of the scientific position, to have been the correct one for men who had no sphere-authority in biology.

Darwin posed the problem for religion of a view which saw man as no longer fallen, no longer unique; while for scientists it seemed that he apparently abandoned the inductive method of science and was unscientific in setting out his theory (for instance in the basic ignorance of a cause of variation). Not surprisingly conservative scientists had deep reservations. Yet by the end of the century the general theory was widely accepted and had in fact been transferred as a paradigm to many other disciplines. It was tending to the nature of a world-view as well as a world-picture, and men like Tyler, Durkheim and Frazer readily applied it as a paradigm within their own spheres of research.

Theistic evolution became acceptable in both Protestant and Roman Catholic circles - the famous Archbishop Temple could assume evolution as a basic axiom in his 1884 Bampton lectures; while Catholics like Zahm and Mivart both wrote of the compatibility between evolution and Christianity. But perhaps the most surprising feature was the ready acceptance of evolution, or at least suspended judgement, on the part of many of the leading conservatives of the last century. McCosh of Princeton, Dana, James Orr, J.C.Jones and J.Strong all fit this category. (Cf. Ramm 1971,pp.200ff.) Even B.B.Warfield was guarded in his statements but seems to have allowed the possibility of evolution. These notable conservative thinkers found no basic metaphysical incompatibility between evolution and Christianity as long as evolution remained a biological theory. Hence it cannot be argued that there was a violent reaction against evolution, even amongst conservatives.

7.4.3.1. Henry Drummond - was one of the most famous theological exponents of Darwin and welcomed the concept of natural selection as a fruitful addition to natural theology. His basic approach was to endeavour an absorption or synthesis of evolution into theological structures. Keenly interested in science, he saw it in general, and evolution in particular, as the key which restored the Bible to ordinary man. But despite his great evangelical piety which made him friends with D.L.Moody, Drummond was hardly the epitome of conservative theology. He defined the Christian faith in progressive terms which saw sanctification as the end of creation. Evolution and Christianity were one; evolution confirmed the faith instead of posing a threat.(Cf. Drummond 1953,p.220.). He espoused a positive approach to evolution that sought to reinterpret it in terms of purpose and design. He saw evolution working through love rather than through a struggle for existence, thus solidly transferring the whole schemata into a Christian framework.

7.4.3.2. George Matheson. Another Scottish theologian and minister, he was opposed to Drummond's approach, but initially open to the possibility of evolutionary processes. (Cf. Macmillan 1910, pp.205f, 309f.) Matheson was deeply interested in scientific studies and gave frequent talks on archaeology, anthropology and pre-historic humanity; he evinced great enthusiasm for the work of men like Pasteur and Lister and was himself elected a Fellow of the Royal Society of Edinburgh. He was blind! Matheson did not accept or reject evolution as a valid scientific theory - but welcomed it as an aid to thought. He was postulating, not its validity, but the question, 'If this is true, what does it mean for theology?' He, like many others, reconciled science and religion together in a unity of truth - truth must ultimately be one compatible whole and not contradictory parts. In later years he came to the conclusion that evolution was not true, but it remains a testimony to his intellectual honesty that for long he kept an open mind on the subject.

7.4.3.3. Charles Hodge. Naturally many clerics were dogmatically opposed to evolution and indeed to science generally. Of all the theologians who resolutely opposed evolution (but had high regard for science) one of the most articulate and penetrating was Hodge. He rejected evolution, but it was a temperate and calculated rejection based on a sound knowledge of past and contemporary science. He made careful distinction between Darwin and Darwinianism (cf. Hodge 1960, Vol.II p.12.); charges of atheism may be brought against evolution but that did not mean to say that they could be brought against Darwin. Nevertheless Darwin was guilty of reducing man (in the 'Descent' not the 'Origin') to an exclusively zoological question and thus ignoring the "testimony of history, of language, and of scripture." (ibid p.27.) Against the theory of Darwin could be brought objections concerning missing connecting links, the peculiar appeal to the imperfection of the geological record, and the problem of the sterility of hybrids.

Hodge went on to appeal to the immutability of the species as argued by Cuvier, Agassiz, Lyell, Murchison and Sedgwick - all of whom were world authorities in this area. He also refers to the discussion at the Academie des Sciences in 1830 where Cuvier won an almost unanimous victory over St. Hilaire. Hodge continued his argument against evolution by an appeal to the actual data available - lake dwellings, fossil human remains, races of man, and ancient monuments - and comes to the conclusion that evolution was not acceptable. Further, it was to be rejected because it was a mere hypothesis incapable of proof, all the facts being open to other interpretations as indicated in many scientists rejecting it; and finally it was an atheistic system which was being used to attack teleology. In all of this Hodge was perfectly in line with a large number of leading scientists, never mind conservative theologians. He is clear in one thing - the first two chapters of Genesis teach clearly that man's body was formed by an immediate act of God and was in no way subject to a process of development. Evolution, then, was seen as a return to primitive doctrines from Greek and Roman sources.

The basic problem was that the question of origins was not open to science. Therefore the religious presuppositional stance was of decisive importance, though Hodge's own presuppositional critique was relatively poor. Hodge tried to distinguish between facts and theories, and correctly pointed to the differing epistemological base of Darwin from normal scientific theories. In the end Hodge tied it all back to the denial of the design that was in the universe, though he was well aware of the weaknesses of this argument.

7.4.4. Review. To summarise the response in general terms is obviously impossible. The crusading Huxley founded the 'X-Club' which was aimed at showing the triumph of science over religion. It consisted of nine scientists - Busk, Frankland, Hirst, Hooker, Huxley, Lubbock, Spencer, Spottiswood and Tyndall. However a counter grouping of scientists was founded in 1865 for the opposite reason - the Victoria Institute or Philosophical Society of Great Britain - which continues to function today. Its function being to promote the investigation of the relationship between science and religion. Interestingly in the same year there was produced by the British Association a 'Declaration' bearing the signatures of some 617 scientists condemning evolution. (Cf. Russell, C.A. 1974/b, p.66.)

7.5. THE THEORY: ITS STATUS AND PROBLEMS

It is perhaps appropriate to preface this section with the comment by W.R.Thompson in his introduction to the centenary edition of 'The Origin of Species', where he confesses that he is:

> "....not satisfied that Darwin proved his point or that his influence in scientific and public thinking has been beneficial..... Darwin did not show in the 'Origin' that species had originated by natural selection; he merely showed, on the basis of certain facts and assumptions, how this might have happened, and as he had convinced himself he was able to convince others...." (1959, pp.vii,xii.)

The problem is different paradigms. Poincaré wrote that: "Any fact can be generalised in an infinite number of ways, and it is a question of choice." (1905, p.146.) Facts are selected by the theories, and the theories are selected from the paradigm held. Even within evolutionary thought three main conceptual frameworks competed for primacy - Darwinianism, Saltationism, and Lamarkianism. But within any evolutionary paradigm it becomes impossible to refute the paradigm once it is assumed evolution has occured; once it is adopted as a scientific methodology applicable to the question of origins. This makes the question philosophical rather than simply scientific, for there is nothing open to testing.

As a philosophy of progress it seems to me that it must be challenged. If this is postulated as a basic axiom then the question can be asked as to how we have progressed aesthetically or qualitatively, and how degenerate civilisations are to be explained. This last point is an apparent refutation of the view which sees primitive tribes as 'living fossils', when we now are aware that the reverse is often true. In general I would agree with the principle enunciated by Hookyaas that: "The term 'evolution'....should be avoided outside the realm of biology." (1974/c, p.23.) Unfortunately it is not, and <u>much confusion exists because of the acceptance of evolution as a scientific theory when in fact it is a philosophical concept that is being accepted.</u>

It is required, then, to distinguish between the 'vague' theory and the 'precise' theory of evolution as well as the above. The vague theory is the general belief that evolution has occured, whereas the precise theory involves some mechanistic hypothesis - and there is: "No known satisfactory and clearly demonstrated precise theory of evolution." (Ramm 1971, p.189.) This is borne out in the conclusion of a (relatively) recent article where a strongly pro-evolutionist writes: "Pending additional discoveries it may be wiser not to insist that the transition from ape to man is now being documented from the fossil record." (Simons 1964, p.62.)

Perhaps the basic technical difficulty with evolution as a scientific theory was how to deal with a theory that explained why there was so little evidence to support it. This remains an outstanding feature of the 19th century debate, for whatever the present evidence there was certainly little or none when the theory was formulated. Since the theory was formulated data is interpreted to fit! Thus the choice between creationist and evolutionary views is not primarily a scientific choice.

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CHAPTER 8

THE NEW WORLD OF PHYSICS

8.1. THE NEWTONIAN BREAKDOWN

Through the 19th century two main themes dominated physical science -- Newtonian mechanics and Maxwell's equations which governed electricity and magnetism. The first provided the deterministic base for scientific activity: the belief that if all the initial conditions of some event were known exactly, then the outcome could be predicted indefinitely. Maxwell had formulated a set of equations that quantified Faraday's lines of force; and, *inter alia*, related the partial variation of an electrical field in space to the time variation of the magnetic field. According to Einstein this was the first blow at the heart of the Newtonian system, for it entailed, not instantaneous action at a distance, but action by a process propogated through space at finite speed. (Cf. Einstein 1973, p.259.) One of the conclusions was that wave propogation occurred in empty space and many rejected this because it ran counter to Newtonian theory. It was only confirmed by Hertz in 1888, nine years after Maxwell's death, when it was shown that radio waves passed Maxwell's prediction of the identity of light and electromagnetism.

This raised problems for classical physics as it could not accommodate waves oscillating in empty space. Thus the *ether* was postulated. This did not solve the problem for if someone was to move at the speed of light in the ether the wave pattern of light would disappear, and Maxwell's equations did not provide for this eventuality. Therefore either the theory of the ether was wrong, or nobody could move at the speed of light. This second alternative was incompatible with Newtonian mechanics.

Concerning the ether there were two possibilities -- either it was dragged along by the earth or it was at rest and the earth moved through it. The first alternative was quickly ruled out because of the phenomenon of stellar aberration which was widely recognised and would have been cancelled out if there was an ether moving with the earth. The second possibility gave the suggestion of some absolute rest-frame. The experiments to detect the ether are commonly regarded as the jumping off point for modern relativity theory. The crucial experiment was the Michelson-Morley one (1881 and 1887), and concerned the attempt to measure the difference in the velocity of light in, and at right angles to, the earth's motion. The idea was that if the earth was in motion relative to the ether it should have some effect on the speed of light in these two directions. But no effect was observed which suggested that the ether moved with the earth - though Lodge disproved this conclusively in 1893.

In 1892-3 Fitzgerald endeavoured to explain the Michelson-Morley failure by postulating a contraction of their apparatus in the line of the earth's motion. If there was an alteration in the velocity of light and a corresponding alteration in the measuring apperatus, then no effect would be detected. But there was no reason to support this except as an ad-hoc hypothesis to explain the unsatisfactory outcome of the Michelson-Morley experiment. What was needed was a new approach in which the hypothesis of the ether would be abandoned.

8.2. EINSTEIN AND RELATIVITY

Einstein is often regarded as negating Newton's views, or reducing them to a limiting incidence of his own theory of relativity. However Einstein himself noted that Newton was aware of the weaknesses of his system even if his followers were not. Nevertheless classical physics was undermined. (Cf. Einstein 1973, p.313.) But though Einstein saw his theory replacing Newton's, such that the classical position could no longer be regarded as the foundation of theoretical physics, he retained the highest regard for Newton and his theories. (Cf. ibid pp.232,300.)

Einstein was a remarkable man and his contribution to science extensive. (Cf. 10.3.5. and 18.5.3.) In 1905 he produced four papers in the 'Annalen der Physik' which changed, in different ways, our view of the universe. There were the two famous papers on <u>special relativity</u> which outlined the principle of the equivalence of mass and energy. There was a paper on <u>Brownian motion</u> concerning the kinetic theory of matter; the incessant motion of suspended microscopic particles in liquids which had the result of establishing once and for all the existence of atoms. Mach had not accepted the reality of atoms until this point! The fourth contribution, the first published, concerned the concept of <u>light quanta or photons</u> and provided the basis for Bohr's model of the atom. It was in this field that he received the Nobel prize in 1922. His other major contribution was the General Theory of Relativity in 1916 which set forth the equivalence of inertial and gravitational mass. Taken singly each of these papers was a crucial and important step in science; regarded collectively they represent a staggering output.

Einstein drew initially on the physics of Lorentz and the philosophy of Mach (cf. 10.2.1.), though he later moved away from a positivistic position and such views do not reveal his overall philosophical stance. The renaissance of positivism was crucial, however, in this early phase of the new physics, but Einstein penetrated far beyond Mach's reductionistic approach (that tried to abandon metaphysical questions) into the ontological structure of being where the real merged with the ideal in a non-Euclidean universe. He had a deep perception of the essential religious character of scientific activity - not in any Christian or Jewish sense, but a mystical perception of the order and harmony of the universe that drove man to search for the underlying unity in the midst of diversity. Despite his frequent references in amicable style to the 'secrets' and 'plans' of the 'Old One' he was a self-confessed mystical pantheist. He expressed this religious awe in the basic premise of science: "One may say 'the eternal mystery of the world is its comprehensibility.'" (Einstein 1973, p.292.)

The genius of the man is without question. Despite the obvious connection of his theory to the Michelson-Morley experiment he apparently arrived independently at his position. (Cf. Bernstein 1973, p.49.) Even the great Lorentz, from whom he drew so much, could not, as late as 1909, believe the theory of relativity - and yet Einstein claimed to have had the basic idea at 16. Here was displayed for all to see a mind of inexorable logic that had no recourse to academic research facilities and was ignorant of much of the contemporary scientific frontiers. Indeed Einstein in a way recaptured the ancient Greek methodology of the 'thought experiment'. If thoughts seemed to run counter to common-sense, then the recourse was to abandon common-sense - and even experimental results if they did not fit! So he was driven to the conclusions that length, time and mass were not constant, but varied with the speed of the observer. In this he marched triumphantly along well in advance of any experimental corroboration. He was "continuously ahead of the experimental confirmation that eventually established his predictions." (ibid p.151.)

What was the basic problem and the basic premise? <u>The basic problem</u> was how to reconcile Newtonian mechanics (which would allow an observer to be accelerated through the speed of light) and the relativity principle of electromagnetism (which would not allow this). This was where the ether had been invented to effect reconciliation, but Einstein's breakthrough was to abandon the ether and see that the two cannot be reconciled because Newton was wrong. The basic premise adopted was that any state of rest, or motion at constant velocity, cannot be distinguished by any experiment from another, either electrically or mechanically, when analysed by an observer in one or other of the systems - though relative motion can be determined.[1]

8.2.1. Special Relativity. (Cf. Einstein 1951; Eddington 1923; Eddington 1930; Marks 1972) At the heart of this was the question of simultaneity, mass-energy equivalence and geometry.

8.2.1.1. Simultaneity. Here we find the ingenius thought experiments of Einstein coming into play. He posed to himself the question as to what would happen if he were to ride a beam of light away from a clock - the answer was obvious. If he was receding from a clock at the speed of light, then the time on that clock would freeze. Therefore if time could stop there could be no such thing as universal time. Thus even the objective sense of time as measured by clocks was not as simple as it was thought to be. (Cf. Eddington 1930, p.36f.) Simultaneity is an undefined factor.

Now the speed of light is the same to any observer no matter the speed of its source as long as this source is moving at uniform velocity; though as the source moves to the observer there is a shift to blue, and when away a shift to red - the Doppler shift. In other words: as the light source moves towards an observer there is an increase in the frequency and a decrease in the wave-length that cancels out and leaves the speed the same. It should be noted, however, that this constancy is only concerning uniform motion and if the observer is accelerated relative to the source then the measurement of the speed of light will show a decrease from that of a rest-frame. This was a challenge to the Newtonian system which would be confirmed experimentally by de Sitter in 1913.

From this it followed that the rate of moving clocks was slower than that of rest clocks. A watch at the north pole will run faster than one on the equator - confirmed experimentally by Hay. This

1. Others were close to relativity (cf. Bernstein 1973, pp.190,195.).

would be developed to show that a clock in a *gravitational* field is slow relative to one that is not, and that the stronger the field the slower the clock. This had grave effects for the assumption of simultaneity. Later Einstein and Infeld postulated the following thought experiment. Imagine a laboratory with transparent walls and fitted on a truck. Observers are prepared inside and outside with all the necessary instruments. A device at the exact centre of the laboratory emits a flash of light as the truck moves uniformly forward. The physicists inside the laboratory measure the velocity of light, find that it is 186,000 miles per second, and note that the front and rear walls of the laboratory are illuminated simultaneously. However, their counterparts outside have different results. They agree that the velocity of light is 186,000 miles per second, but see the emission of light reach the rear wall an instant before it reaches the front. In other words: what is simultaneous inside is not so outside. This would be quite impossible in a Newtonian universe.

For Einstein the velocity of light is constant and independent of the velocity of the source and observer; whereas Newton saw these factors as additive. (Cf. Mason 1962, p.543.) Now for Newton the application of a force would cause an indefinite increase in the velocity and kinetic energy of a body while the mass component of the kinetic energy remained constant; Einstein on the other hand saw the application of a force causing an increase in the mass of a body as it approached the speed of light. The force conferred energy in the form of mass upon the body because no longer could it be seen as enhancing the velocity component of the kinetic energy when the limit of the speed of light was approached. The net outcome was for Einstein to challenge the epistemological basis of the assumption of absolute time. No longer would space be regarded as independent of time.

Bernstein commenting on this principle points out:

> "This has been interpreted to mean by some science-fiction writers, poets, novelists, and philosophers....that somehow because of the four-dimensional aspect of relativity one can move oneself back and forth in time into the future and past and God knows what. Unfortunately, nothing like this is true. We are each attached to our own proper Lorentz frames, and for us, so far as the theory of relativity is concerned, the future remains the future and the past the past." (1973, p.95.)

8.2.1.2. Mass-Energy Equivalence. Special relativity indicated that mass was not constant but a function of the energy content. Einstein related mass and energy such that an addition of energy 'E' to a body increased its mass by 'E/c^2'; and a mass 'm' is to be regarded as the same as a store of energy 'mc^2'. (Cf. Pledge 1966, p.287.) It follows that as the speed of an electron approaches the speed of light (c), it tends to become more massive until at the speed of light its mass becomes infinite - clearly necessitating an inability to reach that speed. At the same time it hints at a new source of energy in matter itself.

8.2.1.3. Geometry. Einstein wrote:

> "From the latest results of the theory of relativity it is probable that our three-dimensional space is also approximately spherical, that is, that the laws of disposition of rigid bodies in it are not given by Euclidean geometry, but approximately by spherical geometry, if only we consider parts of space which are sufficiently extended." (1973, p.243.)

So we are introduced to curved space. Many think that this is unpicturable, but if anyone has looked at the reflection of a room in a rounded doorknob they have experienced a type of curved space. It is popularly thought that the sum of the angles of a triangle always equals 180 degrees. But a triangle on a curved surface will be more or less than 180 degrees depending whether the surface is concave or convex. There is a choice of geometrical systems between Euclidean, Riemannian and Gaussian. It so happens that the one that fits best with relativity is the Riemannian - though this was not settled till 1915.[2]

8.2.1.4. Four Important Features.

(a) The birth of relativity lies in aesthetic qualities - a search for unity, beauty and order - and we have Einstein's own testimony to this. This indicates something of the metaphysical nature of the theory.

(b) Despite the attribution of relativity and the undetectability of absolute velocity; this is a system, or theory, which still has absolutes. Einstein writes:

2. Eddington concluded a discussion on 'What is Geometry?': "it almost appears that the physics has been absorbed into geometry." (1959, p.183.) Involved in geometry is measurement and any knowledge of metrology reveals the inability to accurately measure anything for there can be no measurement without some 'rule' and how can that be tested against variations?

"According to the special theory of relativity, spatial coordinates and time still have an absolute character in so far as they are directly measurable by stationary clocks and bodies. But they are relative in so far as they depend on the state of motion of the selected inertial system." (1973, p.247.)

(c) The theory has severe limitations for it accounts only for systems which are uniform and relative in motion; and thus though it has wide application it excludes acceleration and gravitation.

(d) It should not be thought that once formulated this theory was accepted with open arms by the scientific community. Most scientists at the frontiers of knowledge quickly realised the value of Einstein's work, but the immediate reaction to the 1905 papers was one of indifference. (Cf. Whittaker 1960, Vol.II p.40.)

8.2.2. General Relativity. Here we are faced by, though only a little quantitative difference from the Newtonian schemata, a profound qualitative difference. The essential incompatibility of the two systems - which seems to me to suggest that the idea of Newtonian mechanics as a limiting case, though practically so, is not maintained theoretically - is seen in that the two systems have radically different sets of definitions concerning basic components.

Several basic postulates lie at the heart of the general theory of relativity. It is assumed that the laws of nature are the same for all observers moving in any manner relative to one another, that is a uniformity of the laws of nature in all coordinate systems; that the geometry of space-time is non-Euclidean; that the gravitational motion takes place along the shortest paths in space-time (not straight lines, because non-Euclidean); and that the curvature of a given region of space-time is dependent on the amount of matter in that region.

Involved in the formulation of this theory is the Principle of Equivalence. On the one hand there was 'inertial mass', that property of an object which measured its response to the application of a given force (according to Newton's law $F = ma$) and which could be measured apart from gravity. On the other hand there was 'gravitational mass' which measured specifically the gravitational attraction between two particles. As Bernstein notes: "A priori it is not evident that these two numbers are the same." (1973, p.99.) In an early attempt to derive the general theory in 1911, Einstein arrived at the principle of equivalence between these two factors, pointing out that there was no difference in effect between a condition of uniform constant acceleration on an observer and the observer being at rest but subjected to a uniform gravitational field.

This led to the prediction that since light possessed mass, gravity should affect it. Einstein worked this out, erroneously in 1911, but by 1916 had arrived at the general theory of relativity as formulated in all its precision. The crux of any theory is, of course, its submission to experimental predictions and tests, and this, as Einstein noted, presented problems. (Cf Einstein 1973, pp.231,232.) The two most spectacular confirmations were the prediction of the perihelion advance of Mercury and the bending of light in the gravitational field of the sun.

(a) Einstein had indicated that the shortest path in space-time round weight particles should be an ellipse which rotated round the particle - whereas the Newtonian system held to a stationary ellipse. The French astronomer Leverrier (1811-77) had already indicated the elliptical orbit of Mercury as showing a rotation round the sun, and the amount of this rotation agreed closely with Einstein.

(b) The second prediction (which had an influence on the philosophy of Popper) centred on the fact that if light has energy, which it obviously has, then it should possess mass also and therefore be open to gravitational deflections. The only way to test this seemed to be the observation of starlight passing close to the sun, and this in turn would only be capable of detection during an eclipse. Consequently Eddington set out for the Isle of Principe in the Gulf of Guinea to record the 1919 eclipse.[3] Einstein's prediction was a displacement of 1.74 seconds of arc, and the Principe results were 1.61 seconds with a margin of error of 0.30 seconds; other results from Sorbal data gave 1.98 seconds with an error margin of 0.12 seconds. Both were therefore in reasonable agreement. Since then several repeats have been made, and in 1929, 1936, 1947 and 1952 there were considerable divergences from the predicted results. However one of the 1952 results (from the Sudan) agreed well. This wide scatter of results is probably more indicative of the difficulties of astronomical observation than in anything inherently wrong with the theory.

(c) A third prediction was that in a strong gravitational field the light emitted by atoms should lose energy while moving away from the

3. For a graphic account of this classical experiment see Eddington (1959) pp.114-116.

field, the light becoming redder. This would not be confirmed until a series of observations from 1923-28 showed a shift to the red in the spectral lines given out by iron, titanium and cyanogen on the surface of the sun.

From this it can be gathered that the general theory of relativity has its limitations of applicability. There are grave difficulties in trying to apply the theory to rotary motions, and to most gross situations (it was Newtonian mechanics that put man on the moon). Nevertheless the general theory has been claimed to be the most perfect and aesthetic theory of all scientific theories and has in theoretical principle replaced the Newtonian theory of gravitation. At heart the question for Einstein was not one of practicability but of the reality of the universe - as it was for Newton. In this quest he was guided by ontological and epistemological principles and not scientific experiments alone, as any cursory reading of him swiftly indicates. In this he stood opposed to the philosophical stance of Mach who had tried to abandon metaphysics and rely solely on sensory experience.

8.3. QUANTUM

Towards the end of the 19th century there began to appear in several fields a break from the older traditional concept of the continuous nature of matter and change. In Britain the work of Faraday, Kelvin, Maxwell and Fitzgerald envisaged electrical phenomena as resulting from a strain in a continuous ether. Faraday realised the implications of his theories pointed to an atomicity of electricity and matter but rejected this idea. The Germans were open to it and men like Riemann, Kirchoff and Clausius were prepared to see electricity as charged particles - an idea Maxwell had failed to develop although it was implicit in his theory of the ether. Through this period there were several discoveries which indicated that the future lay in the atomic concept of matter, for between 1890 and 1900 electrons, X-rays and radioactivity were all discovered.

The starting point was the problem posed by the study of light and heat emitted by black bodies [4] - this indicated a continuous spectrum of radiation as opposed to the line spectra given by chemical elements. Experiments showed that when black bodies were heated to some given

4. A black body is one which completely absorbs any heat or light radiation falling upon it.

temperature they emitted a maximum amount of radiation energy at a particular wavelength; the wavelength of the maximum decreasing as the temperature increased. This could not be accounted for by the wave theory of light which had dominated the scene for many years, indeed ever since the Newtonian corpuscular idea was abandoned. There was therefore an electron theory which gave an electrical approach to radiation and a thermal theory. But the only correlation found between these two approaches was that both were erroneous - quantum theory was needed to correct them. (Cf. Pledge 1966, p.271.)

The man who achieved the conceptual breakthrough was Max Planck (cf. 10.3.1.) who posited a solution in 1900 at Berlin. If black-body radiation was considered as emissions of discontinuous quanta, so that the energy of a quantum was proportional to the frequency of the radiation, then the emission of longer wavelengths would shift to the red end of the spectrum which would be favoured at lower temperatures. So Planck showed that the spectrum of radiation from a hot object was accounted for if it was assumed that the atoms vibrated, not anyhow, but only in quantized energy values. This broke the wave dominance of light and suggested that it was discrete. But so-called crucial experiments had proved that light was not corpuscular but wave-like in character. Nevertheless Planck had shown it to be discrete with a quanta whose value was constant for a given spectral frequency. For every wavelength of electromagnetic radiation the value of the corresponding quanta of energy can be calculated by multiplying the frequency by Planck's constant 'h'. This value 'h' has assumed a comparable role in physics to thatof 'pi' in mathematics.

The advent of quantum theory was a radical break. Even the special and general theories of relativity fitted, in a sense, into the classical tradition in that they were contained in a philosophical context of causal description in space and time. Quantum theory, however, denied the reality of causality as traditionally conceived and undercut the epistemological basis of science. The idea of a discontinuous nature introduced an entirely new framework of reference. Needless to say the picture was confused to begin with and there were early doubts as to whether the quanta referred to energy in matter, in the ether, or in some transformation between them.

It might have been thought that in turning from relativity to this field that Einstein had been left behind, but in fact his contribution was crucial. There was the important paper of 1905 on the quanta of light which indicated his interest in the field - an interest pursued positively up to about 1925. Light had assumed a rather schizophrenic character, being both wave-like and corpuscular-like, and Einstein devoted his genius to try to understand this irrational situation. He indicated that light was particle-like and that each particle had its own quanta of energy - a postulation verified in 1923 by Compton. So paradoxically, while Einstein was ousting Newtonian mechanics he was reviving Newton's theory of light. It now appeared that Newton was right in regarding light as corpuscular with respect to the spectrum of a dark surface, photo-electric effects, and the Compton effect [5]; but that Fresnel was right with reference to light as a wave concerning interference fringes and defraction. (Cf. Rouzé 1964, p.28f.)

Yet Einstein eventually turned his back on quantum theory and pursued a lone path in opposition to the consensus of scientific opinion. At the root of his reservations was the loss of visualizability of causal events and in 1936 he wrote:

> "I believe that the theory is apt to beguile us into error in our search for a uniform basis for physics, because, in my belief, it is an incomplete representation of real things, although it is the only one which can be built out of the fundamental concepts of force and material points (quantum corrections to classical mechanics)." (1973, p.315.)

His reticence was backed up with detailed scientific argument.

8.4. THE NEW WORLD OF ATOMIC STRUCTURE [6]

Atomism lies very much at the heart of the new scientific view of the world; it had been the subsistence of the reality of ultimate particles that had provided classical physics with its ontology and it was to be the destruction of that view that would provide new vistas. Atomism had existed as a philosophic position from the time of Democritus; Newton had held to ultimate, hard, indivisible particles at the root of nature; and Lavoisier had postulated atoms at the substratum of his chemical theory. But these views are not to be compared with the modern atomic theory and it is wrong to attribute to them, as is sometimes done, atomic ideas as that term is now conceived.

5. Compton effect: the elastic scattering of photons by electrons, that is, collisions in which both energy and momentum are conserved.

6. This field changes very quickly today and can therefore go out of date. A reasonable modern introduction is Calder, N. 1977

Possibly the first to really utilise the atomic concept in modern ways was in 1738 when Bernoulli presented his statistical mechanical approach to the physics of gases in which the atomic hypothesis was used in a quantitative way as opposed to a qualitative sense. Like Lavoisier, however, this was still not compatible with the modern divisible atom.

Today we have the popular picture of the atom, consisting of electrons, protons and neutrons, giving a picture that is visualizable and often compared to a microscopic solar system - the nucleus of protons and neutrons being the sun and the electrons circling round in their orbits like planets. But this is a simplified conception and the modern thrust is to an atomic world that cannot be easily represented by models. Today there is a confusion of particles at the sub-atomic level with well over one hundred elementary particles. In 1947 the list of elementary particles consisted of electrons, positrons, photons, protons, neutrons, positive and negative muons, and positive and negative pions - to this was added those for which there was theoretical support; the neutrino, antineutrino, neutral pion, antiproton and antineutron.[7] Since then however whole new lists of resonant particles, kaons and hyperons, strangeness, charm and colour, plus the fact that every particle has an associated antiparticle, has tended to obscure the original simplicity of the atomic world. (Cf. N. Calder 1977; Wick 1972, pp.9-14.)

The story of the unfolding of the mystery of the atom starts with Becquerel in 1896 and journeys through the researches of J.J.Thompson, Millikan, Rutherford and many others. The atom became conceived of as a little machine, but under classical mechanics it had a fatal flaw. Machines run down in the classical concept and if Rutherford's picture was correct it meant that orbiting electrons should decay into the core. They did not appear to do so and therefore there must be something stopping the electron losing energy.

At this point Niels Bohr introduced the quantum theory into the atomic structure. This saved the electron decay and set them in stable orbits round the nucleus, with energy emissions only occuring

7. Consider the proton. In the 1920's it was conceived as a very small object in the heart of a hydrogen atom; by the 1950's it was a small object with mesons in its vicinity; by the 1960's it had become a fairly large object (cf. electron) and denser at the centre; by the 1970's it was a large object containing smaller objects. Today it has been conceived as having three quarks exchanging gluons.

when an electron jumped from one orbit to another. Thus the Bohr model of the atom, incorporating discrete energy levels, ran counter to classical physics and all conceived atomic structure prior to it. Three features are to be noted: (a) that electrons move only in specific orbits forming a discontinuous series whose distances from the nucleus are to one another as integers - the further out it is the easier to be detached; (b) so long as an electron remains in the same orbit it does not radiate energy; (c) whenever it jumps from one orbit to another it absorbs or emits energy.

Thus the arena became increasingly complex and confusingand several principles began to emerge to clarify the picture. There was Bohr's Principle of Correspondence which stated that in the limit of quantum numbers, the predictions of quantum and classical physics always corresponded. In effect this meant that all other properties but the frequency (e.g. intensity) of the spectral lines were given by the classical theory in the macroscopic situation. But the absence of any explanatory physical mechanism for this principle kept it under constant criticism. Then in 1925 Pauli formulated his famous Exclusion Principle which stated that no two electrons in any given atom could have the same set of quantum numbers (four to a set) and therefore the same energy value. The four numbers being attributed to each electron with no two possessing identical sets.

Yet another model of the atom appeared in 1924 under the guiding hand of Louis de Broglie. This was drawn from the field of wave mechanics and the basic idea was that as light was both wave and particle, so the elementary particles possessed both undulatory and corpuscular characteristics - or in other words, with every particle there was an associated wave, which meant that electrons did not travel in orbits as such but were contained in wave-bands. To further confuse this for the layman, the wave associated with a system of particles did not move in ordinary space of three dimensions, but in an abstract space of a large number of dimensions.

At this point Heisenberg (cf. 10.3.4.) suggested that the attempt to derive models should cease and that the Rutherford-Bohr model, along with all other mechanical representations, should be abandoned. Certainly all the models had severe limitations. So he abandoned the concept of orbits and tried to confine himself to observable quantities such as frequency and intensity of spectra in a new phase of the atomic adventure which was characterised by the increasing preference for symbolical over physical models. This move was in keeping with the increasingly statistical nature of research and the idea that nature itself was fundamentally statistical. Statistics existed in the classical tradition, of course, but in that realm every particle was recognisably different. In the new theory, the Bose-Einstein statistics - 1924 - gave every particle as indistinguishable; while the Fermi-Dirac - 1926 - form suggested there could be no multiple filling. As Born remarked, theoretical physics was becoming increasingly a question of philosophy. (Cf. Bronowski 1973, p.364.)

Following de Broglie's prediction that matter, as well as radiation, had particle and wave properties, Schrodinger - 1925 - and Heisenberg made the theoretical breakthroughs that led to modern quantum mechanics. In the beginning it had looked as though they had invented differing theories, but Schrodinger soon proved that they were mathematically equivalent, and Einstein greeted Schrodinger's first paper with enthusiasm. Schrodinger covered the same facts as Heisenberg on the assumption that an electron had a wave form but not a fixed or definite orbit. Perhaps it should be noted that his quantum mechanics, though most fruitful was non-relativistic in that it contained no time parameter. It was left to Dirac -1928- to derive a relativistic quantum mechanics. Dirac's formulation was, however, very complicated and therefore found fewer applications than Schrodinger's theory. In 1927, following Schrodinger, Heisenberg indicated that the momentum and energy of any given particle was indeterminate and this led to the formulation of the Principle of Uncertainty (cf. 27.4.)

This principle centred on the reality that no matter how objective or accurate measurements are they will in some way affect the system being measured. If we think of a thermometer being used to find the temperature of water we see immediately that unless by some remarkable coincidence it is at exactly the same temperature as the water to begin with, it must affect the water by either minutely heating or cooling it. Heisenberg postulated that this indeterminancy resided, not merely in the knowledge that can be gained about a system, but in nature itself.

The Uncertainty Principle states, inter alia, that we can never know both the position and momentum of an electron exactly. Thus Heisenberg set forth a precise formulation of the fact that all scientific knowledge is tentative by indicating that the very physical means we take to get within 'p' of the momentum ensures that we shall not get within 'q' of the position, where $p\,q = h/2\pi$. Perhaps for the moment it is best considered, as Pledge notes, "not as a profoundly new philosophy releasing man from determinism, but as another case of the old tendency of abstract science to negative modes of statement." (1966, p.280.) It is also obvious that philosophical connotations can, and have, been attached to this principle. Einstein firmly sets forth his rejection of it - especially where it was extended in a philosophical sense to cover the whole of life and reality. This great scientific genius rejected in principle both quantum theory and indeterminancy. (Cf. Bernstein 1973, pp.176,177.)

Important aspects concerning prediction, probability and the laws of nature are involved. Does it mean that the laws of nature are merely statistical probabilities? Does it mean that there must be a total breakdown of the old concept of rigid causal laws in all spheres of existence? Scientists themselves were, and are, deeply divided. Einstein and Schrodinger insisted that uncertainty was a by-product of man's ignorance; Bohr pointed to experimental and conceptual limitations; while Heisenberg noted the inherent randomness of reality. But as de Broglie indicated, whatever the macroscopic picture, the microscopic one was at present indeterminate even if one day we may return to a deterministic framework. (Cf. de Broglie 1953, pp.216,217.) No longer can firm predictions be made (in theory or practice) when an individual radioactive atom will disintegrate after removal from an atomic pile.

This development of atomic theory quickly led to troubled philosophical waters. Dirac pointed out the necessity for antiparticles, which on contact with their corresponding particles annihilate one another, leaving gamma radiation or mesons. To get round some of the inherent difficulties in this he posited an "infinite sea of negative electrons" which created all sorts of problems. "Many physicists are not pleased with a universe filled with an unseen, unfelt negative-energy electron sea." (Wick 1972, p.26.) It will be noted that new and more complicated elementary particles are entering the discussion. Pauli posited the existence of the neutrino, a chargeless and massless particle, in 1931 - only observed in 1956. In 1935 Yukawa suggested that protons and neutrons were held together in the nucleus by the binding force of a meson (subsequently pi-mesons and mu-mesons) - discovered in 1947 by Powell. Neutrons themselves were not discovered until 1931.

In 1931 Bohr discovered a constant ratio existed between the energy and the frequency of the emission from electrons - and lo, this ratio was a constant known from 1901, Planck's constant 'h'. Therefore the electromagnetic radiation of atoms obeyed the same laws as an emission by quanta, by fractions of energy. (cf. de Latil 1965, p.43.) Bohr was led to suggest a way out of the apparent dichotomy between wave-corpuscular confusion, and the uncertainty principle in relation to the macro-world. This was the Principle of Complementarity which he borrowed from philosophy, and for which he has been criticised. Bohr wrote:

> "However far the phenomena transcend the scope of classical physical explanation, the account of all evidence must be expressed in classical terms. The argument is simply that by the word 'experiment' we refer to a situation where we can tell others what we have done....This implies the impossibility of any sharp separation between the behaviour of atomic objects and the interaction with the measuring instruments which serve to define the conditions under which the phenomena appear. Any attempt of subdividing the phenomena will demand a change in the experimental arrangement, introducing new possibilities of interaction between objects and measuring instruments which in principle cannot be controlled. Consequently, evidence obtained within a single picture must be regarded as complementary in the sense that only the totality of the phenomena exhausts the possible information about the objects." (1958, p.39.)

He is saying that we cannot avoid conventional concepts; that no sharp line can be drawn between what is observed and the process of observation; that different models have to be used differently, but that they complement rather than contradict one another; and that conventional concepts cannot give a unified picture of atomic structure. This is an attempt to renounce the possibility of interpreting atomic theory as a description of anything.

Against this background the neutron was discovered in 1931, thus completing the Bohr-Rutherford model of the atom and opening up a new era. The neutron, as a particle with no charge, was faced with no barrier of potential, no force of repulsion, and therefore became the ideal projectile for bombarding the nucleus. At this point the Joliot-Curies had a crucial role to play and pioneered much of the early work. They showed that positrons (positive electrons) continued to be emitted <u>after</u> the source of alpha particles was removed in 1934; and in an important experiment showed that aluminium had been transmuted into phosphorus. Joliot played a crucial role in the breakthrough to the first atomic explosion and was possibly the first to record such an event in January 1939. He and Frisch worked out that the energy liberated was of the order of 200 million electron volts for every nucleus split - and in splitting a chain reaction was envisaged from the balance of neutrons left over. The magnitude of this energy is seen when compared with the combustion of one atom of carbon which yields 50 million times less energy. (Cf. Biquard 1965, ch.3.)

The man who above all others led to the first atomic chain reaction was <u>Enrico Fermi</u>. He was the first to apply the new theories; the first to bombard the nucleus with neutrons, thus giving to it an artificial power of emitting radiation; the first, in 1942, to build an atomic pile and achieve a continuous chain reaction; he was the true progenitor of quantum mechanics; named the pion and muon; and had the final accolade of having an element named after him - fermium. His genius is seen in that having become interested in the field for which he is best known, he turned to it from other pastures (in 1934) and within three months had overtaken those who had long been in the field, and was producing crucial research papers along with his Italian team. (Cf. de Latil 1965, pp.60ff.)

By the end of the year he, and his team, had discovered that screening effects of neutron bombardment were not constant and that neutrons in fact had their effect increased if slowed through collisions. In pursuing this particular line there is one delightful incident where he and his team finished up experimenting in a professor's goldfish pond - water being a good slower of neutrons. Methodically going through all the elements Fermi came at last to Uranium where he thought he had produced the elements 93 and 94. This was a false trail and others were to find the true answer - that uranium had fissioned into two lighter elements. However before Fermi could pursue this his team was broken up. The man known affectionately as 'the pope', 'the prophet' and 'the admiral' was forced to flee with his wife (a Jew) from Italy to America. But Fermi realised the consequences of fission and lent the brilliance of his mind to the construction of the first atomic pile. On 2

December 1942, George Weil, under the commands of Fermi, withdrew the control bar from the atomic pile and at 3.30 that afternoon a chain reaction was achieved. The world was irrevocably changed – physically and psychologically.

8.5. A NOTE ON METHOD, MAN AND SCIENCE.

The above is a very brief and superficial account of two basic reorientations in the physical sciences – relativity and quantum, and their application to atomic structure. There has occured, however, another and deeper reorientation in methodology. The classical physics of Newton, framed in a Euclidean world, was seen as final and absolute; the basic discoveries had all been made and though there were gaps in the record these would be filled in in due time. All was seen in a localised concept of time and space, and the scientific enterprise was characterised by the fact that it could create easily picturable accounts of reality. Today this is gone for there is no single pattern or method that is applicable at the frontiers of science, nor any visualisable models. Yet in the midst of this it must be clearly seen that for most people in ordinary life the world is still Newtonian – quantum, relativity, curved space and 170 degrees to a triangle are irrelevant.

The great advances into the modern scientific world had been made, not by careful deductions from experimental researches in the first instance, but by gigantic leaps of the imagination. Einstein noted this time and again: it was a mental leap for him when he announced that matter could not travel at the speed of light; it was a creative leap for Bohr when he proposed that electrons, to account for their stability, could spin in their orbits without emitting energy; so also it was an imaginative leap for Planck when he altered the entire picture of the physical world by quantifying energy, meaning that energy, like matter, could not be indefinitely subdivided.

Part of the aim of science never changes – namely the attempt to unify all science in one comprehensive structure. Though we "need to recognize that 'science' as such does not exist. Only flesh-and-blood scientists exist, and they hold certain scientific theories." (Schuurman 1977, p.18.) However, Einstein wrestled with the dichotomy between gravitational theory and electromagnetism, trying to reconcile them in a unified whole. Noting his failure he wrote:

"....it cannot be claimed that these parts of the general relativity theory which can today be regarded as final have furnished physics with a complete and satisfactory foundation." (1973, pp.330,331.)

There are many motives to scientific endeavour, but the aspiration for unity that explains all the diversity of phenomena is deep, profound and essentially religious.

Resulting from this scientific work in our century we have the reality of the nuclear age - which man has had to learn to live with. But the problems introduced are not dissociated from man. Science is a human enterprise and this is sometimes lost sight of. As Bronowski movingly related in a television programme:

"It is said that science will dehumanise people and turn them into numbers. That is false, tragically false. Look for yourself. This is the concentration camp and crematorium at Auschwitz. This is where people were turned into numbers. Into this pond were flushed the ashes of some four million people. And that was not done by gas. It was done by arrogance. It was done by dogma. It was done by ignorance. When people believe that they have absolute knowledge, with no test in reality, this is how they behave. This is what men do when they aspire to the knowledge of the gods.

Science is a very human form of knowledge. We are always at the brink of the known, we always feel forward for what is to be hoped. Every judgement in science stands on the edge of terror, and is personal. Science is a tribute to what we can know although we are fallible. In the end the words were said by Oliver Cromwell: 'I beseech you, in the bowels of Christ, think you may be mistaken.'

I owe it as a scientist to my friend Leo Szilard, I owe it as a human being to the many members of my family who died at Auschwitz, to stand here by the pond as a survivor and a witness. We have to cure ourselves of the itch for absolute knowledge and power. We have to close the distance between the push-button order and the human act. We have to touch people. (1973, p.373. cf. Bronowski 1961, ch.1.)

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POSTSCRIPT TO PART I

Any viewpoint can be 'proved' by careful selection of historical data; nevertheless I believe several points can now be made. The thrust of the material reviewed is that there is a positive impetus to science from religious interests. There was the involvement of the Babylonian priests, not only because they were the scholars of the day, but out of the religious necessity of calendar construction and the correct prediction of feast days (cf. 1.2.). More specifically there was the contribution of the Reformation and Puritan mentality in forming an ethos conducive to science; seen clearly in the individual testimony to their motivation in science from Kepler, Bacon, Boyle and many others (cf. ch.3.). As Hookyaas points out (1973, p.162.) the onus is on those who wish to disprove this correlation between the Reformation and the rise of modern science. The religious roots of science have had to struggle against a mythology (dearly loved even by academics - cf. 2.2.3.3.) that the church was against Copernicus; that the Reformation was anti-science; that the Puritans stood merely for a rigorous morality; and that Darwin was the champion of free thought against the oppression of religious thought. I hope the foregoing helps to dispel such mythology, though I do not deny that particular episodes have seen the church arraigned against the individual scientist or theory.

Part I sets the stage for Part II. It has shown, in the rise of the Newtonian worldview, how a rigorous objectivity was sought and claimed in the natural sciences. But in chapter 8 we have seen this objectivity undermined by the theories of relativity and quantum mechanics. Yet the paradox is that, while we live in an Einsteinian world as far as physics is concerned, there is still a popular worldview firmly attached to objective Newtonianism. Chapter 8, then, provides a bridge into Part II as I seek to set forth something of the nature and philosophy of science.

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PART II

A PHILOSOPHICAL PERSPECTIVE ON THE FOUNDATIONS OF SCIENCE

PREFACE

I now wish to turn to the intrinsic nature and aims of scientific endeavour; the character of its theories; how they are arrived at; and what they are conceived to be. I am not seeking to develop an overall philosophy of science, but to indicate how modern philosophies of science give substance to the proposition that there is a metaphysical stance, a basic heart-commitment, and a set of presuppositions that undergirds scientific thought and practice.

I will make particular note of the work of Karl Popper and some of his followers.[1] Often individual thinkers are categorised into artificial moulds - such as verificationist or falsificationist or revolutionist - but as far as possible I have sought to focus on the individual rather than a position. It is more fruitful to examine the fluids views of creative thinkers like Bridgman, Eddington, Einstein, Kuhn and Popper, without labelling them as operationalist, idealist, realist, revolutionist, sceptic and so on. Again, because of shortage of space this discussion is highly arbitrary and I have had to omit several people I would have liked to include - notably R.Bhaskar, I.Lakatos, G.Clark and V.S.Polythress.

It is not my aim at this juncture to present a coherent Theistic stance to the philosophy of science although I have sought to plant signposts. A more systematic statement of a Theistic perspective will be developed in Part IV.

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1. Though I will look at Popper and Kuhn I will make no direct reference to the debate between them. Nevertheless this debate (cf. Lakatos & Musgrave 1976) is central in the study of the philosophy of science and will obviously exist in the background of what I am discussing.

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CHAPTER 9

GENERAL INTRODUCTION

The purpose of this chapter is to indicate something of the problems facing scientific endeavour; to note the nature and aim of scientific activity; outline some of the views regarding the relationship of science and belief.

9.1. SCIENCE : ITS PROBLEMS

9.1.1. The Collapse of Newtonian Mechanics. (Cf. 8.1.) This stands at the centre of the philosophical problems of science today. Newton's first law of motion, the foundation of his mechanics, is the law of inertia with its attendant assumption of rectilinear motion. But with the realisation that nothing is at rest this had to be abandoned - and this automatically alters all that follows in Newton's system. The concept of absolute rest, motion, space and time are not in good repute today; and although Newton entered qualifications against these concepts, the fact is that his system was built on the assumption of their validity. Today the Newtonian system has gone. It presupposed the possibility of determining the position and velocity of any particle absolutely, that is apart from any relation to other particles. However at the same time the law of gravitation asserted the continuous interaction of all particles! For a long time this basic incompatibility did not seem to be of great consequence, but as seen in the last chapter it eventually broke down under relativity theory.

The advent of the Einsteinian worldview radically altered the old classical concepts, and although some argue for the Newtonian system as a limiting case this seems to me untenable. Without, for the moment, bringing in concepts of worldviews which I believe are crucial, this can be seen in the basic concepts of mass and velocity. In the Einsteinian system the relativistic mass (m) is not constant but a variable connected to the mass of the Newtonian system (m_0) by the equation: $m = m_0 / \sqrt{1 - v^2/c^2}$. This means that logically a new principle of conservation of momentum is called for. It is also evident that logically (while when 'v' is small 'm' tends to 'm_0' so giving a practical equivalence) there is no theoretical identity. (Cf. Nagel 1974, pp.111ff.; Feather 1970, ch.8.)

The same applies with the concept of velocity. In the Newtonian system two velocities are additive - a man walking forward at 4 miles per hour in a train travelling at 50 miles per hour is moving forward at 54 miles per hour. But in the relativity theory the equation is more complex. It is: $V = (V1 + V2)/(1 + V1.V2/c^2)$. For values of V1 and V2 which are small relative to 'c' (the speed of light) the two systems become practically the same. But the Newtonian formula $V = V1 + V2$ cannot be theoretically or mathematically deduced from, or be a special case of, the relativity formula. So the two are often similar in value, but that is quite a different matter from saying that the one is logically derivable from the other, or that the Newtonian system is merely a limiting case.[1]

Thus we have the situation today where perhaps the majority of physical science is carried out on the basis of Newton's theories which are theoretically known to be false! To this confusion can be added the ambivalence of the two theories of light, or the two theories of gases. (Cf. Eddington 1930, p.182f.) Experiments on the thermal properties of gases use a theory which pictures a gas as an aggregate of discrete particles; but in acoustics the scientist sees gas as a continuous medium. Logically, as with light and the Newtonian-Einsteinian theories, both cannot be 'true' - or can they? It would seem, on the surface at least, that scientists are not concerned with the literal truth of their theories! But is this really so? And if so today, then has it always been thus or is this a new departure in the status of theories?

It was in this setting that Karl Popper came to the conclusion that all previous ideas of the working of science and the nature of scientific knowledge were incorrect. He asserts that the modern reorientation of science "showed that no theory can be claimed to be inductively established." (Popper: In Magee 1973/a, p.94.) After all, the Newtonian system has had probably more experimental verification than any other scientific theory, and yet it finally had to go - in theory if not in practice. (Cf. Magee 1973/b, p.30.) As Newton is now seen to have fallen short of final truth, so it would be folly to think that Einstein had given us such knowledge (cf 8.3. - quote on p.178.)

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1. It would seem that an instrumental view lends itself to the idea of a limiting case (Nagel); but that realism seeks a disjunction.

9.1.2. The Problem of Number. Numbers are of the essence of physical science ("the language of science" (Dantzig 1947, p.iii.)) for what science does not measure and how do we measure without numbers to count by? Yet there is no consensus of opinion as regards the nature of numbers; whether they are part of a formal, logical or intuitive system; whether they were discovered or invented.[2] This is a problem at the very root of science and it is an uncomfortable experience for the various disciplines to be made aware of the fact that their particular branch of science rests on foundations which are undecided and impossible to demonstrate.

Allied to this is the problem of geometry. Why do we use one form rather than another when "there is certainly no intrinsic property of space which leads a priori to a particular geometry." (Theobald 1969, p.7.)

9.1.3. The Problem of Reductionism and Specialism. The problem of reductionism is where a science abstracts, as it must, but then the scientist forgets that he has made an abstraction and seeks exhaustive explanation of reality of that perspective. This leads to the scientific assertion that music is merely audible mathematics! Related to this is the problem of specialism of which the famous biochemist Chargaff wrote:

> "A unified and consistent vision of Nature has become impossible in our days, at any rate for working scientists. ....Each science protects itself from its neighbours by a cordon of slogans and catchwords; and fashion dictates whether this year we are featuring enzymes or proteins or nucleic acids and whether we wear molecules long or short. New journals are born every day by Caesarean section performed by skilled publishers; and as new disciplines are formed, so are new and mutually unintelligible languages: a Tower of Babel of paper." (1963, p.109.)

But safe in the retreat of speciality the scientist has moved himself beyond reproach, beyond the need of public accountability.

9.1.4. The Lack of Self-Criticism. This creeps insidiously into all areas of thought - especially in the social sciences. When the physical sciences become unsure of their basic reference to reality it

2. Waismann quotes Frege : "science does not know the thought content attached to its propositions; it does not know what it deals with; it is completely in the dark regarding their proper nature." (1951) Cf. Frege 1893, pp.1-32; B.Russell 1956,pp.111-116; Dantzig 1947, pp. 71ff. In that number is a mode of reality and possesses an irreducible kernel moment - no definition is possible (cf. 19.7.)

seems strange that the social sciences, dealing with a much more diffuse area, are as positive as they are. All science needs perpetual self-criticism of the subject being examined and the selfhood engaged in that task. Here lies a radical weakness in modern science, for even when the subject is examined radically, all too often the selfhood and the rationality of the ego goes unchallenged.

9.2. SCIENCE : ITS NATURE

There is no consensus as to the nature of science. There are still those who conceive of science as relatively a body of certainty, resting on some self-electing presuppositions of scientific inquiry (cf. Torrance ?). D.L.Dye - a scientist and a Christian - maintains that science is the best means of acquiring certain knowledge and accurate descriptions of the world, and in doing so is philosophically neutral. He claims:

> "....since science describes observable phenomena it can equally well support any philosophical outlook that is rationally consistent with these observable phenomena. To borrow a mathematical phrase, science is philosophically indeterminate." (1966, p.12.)

In his view science marches autonomously forward as the basic cohesive force in modern society. Technology has given us our modern world, and is the ground for building a secure way of life for man and society. As I see it this neutrality is contrary to the intrinsic nature of science and how technology is worked out in society.

There is, in fact, no definitive statement of the nature of science; but following are several statements that tackle this question and indicate several aspects. First of all: the basic aspiration of science is to achieve a unitary power of explanation.

> "The supreme goal of Science has been the unification of all knowledge within a single all-embracing system, and the uniform interpretation of all reality through a single all-sufficient principle of explanation." (Van Dusen 1963, p.62.)

Koestler writes in similar, but more tempered vein:

> "In the discoveries of science, the bisociated matrices merge in a new synthesis, which in turn merges with others on a higher level of the heirarchy; it is a process of successive confluences towards unitary, universal laws..." (1970, p.354.)

Following from this, the scientific enterprise is involved in a search for overall order; it seeks to unfold an harmony which presupposes an existing order. Bronowski writes:

> "Science is not the blank record of facts, but the search for order within the facts. And the truth of science is not truth to fact, which can never be more than approximate, but the truth of the laws which we see within the facts. And this kind of truth is as difficult and as human as the sense of truth in a painting which is not a photograph, or a feeling of emotional truth in a movement of music. When we speak of truth we make a judgement between what matters and what does not, and we feel the unity of its different parts." (1951, p.87.)

Einstein clearly acknowledges the religious character of the scientific quest and notes that science is in effect a <u>reconstruction of existence</u>.

> "Science is the century-old endeavour to bring together by means of systematic thought the perceptible phenomena of this world into as thorough-going an association as possible. To put it boldly, it is the attempt at the posterior reconstruction of existence by the process of conceptualization." (1973, p.44.)

In similar vein Ritchie Calder writes:

> "Science is the everlasting interrogation of Nature by Man. It certainly did not begin with Aristotle, and will not end when someone produces a 'unified theory'. Even when a theory assumes the stature of a 'law', because the consistencies seem to leave no room for doubt, it is not definitive; it is waiting for the next amendment." (1968, p.3.)

But in this search for unity and reconstruction of reality the case can so easily be overstated, such as by Van Dusen above or by Pearson when he writes that: "The goal of science is clear - it is nothing short of the <u>complete</u> interpretation of the universe." (emphasis mine) (1911, p.14.) Such assumption of the sovereignty of science and attribution of (potential) omniscience must be called into question, as must the implicit <u>ding an sich</u>.

A more limited view, from a typically modern instrumentalist viewpoint, is given by Holten and Roller who argue that:

> "When you ask 'What is science', you are in effect asking mainly 'What do scientists now do at their desks and in their laboratories, and what part of their past work is still useful to men in a given field." (1958, p.213.)

<u>9.2.1. An Human Aspiration for Order and Understanding.</u> This is an essential part of the nature of scientific activity. As a human search, and therefore finite, it can never exhaust truth or knowledge, but nevertheless it can attain 'true truths' concerning reality.

Science is that body of knowledge dealing with the structure and causal/functional relationships of certain facts of the created order. In the commonly accepted English connotation of the word 'science', these disciplines have little to say concerning theology, ethics, justice or aesthetics.

9.2.2. The Corporate Character of Scientific Inquiry. Science is a social enterprise and subject to the problems of social structures and institutions (cf. the role of the Royal Society and the French Academy). Deriving from the essential human character of science, it becomes imperative that science be seen as possessing a tentative and not an absolute status. It is men who carry out scientific research and as men bring to this judgements, prejudices and personal aspirations - though the corporate character helps to minimize individual traits. But as a community, the scientific enterprise is like all human communities susceptible to a set of values, a bias of mentality, a pattern of attitudes.

9.2.3. Tentative Knowledge. Karl Popper is one of the leading philosophers of science today and his philosophy is:

> "....fundamentally at variance with all views of science or rationality which see these as excluding passion or imagination or creative intuition; and it condemns as 'scientism' the notion that science gives us certain knowledge and might even be able one day to give us settled answers to all our legitimate questions." (Magee 1973/b, p.68.)[3]

Scientific theories have increasingly been seen to be of a tentative nature - the fate of all being potential replacement. The Baconian view received a severe set-back in the breakdown of the Newtonian universe, for if laws had been really discovered then they would not be open to discarding. Diagram I helps to illustrate the formulation and subsequent development of a scientific theory. (Cf. Davies 1975, p.5.) Starting from general experience a vague idea may be formed which can be tested against experience. From there further conjectures, analogies or creative intuitions may lead to the formulation of some scientific theory of more precise nature. This in turn is tested against predictions and may be modified into yet more precise format. As examples the following two cases are cited.

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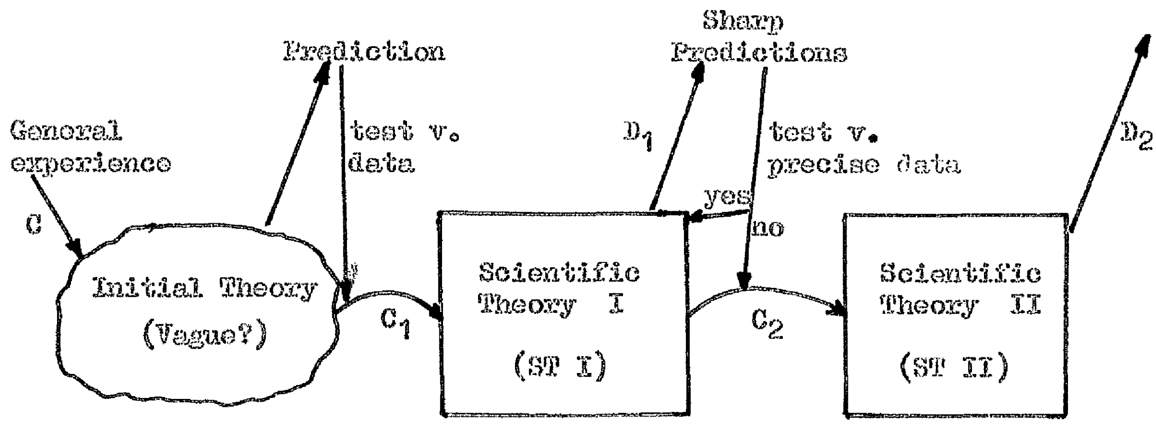
3. Popper himself notes, in language reminscent of Einstein, that: "Science is most significant as one of the greatest spiritual adventures that man has yet known." (1961, p.56.)



C = Conjectures, dreams, analogies etc..

D = Deductions.

<u>DIAGRAM I : Theory Formation</u>

The basic Gas Law P.V. = R.T. is ST I, but as this noticeably breaks down under certain conditions it has to be modified by the van der Waals correction such that it becomes $(P + \alpha/V^2)(V - \beta) = R.T.$; where α relates to intermolecular attractive forces and β relates to molecule size. This is now ST II. The theory is no longer as simple, but it is more general and precise. A second example is where the Newtonian theory is ST I and the Einsteinian is ST II.

To extend this briefly the following may be noted. (a) Theories which have been disproved by so-called crucial experiments are nevertheless useful - such as the wave and particle theories of light. (b) Theories are commonly formulated before there is any data or experiments to verify them - such as relativity, Harvey's postulation of capillaries, and Kekule's benzine ring. (c) Theories can be totally rejected such as the theory that the earth is flat; while (d) the converse theory that the earth is a rough sphere may move from the arena of a 'theory' into that of an accepted, observed 'fact'.

<u>9.2.4. Communicable Knowledge.</u> This does not mean that the progress of knowledge is continuous or cumulative. Scientific knowledge and technologies can be lost; men forget or become ignorant of past researches and while the danger of this has been curtailed with the printed word it is not altogether obviated. An obvious modern problem is the lack of inter-disciplinary communicability.

But underlying the scientific quest there resides in the minds of individuals a shared pattern of expectation, as well as common concepts of regularity and intelligibility. It is not enough to glibly assert that such phenomena are written into science in a philosophically neutral manner. Many philosophical systems provide no rationale for the assumption of such thought - existentialism, logical positivism and linguistic analysis to name but three. It seems to me that here is a factor all too often ignored by the modern communicator with a naive assumption of these qualities without any attribution to their derivation.

<u>9.2.5. The Aim of the Enterprise.</u> This is to understand nature; to derive laws which give a predictive power, and theories which will have some explanatory force. As Einstein claimed:

> "The aim of science is, on the one hand, a comprehension, as <u>complete</u> as possible, of the connection between the sense experiences in their totality, and, on the other hand, the accomplishment of this aim <u>by the use of a minimum of primary concepts and relations.</u>" (1973, p.293.)

There is the question what? and the question how/why? But the two do not go together. The Babylonians were good at predictions of certain heavenly phenomena, but in the light of modern astronomical knowledge we must consider their theories as of low explanatory force. In turn modern explanations must not be considered to lead to final truth, or as giving necessary insights of the complete canvas of reality. Nevertheless, it seems safe to claim that science deals with data concerning the world we live in and desires to arrange this data in some intelligible order - though there is no such thing as an isolated 'fact'. Prediction is not enough, there is also this craving to understand.

This quest is fraught with immense philosophical and internal scientific problems. As Bronowski records: "One aim of the physical sciences has been to give an exact picture of the material world. One achievement of physics in the twentieth century has been to prove that that aim is unattainable." (1973, p.353.) Here is a discrepancy between aim and achievement that needs examination and which highlights a question that must be raised against the aim of total, exact descriptions. As I hope shall become clear: the problem is one of abstraction from the totality of reality, and then, <u>in the drive for exhaustive knowledge in that abstraction, a failure</u>

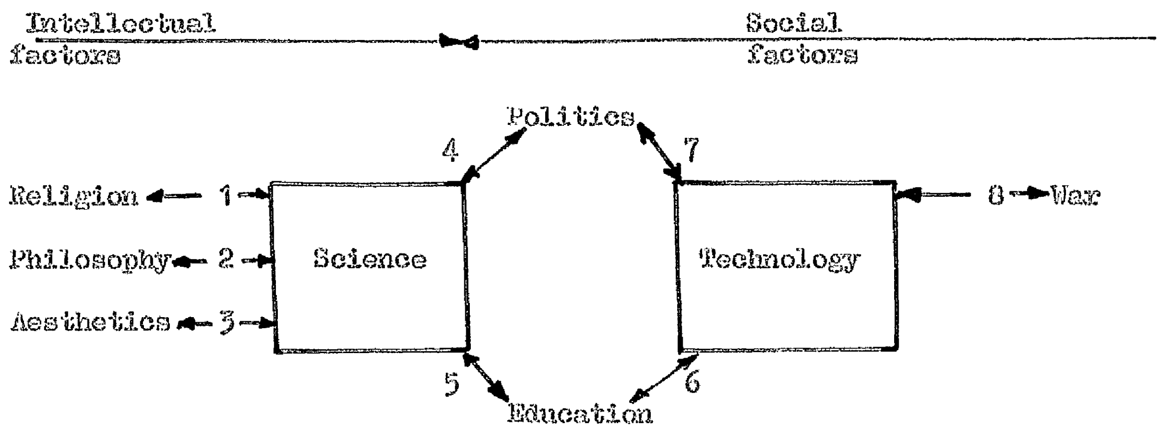


DIAGRAM II : An Externalistic Model

to remember that, in the first instance, an abstraction from reality has been made.

9.3. APPROACHES IN SCIENCE

9.3.1. To the Nature of Theories. Two approaches stand out – the internalistic and externalistic. The former emphasises the internal changes and processes of development within a scientific discipline, holding to a certain autonomous inevitability in the path that science follows. It seems to me that this is inadequate in providing a satisfactory model for the nature of science although it is widespread in its adoption. The latter view seems more consistent to life. Diagram II is posited as a possible structure concerning the interactions of science and other spheres of life. (Cf. Russell, C.A. 1974/a, p.22f.) Different ideologies, of course, stress different features and affect even directly the scientific sphere. With reference to the model the following examples are cited:

1. The interaction of Darwinian belief and Christianity.
2. The impact of quantum on the philosophy of causality.
3. Oppenheimer's aesthetic appreciation of the H-bomb.
4. The Lysenko affair; research directives; government funding.
5. Interaction of psychological theories and education.
6. Development of teaching-aids.
7. Public health.
8. Weaponry.

Thus it seems to me there is an interaction of intellectual and social factors which influences the scientific enterprise and gives direction to it. This was, of course, implicit in Part I.

Certain inherent criteria are evident in the structure of any scientific theory. (a) The scientist will use words and symbols in a manner that is relatively explicit and formal in contrast to the pre-theoretical usage of words in everyday thought. (b) He will exercise a "strong aesthetic appreciation of the elegance of basically simple general theories." (Davies 1975, p.6.) This is aspect 3 in Diagram II. (c) He will endeavour to make sharp predictions and carry out rigorous tests to see if these theories work. (d) In the event of refutation or criticism, he will be ready to modify the theory in favour of a better one.

However there is no consensus concerning the status of theories. Some advocate that a theory gives something of the essence of reality (essentialism); others see a theory as a true representation of the world but claim that the essential world is not observable (v. essentialism), yet theories are true as well as useful (v. instrumentalism); instrumentalism in turn asserts that the truth or falsity of a theory is irrelevant and that what matters is the utility value of a given theory; operationalists point to the crux lying in the techniques involved; while others, such as Kuhn, stress the importance of worldviews.

<u>9.3.2. To the Derivation of Theories.</u> If there is confusion as to the nature of scientific theories, there is also controversy as to their derivation. Among others, three are here mentioned.

<u>9.3.2.1. Bacon's Bucket (The tabula rasa).</u> Historically the Baconian tradition is seen as exercising a strong influence. Commonly called 'the bucket approach' it is the idea that man observes the world and gathers into his mind, as into a bucket, all the facts of his world through his sensory channels. Then, having assimilated all this information, with the mind passively receptive, theories are formed to relate the collected data. This view comes under radical attack today but is popular in the minds of non-scientists, popularisers and theologians. (Cf. Popper 1975, pp.60f, 341ff.)

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4. This view fits naturally in with British empirical traditions. But it should not be tied too closely with Bacon, much as Newtonianism should not be equated with Newton.

9.3.2.2. Eddington's Fishnet. Eddington suggested that theories were like fishing nets. A net of two inch mesh would never catch fish smaller than this - unless by accident a few small ones got caught together. In similar vein the scientist has a presuppositional grid of a certain size which predetermines by its construction what is going to be caught. If something is not caught in the grid (or net) it is considered not to exist.[5]

9.3.2.3. Popper's Searchlight. In this analogy theories are formed in the mind and then focused on the observable range of phenomena for confirmation or refutation - in a similar way to a searchlight tracking an aeroplane. This is the reverse of the Baconian bucket. The mind is crucial in forming a pattern, or focusing a beam, on the observable world - thus selecting data. It is not a process of collecting facts blindly out of which theories will automatically follow. To pursue that path buries the observer under a veritable avalanche of 'facts'. The command to 'Observe!' is, by itself, meaningless. (Cf. Popper 1975, pp.341ff.)

9.4. SCIENCE AND BELIEF ?

The very postulation of 'science and belief' implicitly assumes that the two are somehow separate, autonomous realms. But is this so? Certainly there is no apparent reason for the assumption that it is; and if it is, then cogent arguments for it are required. As I hope to show, any such argument fails in the face of a radical presuppositional critique, the examination of the selfhood, and the nature of science. As already argued, the modern scientific traditions came into being in a particular weltanscauungslehre, and in no other. As Professor Zaehner once noted: "it was within a Western Christian setting that our technological civilisation came to birth, and this was no accident, for Christianity is both this-worldly and other-worldly." (1963, p.184.) In similar vein C.S.Lewis pointed to the concept of the Lawgiver as a necessary prerequisite of the concept of uniformity and law:

> "Men became scientific because they expected Law in Nature, and they expected Law in Nature because they believed in a Legislator. In most modern scientists this belief has died;

5. Eddington wrote: "We picture the mind like an editor in his sanctum receiving through the nerves scrappy messages from all over the outside world and making a story with them with, I fear, a good deal of editorial invention." (1930, p.100.)

it will be interesting to see how long their confidence in uniformity survives it." (1960, p.110.)

Paradoxically it can be claimed that the churches, as represented by the Roman Catholic and Protestant traditions, provided at one and the same time the bitterest opposition and the ultimate inspiration to the development of science. In this light it is wrong to make hasty generalisations one way or the other, although the thesis here defended is that the Reformed view did enhance and encourage scientific endeavour by providing science with a positive theological framework which saw it as a creational pursuit before the face of God.

This debate has taken new twists in our day with the realisation of the tentativeness of theories. No longer can science be presented as a body of irrefutable, infallible dogma derived by absolute objective research on the part of unbiased observers. The myth of infallibility is nevertheless retained at certain levels, but in practice physical science has become mathematical and abstract and in this isolation tends to support some form of philosophical idealism. On another plane the Uncertainty Principle has been seen to break the cords of intransigent determinism and reinstate the ancient gods of chance, as well as the responsibility of human freedom. Perhaps, in the light of what has been said so far, the greatest need of our modern society is that educated opinion learn the limitations of science instead of appealing to it as the final court of arbitration. (Cf. Barzun 1964, p.78.)

Science has a root-relationship to faith in that all men have faith - whether it be directed to God or away from God. (Cf. 19.7.1.; 20.2.4.) Faith is an essential part of the structure of being human; it is the content and direction of faith that differs. Hence the confession that 'I believe in God' has its counterpart in the confession that 'I do not believe in God'; the claim that 'All ends in death' is no less a confession of faith than 'I believe in the resurrection of the dead.' This aspect of faith must be distinguished from the relation of science to Christian faith which is the relationship of a particular faith to a particular branch of study. Several models are posited concerning science and Christian belief.

9.4.1. The Warfare Model. This is widespread and sees the two aspects in direct confrontation - the idea that science has disproved the Bible; that such and such a belief is impossible because science has proved this and that. In this tradition stands J.W. Draper who wrote 'History of the Conflict between Religion and Science' (1875). In a slightly more balanced approach A.D. White is still exposed in the title he gave his work - 'A History of the Warfare of Science with Theology in Christendom.' (1903) Another revealing title is J.Y. Simpson's 'Landmarks in the Struggle Between Science and Religion.' (1925). While there is a popular belief in the clash of science and belief, it seems to me unsustainable in the light of Part I. The leading thinkers and experimenters of the first modern scientific reorientation were not only unconscious of any dissonance between their scientific work and religious convictions, but saw their science as a conscious expression of these convictions. The notion of a clash is a myth stemming largely from the 19th century - though Einstein could boldly assert that the church 'always' fought against science and persecuted its devotees. (1973, p.39.)

The concept of a clash has been perpetuated by scientists and churchmen. There have been scientists, especially atheists and humanists, who have argued as part of their 'faith' that science and belief are irreconcilable. On the other hand there have been those within the religious traditions, who, advocating monistic or pietistic withdrawal from the 'things of this world', have seen in science that which is alien to their Christian belief. This latter group tend to represent smaller sects rather than any major view of the historic mainline stream of the church; they are not orthodox, but naively hyper-orthodox in their beliefs and representations of Scripture. Paradoxically they are inconsistent in that they see little problem associated with the daily use of the benefits of science, or in their implicit erection of an antithesis between the Word and Work of God.

9.4.2. The Divorce Model. This can be divided into three distinct views. (a) There are those who advocate a separation of science and belief although they recognise the Christian origins of the scientific tradition; (b) there are those who hold that the two spheres have always been distinctly separate; and (c) the view, represented by Clerk Maxwell, that the two are connected but for public purposes should be kept separate.

Alan Richardson provides an excellent example of the first of these positions when he tells us that theology is 'indifferent' to the choice of cosmologies. (1968, p.29.) This seems the current theological consensus, a clear discontinuity being argued for except where science and belief jointly impinge on morality.[6] The Neo-Orthodox theologians point to the uniqueness of the revelation of God and the centrality of man's encounter with that revelation in confrontation with Christ. Linguistic analysis suggests that the languages of religion and science fulfil different functions, follow different sets of rules. Existentialism drives a wedge between the personal and impersonal, between the moment and the being, concentrating on epistemological questions to the negation of ontological.

It is further argued that as faith is enduring and science now seen to be ephemeral any close association must be played down. E.L. Mascall writes: "I can think of no greater disservice that could be done to the Christian religion than to tie it up with....scientific views that are merely temporary." (1956, p.166; cf. 16.5.1.3.)

This view can be criticised in driving experience into discrete autonomous realms, allowing religion to control a religious aspect and science a scientific part of life. This assumes that a fence can be built to delineate these territories and smacks of a god-of-the-gaps mentality. It presupposes and sustains a dichotomy in man's existence.

9.4.3. The Symbiotic Model. Having quoted Einstein's poor historical reconstruction of science and belief (9.4.1.); he is again referred to in pointing out the close connection between the nature of science and belief. While his concept of religion is not Christian, it provides a starting point for this model.

> "The interpretation of religion, as here advanced, implies a dependence of science on the religious attitude, a relation which, in our predominantly materialistic age, is only too easily overlooked." (Einstein 1973, p.52.)

Not only are the two connected, but science is itself a religious quest and has a religious nature. From the Christian viewpoint this dependence is extended to cover the essential harmony that must exist between the Word of God as revealed in Christ and Scripture, and the Work of God as revealed in Creation. In this view the concept of creation is of paramount importance and it is maintained that science is dependent on the revelation of a divine law-giver for its very existence. This is the root of the concepts of law and order, the

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6. I had hoped to deal at some length with Richardson in Part III, but space precluded this. However he is an important figure for my topic, providing a classic apologetic for the divorce model. As I hope shall be clear from my own approach, this is a suspect apologetic.

source of the motivation to demonstrate and master the order God has imparted to His creation.

At the same time it must be clearly stated that both theology and science are human pursuits and therefore fallible. They are human pursuits dealing with different modes of reality. But in the final analysis the proponent of this view maintains that all of man's existence forms a cohesive unity before God, such that Christian belief is in accord with the material, suprematerial and experiential facets of his being. One of the main difficulties facing this view is the interpretation of the Bible in relation to science.

9.4.4. Attendant Problems. The warfare and divorce models have been enhanced by the general cultural revolt against authority (and so the church); by the rise of much modern philosophy; by the rapidity of scientific growth into an overwhelming monolithic structure which no one person can ever hope to master; and by the internecine warfare within the church. To these can be added the loss of a historical perspective on science *qua* science, though this is now in part being recovered. But generations of students have been turned out in the sciences with no reference to the historical, philosophical or religious roots and problems of the theories they are taught. It will take time for any new awareness to have impact. Implicit in this is the spiral of specialisation which loses general appreciation of the wholeness of life. Other features assisting the first two models have been the increasing ignorance of scientific matters by theologians, due in part to scientific growth; the failure to develop a Christian philosophy of science; the rise of many non-Christian scientists (in contrast to previous centuries); and the general 19th century retreat, via Schliermacher, into the 'sacred'.

Many mistakes have been perpetuated on both sides of the divide. Theologians have often been unsympathetic to science by ignoring it and its problems. Again some have tended to tie a given worldview and its science with specific texts which do not necessarily teach this, failing to realise that the Bible is not a scientific text-book - which is not to say that it has nothing to contribute to scientific work. On the other hand, scientists have been guilty of anti-religious sentiments that have nothing to do with science *per se*; of an irrational bias against teleology; and an *unscientific* rejection of the suprematerial. Again the scientist has often been reductionistic. Bertrand Russell, for example, claimed that:

> "The evidence, though not conclusive, tends to show that everything distinctive of living matter can be reduced to chemistry, and therefore ultimately to physics. The fundamental laws governing living matter are, in all likelihood, the very same that govern the behaviour of the hydrogen atom, namely, the laws of quantum mechanics." (1948, p.33.)

This simply will not do: the evidence is 'not conclusive'.

Other errors from both theologian and scientist follow when scientific theories are seen as final and infallible; from general misinterpretation of the Bible; and from a failure to see that all human knowledge is imperfect, that sin has a noetic dimension. This does not mean that we can never have true knowledge, but our knowledge cannot be exhaustive. Popper (1972/a, pp.29,30.) is mistaken when he equates truth and exhaustive truth.

9.5. REALITY : EXPLANATION : KNOWLEDGE

One of the most important things for Greek philosophers was the nature of 'universals'. For Plato these took on a certainty absent from the world of experience and this was one of the reasons for the stagnation of science within this tradition, and conversely for the great advances in science (cf. Turnbull 1962.). Aristotle saw two types of substance - primary and secondary. The former dealt with particulars, individuals; while the latter dealt with universals. It should be noted that nouns are such universals - man, horse, fruit. 'Accidents' were questions that might be asked of any substance - what is colour, shape, etc.? Aristotle believed that science should concern itself with the examination of the relation between the secondary substances. He further held that the logic of explanation was deductive (as opposed to the intuitive inductive creation of hypothesis), and that the premises of scientific explanation were mainly generalisations from observations.

Obviously it would be helpful to know if any part of scientific knowledge was certain and not liable to revision under any circumstances. Is there such knowledge that is not also tautologous; how do new discoveries affect the status of what we at present think we know; is the information derived from a theory different from that derived from an observation; can observations be made without some theoretical frame; is all knowledge theoretical? At heart - what do we know, and how do we know? Can we know what is too small to be observed; is a chemical equation merely a summary description of certain changes in colour, taste, etc.? Such are the questions to be faced. What is explanation? What is probability? What is energy? These and similar questions are beyond the resolution of scientific observations and techniques for they are philosophical. They determine the paths science will follow. As F.W. Garforth notes:

> "....it is fair to point out that science itself lacks the conclusiveness popularly attributed to it. The history of science, it has aptly been said, is 'strewn with the wreckage of discarded concepts.'" (1971, p.18.)

The scientist does not so much read his conceptions out of the observable world as read his pre-conceived ideas into the world. As a man sows his axioms so shall he reap his deductions. Metaphysics is connected to the world of science and any attempt to dissociate science from it is doomed to failure. We have already seen how belief was a crucial feature in the first modern scientific reorientation and there is no reason to suggest, despite changing theories of science, that this nature has been negated. Science is still bound up with worldviews, with philosophical commitments, and with value judgements that preclude any simplistic view of the objectivity of science.

The Special Theory of Relativity, for example, like all important theories in physics is a blend of metaphysical and empirical elements. Empirically there is the alleged fact of the constancy of the speed of light, while metaphysically there is a denial of the intelligibility of empirical concepts of absolute position and time. The theory assumes that there is absolute simultaneity between events while at the same time asserting that we can never determine which events are simultaneous without reference to some arbitrary frame or grid datum. Again it is claimed that Bohr had a relativistic philosophy which enabled him to accept quantum. These examples could be multiplied, but the point is that in the beginning we have to choose some concepts with which to think about the world, and <u>any set of concepts</u> thus chosen <u>involves ontological, epistemological, methodological and axiological assumptions</u>.

The problem is that truth often is atomised along with scientific thought, thus losing the essential wholeness of the concept of truth. The relation of truths to Truth must be consistent and not envisaged as a bit here and another disconnected bit there. Isolated 'facts' do not exist - a fact only exists as long as it is in relation to other facts. Kant's '<u>ousia</u>', his '<u>ding an sich</u>', is not simply beyond the reach of knowledge - it does not exist. This is not to say that there is no distinction between appearances and essential attributes. (Cf. Kuyper 1898, p.22.)

The exact role of sensory perception is not simple to analyse. Some propose contemporary versions of Kantian idealism, while others disparage the senses. But it seems to me that we should realise that our senses do not as much report, as help us to construct a universe. <u>Of themselves</u> they discover nothing, but transmit to the mind a selected chaos of phenomena which has order imposed on it. Again, this perhaps goes too far as there is conceived to be an order latent in the phenomena - God's order - and care has to be taken not to reduce objective reality to the mental; but superimposed order is not necessarily the order inherent in creation.

> "Etymologically, it is fairly certain that <u>to know</u> as an intellectual conception is derived from the sensual conception <u>to see</u>; and more particularly from seeing something one was looking for in a sense of <u>finding</u>. As a result, there is both a naive and a deeper sense of knowing just as there is a naive and a deeper sense of seeing." (Kuyper 1898, p.16.)

In science, then, there is at least a threefold organic relation between the subject and the object: between the object and our nature; between the object and our consciousness; and between the object and the world of thought. It therefore follows that truth is something towards which science moves, and that this movement is governed by diverse factors. Prior to seeing or observing is a conceptual framework - consciously or unconsciously held - that governs what is 'seen'. Note the distinction between 'to see' and 'to see as'; the former asserting something of factual import and the latter being the forming of a hypothesis. This suggests that experience does not give meaning to concepts, but that concepts give experience meaning. (Cf. 21.1.4.)

What is scientific explanation ? Is it a description of what is, of what appears to be, or something else? Perhaps there is no general characteristic feature of all explanations and this compounds the situation. It is often held that scientific explanations must yield predictions of some sort,and although some deny this, it seems difficult to dismiss as this would entail a rejection of usefulness, testability and validity. Certainly there can be predictions without adequate force on the explanatory side, but this does not in my opinion hold in reverse. It is of the nature of scientific explanations that they predict in some form and it seems to me that this is of paramount importance in all the objective modes of meaning (as opposed to the normative modes). Explanation must be reasonable to, but not necessarily wholly consistent with, what we know. If it were totally consistent then new breakthroughs would be precluded, though consistency is demanded in relation to previous theories and other modes of being to some extent. (Cf. 15.2.2.1. and 15.4.3.)

Poincaré gave a famous proof that if one mechanical explanation could be given for a phenomenon then an infinity of explanations could be constructed. (Cf. Nagel 1974, p.116f.) This supports the factor of the crucial role of philosophy and religious interest as determining influences behind theories and their explanations. Thus we are left with a position that is far from popular thought. It is well summed up by Sir Julian Huxley.

> "The clear light of science, we are often told, has abolished mystery, leaving only logic and reason. This is quite untrue. Science has removed the obscuring veil of mystery from many phenomena, much to the benefit of the human race; but it confronts us with a basic and universal mystery - the mystery of existence in general, and of the existence of mind in particular. Why does the world exist? Why is the world-stuff what it is? Why does it have mental or subjective aspects as well as material or objective ones? We do not know." (1961, p.42.)

Within the logic of the humanistic position of a closed universe Huxley does not know. But the Theistic position claims to unfold something of this mystery.

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CHAPTER 10

THE ONTOLOGY AND EPISTEMOLOGY OF SCIENCE I

DIVERSE PERSPECTIVES

10.1. WHAT IS A SCIENTIFIC THEORY ?

The question of the status of scientific theories is essential to any understanding of science. Is a scientific theory a description of reality, or an explanation? Is it merely a tool with which to make predictions? Is it solely a construct of the mind? Immediately problems arise concerning the being and nature of 'truth' and 'reality'. Naturally there is no consensus here for these questions assume a philosophical and religious character that cannot readily be resolved. Thus a long and inconclusive debate has surrounded the question of the correspondence of science to reality. The issues are complex and involve points of formal logic and scientific data as well as philosophical considerations as to the nature of meaning and knowledge.

The historically oldest view, and possibly the most widely held at non-scientific levels, is that scientific theories are essentially true (or false). Even if in the limit this cannot be established, it is held in principle to be a valid framework within which to place theories. The other extreme - the modern 'official' view - holds that a theory is primarily a logical instrument for organising our experience and experimental laws. Theories are viewed as rules or principles for making further actions possible, rather than as premises from which deductions can be made concerning the world. Here a theory is not even in principle probably true/false. (Cf.10.4.1.;11.4.)

Between these two positions are various mediating views that would recognise some correlation between theories and observable events/properties as regards truth. Theoretical terms are seen as shorthand notations for complexes of events, but not therein necessarily indicating some observationally inaccessible reality. This middle ground covers a variety of positions within wide parameters - but it is often associated with the idea that theories describe (not explain) in simple and economical ways any succession and concomitance of events. Singer (1962, p.296.) claims that "description is the aim of science." This view was widespread in the 19th century and saw the birth of the positivistic position which sought to dissociate science from metaphysics. This tried to envisage scientific theories as both accurate analysis and weapons against philosophical positions that would bind science to religion/ metaphysics. However, in pursuing this the word 'description' was made to possess a variety of meanings. Perhaps Ptolemy and Copernicus were both merely describing the heavens as they saw them, but there is a greater explanatory power in the latter theory for it is closer to reality. (It is a better description?) In as much as theories are often proposed <u>before</u> there is any evidence to support them, and therefore no observational reality to be described, one must ask how this can be regarded within the normal meaning of 'description'. Simple description is thus beset with many problems. Indeed to translate theoretical statements into a language of sense-data assumes an autonomous language of bare-sense-content, and such a language would not appear to exist. Note the following examples of theories:

(a) The theory of mechanical force in the formulation of the principles of Newtonian mechanics.
(b) The concept of the light ray, used to give geometrical form to optical discoveries and given two quite distinct interpretations depending upon which general theory of light has dominated.
(c) The concept of heat in the explanation of calorimetry.
(d) The concept of virus to explain the appearance of diseases with no obvious bacterial cause.

Here are four scientific theories whose status seems to take on quite different roles. (a) seems to suit some form of phenomenalism, for in effect it can appear merely as a way of speaking about mass acceleration. (b) seems to fit the concept of theories as fictions or instruments to achieve certain results. It is useful even when strongly refuted. (c) again suits a sceptical view which could be treated as either (a) or (b). (d) has passed from being a candidate for reality to the status of a real entity through the work of Pasteur and Koch, so suiting a realist viewpoint.

10.2. THREE MODERN FORERUNNERS

<u>10.2.1. Ernst Mach (1838-1916) and Positivism.</u> To outline the confusion, not only in determining what a person believes but in the terminology of categorizing, it should be noted that Mach is variously called an 'operationalist', 'positivist', 'phenomenalist' and 'descriptivist'. Mach developed a critique of Newtonian science

akin to Berkley's, both sharing a 'type' of instrumentalist viewpoint. He wrote that "it is the object of science to replace, or save, experiences, by the reproduction and anticipation of facts in thought." (Mach 1960, p.577.) For Mach, the basic unit of all experience was sensation - colour, sound, pressures etc. - and understanding was shut up within the realm of sensory-experience. This meant that his starting point was close to Neo-Kantian positivism, and that what are called 'bodies' and 'minds' were relatively stable complexes of sensations.

From this it followed that science was to concern itself with 'how', not 'why' anything happened. To explain 'why' was to endeavour metaphysically to get behind sensations (or elements) to 'things-in-themselves'. Science, however, merely described 'how' events happen, described the regular connection between elements. So Mach was moved to mount a violent attack on metaphysics. Among other concepts thus attacked were the 'atom' and 'force'. Atoms were seen as merely ordering devices and had no foundation in reality, and Mach refused to accept them as 'real' till late in life. He tried to remove the concept of force by redefining it as the product of mass acceleration, and then define mass in terms of acceleration.

Opposed to any materialistic or mentalistic metaphysics, Mach saw reality as basically neutral. This probably meant that he did not oppose all metaphysics as the later logical positivists did, although this assertion of neutrality is rather an ambiguous proposal which tells us nothing at all, and indeed goes no further than Kant's unknowable. Neutral meant neither mental or material! He postulated that it was a mistake to assume that the concepts and relations of science corresponded to reality as such - and refused to posit a realm of reality behind appearance. (Cf. Berkley)(Mach 1911, p.49.) He sought to reformulate Newtonian mechanics from a phenomenalogical standpoint and dispose of metaphysical accretions, seeing empirical generalisations as contingent truths confirmed by experimental evidences. To guide and direct this aim he suggested a principle of economy - which reintroduced metaphysical factors. (Cf. Mach 1960, p.586.)

The position Mach is most generally associated with is that of positivism - though not with the rigour of the later logical positivists. This view sees scientific theories as summaries of data, shorthand résumés of experiments, and convenient ways of classification. Its emphasis falls on the experimental side and tends to miss the role and influence of theoretical concepts as they stand over against sensory experience. Unanswered is the basic epistemological problem that within the logic of positivism you have no reason to know that data is data; or that what is reaching you via the senses is data. There are no universals, no certainty, and ultimately no real criteria to distinguish reality from fantasy.

The positivists of this early period divided into two distinct camps - the phenomenalists and the psychicalists. The former saw the basic data as sensory where all verifiable propositions must be translated into statements about sense-impressions. The latter required the translation of all conceptual statements into statements about the public world or direct experimental results. In this sense, Bridgman (10.3.2.) pointed to the need to define all operations, claiming that: "The concept is synonymous with the corresponding set of operations." (1927, p.5.)

Three further problems are noted. (a) Man never starts with bare sense-data, but from patterns of experienced relationships which interpret the present. All sensory experiences are conditioned, educated experience. This is readily seen in that what is common-sense for one age (a flat world) is not so of another. (b) The requisite of a neutral observation language has been shown as an illusive dream. (c) It is clear that all conceptual terms cannot be eliminated - as in the attempt to get rid of 'force'.

<u>10.2.2. Karl Pearson (1857-1936).</u> His famous 'Grammar and Science' was based on a thorough-going philosophical empiricism as the basic epistemology of all scientific thought; and further, as he usurped all of reality as the domain of science, this became a general epistemology. His position can be seen in his own words:

> "There is no better exercise for the mind than the endeavour to reduce the perception we have of 'external things' to the simple sense-impressions by which we know them.... Beyond the sense-impressions, beyond the brain terminals of the sensory nerves, we cannot get. Of what is beyond them, of 'things-in-themselves'....we can know but one characteristic....(the) capacity for producing sense-impressions. There is no necessity, nay there is want of logic, in the statement that behind sense-impressions there are 'things-in-themselves' <u>producing</u> sense-impressions." (1937, pp.60-62.)

Like Mach and the other positivists, he held that atoms, electrons and molecules were merely convenient categories for summarising and simplifying laboratory data - but as they do not themselves designate anything real, they must not be thought of as themselves real.

But Pearson went further than Mach in insisting on the all-pervasiveness of science. For him, scientific knowledge was the only possible knowledge; nothing lay outwith the world of scientific description, and so he claimed that: "The whole range of phenomena, mental as well as physical - the entire universe - is its field. The scientific method is the sole gateway to the whole region of knowledge." (ibid p.24.) [1]

10.2.3. Pierre Duhem (1861-1916). His view of theories was that they bound together experimental laws, that they represented a group of laws - carefully delineating between representation as a descriptive and an explanatory function, he rejected the latter. While theories are sometimes thought of as revealing something of the underlying reality of superficial appearances, Duhem criticised this, insisting that it was the representative function of a theory that alone was of scientific value. For him, theories embodied an axiom system and rules of correspondence which correlated the terms, while in addition there may be a picture or model associated with this system. He realised that scientific procedures were impregnated throughout with theoretical considerations and supported Whewell's contention that there were no such things as irreducible 'facts' devoid of theory. In other words $2 + 2 = 4$ is not an isolated 'fact' but only assumes meaning as it stands within a theory. From this standpoint Duhem went on to criticise the inductive generalisations advocated by Newton and wrote in criticism of inductive methodology. (Cf. Duhem 1962, p.32.)

10.3. VIEWS OF SCIENTISTS

10.3.1. Max Planck (1858-1947). He envisaged different levels of reality. (a) The world of sense-perception; the world as man

1. Views such as this were challenged even in the 19th century and it must not be thought that Mach and Pearson represent a consensus view flowing in the wake of the Newtonian breakdown of essentialism. Men like Meyerson and Boltzmann, for example, opposed such views, maintaining that the object of science was to discover the actual structure of the physical world - atoms if substantiated experimentally were to be considered part of physical reality.

perceives it and from which he draws his scientific statements about nature. This is where physical laws are found. (b) A world of reality behind (a) which is independent of man – though he can gain some insight to it indirectly through his senses and by symbols. But this real world is independent and can never be directly apprehended. (c) The world of science, of physics. This is a deliberate creation of the human mind and as such continually changes as science progresses.[2] The real world, as opposed to the perceived and physical worlds, has a greater depth and richness.

> "Modern physics impresses us with the truth that there are realities existing apart from our sense-perceptions, and that there are problems and conflicts where these realities are of greater value for us than the richest treasures of the world of experience." (Planck 1931, p.107.)

<u>10.3.2. P. W. Bridgman (1882–1961) and Operationalism.</u> Bridgman claimed to make explicit the methodology of Mach, Poincaré, Duhem and Einstein . <u>Mach</u> endeavoured to eliminate concepts pertaining to which no operation could assign a value; <u>Poincaré</u> claimed that a concept was only useful if we could know how to measure its values; <u>Duhem</u> indicated that the first stage of any scientific inquiry was to select primary qualities which could be measured, and in addition extended this operational requirement to theories, maintaining that only the empirically significant was of value when its conclusion made assertions about concepts that could be measured; while <u>Einstein</u> in his discussion of simultaneity revealed how, prior to his work, this was assumed to be an objective property of two or more events, whereas he concluded that it was predicated correctly only of a relationship involving two or more events <u>and</u> an observer. This last point, with its insistence on the observational side, deeply impressed Bridgman. One important conclusion that he drew was that the concept of 'absolute simultaneity' had no empirical significance and suggested that unless all concepts were linked to measuring procedures then they should be excluded from physics. This took the nature of a general principle. (Bridgman 1936, p.10.) Einstein had, in fact, denied that absolute simultaneity was a legitimate concept in physics on the ground that no experimental operation could establish it.

2. Popper's construction (1973/a; 1975.) of three worlds is: (a) the world of physics, or rocks and trees and fields of forces; (b) the psychological world of feelings and fears and hopes; and (c) the world of the products of the mind.

Bridgman erected an operational theory of demarcation and meaning. Science was demarcated by the description of its operations. It followed that science did not describe natural objects or physical reality, but only the concepts and procedures of physics which fell within the operational examination of the physicist. But problems arose. For example, velocity is defined as the limit of the ratio ds/dt and acceleration as d/dt(ds/dt). These cannot actually be measured in any way because as limits they are abstract mathematical concepts. Nevertheless Bridgman held firmly to his operational theory of meaning so that the meaning of a concept is nothing more than the operations performed to assign value to it.

> "....the concept of length is....fixed when the operations by which length is measured are fixed: that is, the concept of length involves as much as and nothing more than the set of operations by which length is determined." (Bridgman 1927, p.5.)

The origin of these views lies, as he records, in the shock of realisation that accompanied the awareness of the Newtonian breakdown. This led to his outlook of pure empiricism. But it was an empiricism lacking finality or certainty. "An explanation is not an absolute sort of thing, but what is satisfactory for one man will not be for another." (ibid p.38.)

So far this constituted a negative attack on the current realist views and he had more to say in a positive way concerning the problems surrounding the philosophy of science. He took the simplest of concepts - length. In the past this had been regarded as a real, physical characteristic of real individual objects; it could be seen, measured and so on. But for Bridgman there was no real individual object and therefore length must possess another meaning. It became synonymous with a set of operations. So he showed that astronomical, naive and microscopic length are quite different concepts.

> "What is the possible meaning of the statement that the diameter of an electron is 10^{-13} cm? Again, the only answer is found by examining the operations by which the number 10^{-13} was obtained. This number came by solving certain equations derived from the field equations of electrodynamics, into which certain numerical data obtained by experience had been substituted. The concept of length has therefore now been so modified as to include that theory of electricity embodied in the field equations, and, most important, assumes the correctness of extending these equations from the dimensions in which they may be verified experimentally into a region in which their correctness is one of the most important and problematical of present-day questions in physics

....As a matter of fact, the concept of length disappears as an independent thing and fuses in a complicated way with other concepts, all of which are themselves altered thereby." (ibid pp.21-22.)

So the scientist describes operations, not natural objects. Indeed the most certain truth of physics becomes that physics is not true - neither as an account of what nature is, or how it works.

Bridgman revised his early views but maintained the theory of the operational demarcation. He rethought the question of meaning, insisting that some of the concepts of a theory must be linked to measuring operations. He himself noted the limitations of his views - that it was impossible to specify all the conditions when any given operation was carried out; and that to function, science needed to assume unanalysed operations. In effect the final justification for the view was that it worked!

Operationalism is a thesis of demarcation derived in part from Newton's assertion (via misinterpretation?) that experimental science deals only with properties whose values can be measured. But while science is undoubtedly grounded in experience it would be wrong to conclude that it is concerned solely with experiences. This is the reductive philosophy at the root of operationalism and instrumentalism. The former holds that theoretical concepts are to be defined in terms of measuring operations, and if this is impossible eliminated from the scientific vocabulary; while the latter holds that theories are no more than instruments for getting our experiences into order. In operationalism only propositions about observed phenomena have the status of genuine knowledge; and phenomena are essentially viewed as the behavioural relationships of ordinary things, such that laws and theories are nothing but the records of past experiences which can be used to anticipate further experiences.

This has problems in the philosophy of mathematics (no observation) and the philosophy of perception. A further problem derives from micro-systems which are not open to ordinary forms of perception, as Bridgman himself noted. Here any operational definition of a micro-quantity has to be given in terms of a theory about the micro-system, together with various ordinary-scaled experimental procedures by which testing can be made. But knowing the meaning of the theory concerned presupposes knowing what is meant by the micro-quantities in question, and therefore, strictly speaking, no operational definition is adequate. It is even more difficult to see how this would apply in the social and biological sciences. Further, operationalism precludes any new statements or claims and hence tends to block any creative intuitions.

Perhaps it it not surprising that this view has been attacked by many scientists. For those who follow it, the path leads to an increasing scepticism concerning the nature of science and its theories. Thus Bergmann complains of the confusion and inconsistency in the use of the word 'operation'. However it must be remembered that no system is free from all confusion and inconsistency. (Cf Bergmann 1957, p.58.) Confusions can be clarified and inconsistencies ironed out. In fact Bridgman asserts a general epistemological relativism while inclining to pragmatism and logical positivism; but this could be avoided by joining the operational aspects (in a clarified sense) to some other epistemological framework which avoided the extreme nominalism of his position.[3]

<u>10.3.3. Sir Arthur S. Eddington (1882-1944) and Idealism.</u> Eddington finds himself placed in several categories - conventionalist, phenomenalist, but primarily as an idealist where he is viewed with men such as Jeans, Milne and Margeneau. Today few support the position of idealism, but nevertheless it still contains relevant insights. Eddington tried to derive fundamental laws of physics and constants of nature from <u>a priori</u> considerations. In his view the ultimate facts are sequences of numbers derived from simple observations and the reading of pointer-measurements on a scale. From this the observer derives a mental picture of the world. The theory is based on an analogy between nerve impulses and the transformation of these into perceptions by the brain; and the changing of pointer-measurements into data by scientists. A problem surrounding this analogy is that the brain does not make inferences concerning the world from the nerve impulses, nor do we infer a world from sensations alone.

Eddington, in fact, makes implicit use of experimental findings, though he regards physical science as a world of symbolism far removed from sensory experience. The scientist begins by abstracting from

3. G.H.Clark maintains (1964) that this philosophy of science is the best possible in a Christian perspective. While he presents cogent reasons for this I will take issue with him in Part IV.

reality these aspects which he can measure and ignores the rest. The work of the scientist is to correlate 'pointer-readings', revealing a tie with the previous viewpoint. There are many symbols - such as electrons and quanta - for which there are no analogues in the world of ordinary sensation and hence he comes to the conclusion that the world of the scientist is a world of 'shadows'. The ultimate reality is spiritual. (Cf. Eddington 1930, pp.332,338.)

The essence of the scientific abstraction is that it is limited in its approach to reality which possesses a wholeness foreign to scientific endeavour. This led him to emphasise the opposite side of the coin from the positivism of Mach , or the traditional realism, by pointing to the subjectiveness of scientific formulations and the crucial forming role of the mind. (Cf. 9.3.2.2. and footnote) Thus:

> "The subjective laws are a consequence of the conceptual frame of thought into which our observational knowledge is forced by our method of formulating it." (1949, p.105.)

Again Eddington writes:

> "We have found a strange foot-print on the shores of the unknown. We have devised profound theories, one after another, to account for its origin. At last, we have succeeded in reconstructing the creature that made the foot-print. And lo! it is our own." (1959, p.200. cf. p.197f)

Within this idealism the 'fact' that $2x + 2x = 4x$ does not lead to the conclusion that $2 + 2 = 4$, for the prior statement is true only of the empirical world while the latter is true of the mathematical world - that is of any world. In idealism theories go beyond the ordering of data - they create 'facts'. The theory of the mind dictates the ontological commitment; it determines the meaning found, and the significance given, in any observation.

The general problem of this view is that it neglects the experimental side of science. However, mere mental economy of thought and simplicity, and a loss of the objective external world cannot be attributed indiscriminately to Eddington. Two more quotations from his 'Space Time and Gravitation' indicate that glib categorisation is unhelpful and that though several philosophical viewpoints nay be adhered to, scientists in their work assume some realism.

> "I am not satisifed with the view so often expressed that the sole aim of scientific theory is 'economy of thought'. I cannot reject the hope that theory is by slow stages leading us nearer to the truth of things." (1959, p.29.)

And finally:

> "The physicist, so long as he thinks as a physicist, has a definite belief in a real world outside him. For instance, he believes that atoms and molecules really exist; they are not mere inventions." (ibid p.180 ; cf. footnote p.175 my thesis)

<u>10.3.4. Werner Heisenberg (1901-)</u>. Perhaps his basic contribution to science and philosophy has been the problems associated with the Principle of Indeterminancy; and the issues which surround it are of the essence of his general views. Heisenberg claims that physics rests on speculation not on 'facts' alone. So in the introduction to his 'Physics and Philosophy' we find F.S.C. Northrop writing:

> ".....the theory of physics is neither a mere description of experimental facts nor something deducible from such a description; instead, as Einstein has emphasized, the physical scientist only arrives at his theory by speculative means.....any theory of physics makes more physical and philosophical assumptions than the facts alone give or imply ....These assumptions..may be ontological..may be epistemological." (Northrop 1971, p.13.)

Heisenberg points out the great change that has occurred over the fundamental concepts of reality due to relativity and quantum theory. He emphasises in detail this break from the past as something radical, and of the nature of a world-view (cf. Heisenberg 1971, p.45.; cf. my 10.4.2.). In facing the difficulties arising from the new world of physics, Heisenberg espouses the Copenhagen interpretation which firmly adheres to the classical language of physics, while holding to quantum perspectives. (cf. ibid p.46.)

Examining any experiment we must be aware of the errors stemming from the experiment itself, and from our observations of it. It is impossible to describe what really happens; "we cannot describe what 'happens' between this observation and the next." (ibid p.51.) Compounding this is the feature that reality itself is changed qua reality by our observation of it. So reality varies, depending on whether we observe it or not (cf. ibid p.52.). Heisenberg argues that we are forced to fall back into the field of probability, and so he reinstates the ancient Aristotelian idea of <u>potentia</u> - the concept that we strike at something which lies between the idea and the actuality of an event, between idealism and realism. Indeed he claims that the theories of Aristotle give a closer representation of modern theories than do the concepts of classical physics. Matter is itself potentia. In practice however there is a feeling of reality:

> "Every scientist who does research work feels that he is looking for something that is objectively true. His statements are not meant to depend upon the conditions under which they can be verified. Especially in physics the fact that we can explain nature by simple mathematical laws tells us that here we have met some genuine feature of reality, not something that we have - in any meaning of the word - invented ourselves." (ibid p.76.)

Having said this he proceeds to reduce facts to experimental results (cf. ibid p.160.). This seems a strangely ambiguous position, for what then is the reality that he is talking about? Is there an external reality that transcends the laboratory; or is reality reduced to this; or is he misusing the words 'reality' and 'truth' ?

He goes on to suggest four systems of scientific theory that have attained independent, final form - the Newtonian system; the 19th century theory of heat; the theory of electricity and magnetism; and the quantum theory. These relate, for example, in that the first is contained in the third when the speed of light tends to infinity; and the first in the fourth when Planck's constant tends to zero. But this does not make the systems compatible as such. Newton is not replaced by Einstein; at least in terms of an improvement.

> "Newtonian mechanics cannot be improved; it can only be replaced by something essentially different. Wherever...the concepts of Newtonian mechanics can be used to describe events in nature, the laws formulated by Newton are strictly correct and cannot be improved. But the electromagnetic phenomena cannot adequately be described by the concepts of Newtonian mechanics." (ibid p.88.)

But this claim that it is 'right' or 'true' where applicable is a devaluation of the concept of truth and reality and reveals a basic commitment to instrumentalism. But two contradictory theories can not both be true to what is. He goes on to reject the postulation that science assumes a world which it has not made and which would be present, essentially unchanged, even if the scientist was not there. This coupled with his rejection of idealism forces him to an instrumentalist view. Nevertheless he concludes 'Physics and Philosophy' with what amounts to a liturgy of unification as the aim, desire and accomplishment of science. He talks of moving 'toward', a 'process of', and a 'final state of' unification as a human enterprise in which physics plays but a small part. (ibid p.176.)

10.3.5. Albert Einstein (1879-1955). Unlike Kuhn (cf. 10.4.2.) he rejected the concept of revolutions in science and pointed to the continuous line, traceable through centuries, with reference to his own theory of relativity. There is no radical or sudden 'conversion'. Turning to the debate between realism and instrumentalism an interesting picture arises. Einstein conceded that theory decided what we observe, but nevertheless saw the phenomena as confining this process uniquely.(Cf. Einstein 1973, p.226.) Thus, while axioms are free creations of the human mind, with scope for the illogical intuition and the occa s ional suspension of logic, he clung ultimately to the objective reality of an external independent world.

While in his early days he drew upon Machian positivism and inclined to instrumentalism in his interpretation of relativity, providing a sort of operational analysis of simultaneity, he later rejected this heuristic stance. Though, despite this rejection, these early views have done much to further the widespread acceptance of the instrumental position. But he exhibited in his thought a realism that sought to find true truths of the universe while accepting the limitations of the human mind.

His scientific procedure was deductive thought at its best. Time and again he derived theory from a thought experiment. He consistently pointed, however, to an objective reality that could be known, and that science strived beyond the construction of a kit of tools. Following are quotations which stand in marked contrast to the views of men like Mach, Pearson, Bridgman, Heisenberg, Toulmin and Kuhn.[4]

> "The belief in an external world independent of the perceiving subject is the basis of all natural science. Since, however, sense perception only gives information of this external world or of 'physical reality' indirectly, we can only grasp the latter by speculative means. It follows from this that our notions of physical reality can never be final." (ibid p.266.)

Speaking at Oxford in 1933 he remarked:

> "If you want to find out anything from the theoretical physicists about the methods they use, I advise you to stick closely to one principle; don't listen to their words, fix your attention on their deeds." (ibid p.270.)

Then, having given this warning, he went on:

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4. Like Planck, Einstein proposed a threefold structure of the world - the real and the perceived worlds, and the ideas of men which lie somewhere in between.

> "I still believe in the possibility of a model of reality — that is to say, of a theory which represents things themselves and not merely the probability of their occurrence." (ibid p.276.)

Similarly in an article written in 1940 he says:

> "Some physicists, among them myself, cannot believe that we must abandon, actually and forever, the idea of direct representation of physical reality in space and time; or that we must accept the view that events in nature are analogous to a game of chance." (ibid p.334.)

10.4. VIEW OF PHILOSOPHERS

10.4.1. Stephen Toulmin and Instrumentalism. Toulmin embodies a clear statement of the instrumental position. Concepts do notnecessarily equate with observable or real entities. "Laws of nature resemble other kinds of laws, rules and regulations. These are not themselves true or false, though statements about their range of application can be." (Toulmin 1967, p.71.) He further suggests differing classifications of laws: as phenomenalogical (i.e. containing no theoretical terms, such as Boyle's Law); and abstract laws (i.e. providing a framework within which to work, such as Newton's Laws of Motion which are useful but not true). Between these extremes are intermediate laws which have theoretical and phenomenalogical components , such as Snell's Law. None of these laws, claims Toulmin, "tell us anything about phenomena, if taken by themselves." (ibid p.77.)

Thus he contends that: "Laws of nature.....to them the words 'true', 'probable' and the like seem to have no application." (ibid p.70.) The essence of this position then is not 'Is it true?', but 'When does it hold?' In a sense this realisation of the non-autonomy of a scientific law is a valuable insight, but it is confused with a particular epistemology and ontology rooted in a humanistic philosophy that makes a sharp distinction between science and beyond-science, between the nature-ideal and the personality-ideal.

Before any science takes place there is a pre-scientific stage, and before experiment takes place a formulation of theory. He writes:

> "No competent scientist does pointless or unplanned experiments.....Before the scientist enters his laboratory at all, he must therefore have guidance about the kind of state of affairs <u>worth investigating</u>, the type of apparatus <u>worth assembling</u>, and the sort of measurements <u>worth making</u>....

....until your theoretical problem has been carefully thought out, experiments will be premature." (ibid pp.59-60.)

<u>10.4.2. Thomas S.Kuhn.</u>[5] Kuhn makes several valuable points in his important essay on 'The Structure of Scientific Revolutions' (1973) where he emphasises the subjective side of scientific activity and the role of faith in the choice of a paradigm. At the outset he states his rejection of the idea of science as a progressive accumulation of knowledge, advance by accretion (cf. ibid p.3.) But while accepting in part his idea, that in any scientific 'revolution' there is a rejection of older views as well as the addition of new factors, I feel he does not give justice to the vital element of continuity that exists from one period to another and from one paradigm to another. He does however acknowledge the cumulative nature of 'normal science'.

In his thesis Kuhn divides science into two realms - that which produces new theories, which creates or chooses a new set of paradigms; the process of normal, routine science. Normal science assumes that the scientific community knows what the world is like and is therefore engaged in 'mopping up operations' within that assumed paradigm. Within this context, normal science seeks for predetermined results that will mean an attitude of rejection to any results outwith the predicted range - a research failure. This means the suppression of novelties and a retardation of the creating potential for new paradigms. A serious criticism at this point is that this division into normal and revolutionary science seems artificial and in practice a new paradigm can arise out of the processes of normal science. (Cf. Toulmin 1976, pp.40f.)

Kuhn notes the implicit role of belief as a necessary prerequisite before the scientist can even begin to collect 'facts'. Collection can only be by selection, and belief will govern this selection and also exercise control over theory articulation. <u>Both theory and experiment are therefore seen as highly directed belief activities</u> (cf. Kuhn 1973, pp.17,18.) He suggests that there are three basic

5. Kuhn acknowledges a debt to Popper (1976, pp.1ff.), noting that both of them are agreed in rejecting growth by accretion; both emphasise an 'inevitable entanglement of scientific theory with scientific observation'; both are sceptical with respect to some neutral observation language; both aim to 'invent theories that <u>explain</u> observed phenomena and that do so in terms of <u>real</u> objects'; both appeal to tradition; neither is an inductivist. The basic difference is that Kuhn divides science into the two realms; Popper does not.

problems which face the scientist - that of determining the significant facts; of matching these with a theory; and in articulation of a theory - and in all these aspects faith will play a decisive role. The scientist will see what he wants to see. Thus he cites the famous card experiment where subjects were exposed to, say, a black five of hearts and consistently saw it as either a five of spades or a five of hearts (cf. ibid pp.50,59,63.)

In the change from one scientific period to another - such as Newton to Einstein, or phlogiston to oxygen - not only are new quantities involved, but a new qualitative way of perceiving reality is entered into (cf. ibid p.7.) A shift of paradigm takes place, a conversion (ibid pp.140,150.), a gestalt switch. Unfortunately it is not precisely clear what is meant by 'paradigm' (Mastermann 1976, p.61f. lists twenty-one senses of its usage) and the word assumes throughout the original thesis several distinct meanings which Kuhn acknowledges in a 1969 postscript (ibid pp.174-210.) Essential to its meaning is the idea of a model or pattern which the paradigm provides, with data and theory being fitted into this preconceived pattern. (Cf. Ibid p.25.) Again he gives the analogy of a paradigm as a map for reading the territory we are in and also as functioning as directions for constructing the map in the first instance! (Cf. ibid p.104.)

There are at least two distinct areas in which a paradigm acts.[6] It functions as a constellation of beliefs, values, techniques; and it also functions as "one sort of element in that constellation." (ibid p. 175.) Thus a paradigm is crucial in the beginning of research and in the detailed continuation of that research; it provides an overall disciplinary matrix which determines the symbolic generalisations that can be made, as well as determining the erection of 'exemplars' (concrete problem-solutions which form a teaching basis). (Cf. ibid p.182.) Kuhn makes the telling point that no one in the first instance learns science from experience, but because a teacher, a textbook, or some accepted authority pronounced that this was the way things were. (Cf. ibid p.80.) Indeed when experiments are recoursed to, in order to back up authoritative pronouncement, they can fail, but that is of little importance. In my own scientific training I have vivid memories of experiments proving the oppositie of what they should!

6. Masterman (1976, p.61f.) lists three: a metaphysical paradigm, a weltanschauung prior to theory; a sociological paradigm, a set of scientific habits; and an artifact paradigm, less than a theory.

Paradigms, then, are standard accepted examples which guide research because they define the legitimate questions to be asked, the techniques to be employed, and the solutions which will be admissible. In the selection of a paradigm the factors concerned are not scientific, though the choice will not rest ultimately with a single individual but with the scientific community. Before this paradigmatic stage there is a pre-paradigmatic stage in which various ideas compete for acceptance without any one gaining ascendancy. (Cf. ibid. p.61.) But once a paradigm becomes accepted it is coercive over nature - nature is forced to fit. (Cf. ibid p.135.)

Within this setting he regards laws as tools - a paradigm shift involves 'retooling' (ibid pp.46,76.). Yet against this he avoids the claim of Heisenberg concerning Einstein and Newton by unequivocably stating that Newton was wrong; that only one of them could be right. He thus argues cogently for the rejection of Newton as a 'right' but limiting case of Einstein. So he presents no simple instrumentalism, nor a simple subjectivism, for he talks analogously of science seeking to solve a 'jig-saw puzzle' for which there is obviously only one objective solution. (Cf. Eddington 1930, p.352.) Science seeks not just to manipulate the world, but to understand it - thus assuming some reality that can be unfolded. (Cf. Kuhn 1973, p.36.) Thus he contends that a paradigm is not only to be compared with other paradigms to see which is the best suited from predictive purposes, but they are to be compared and measured against nature. (Cf. ibid p.77.) The scientist is to seek to solve the problem of nature (cf. ibid p.168.) yet only a few paragraphs later he tells us that he does not think that science ever gets closer to the truth (cf. ibid pp.170,171.) Thus despite his talk of problem-solving, truth appears to be an illusive something outwith the domain of science. This is consistent with his attack on Popper where he contends that, though falsification appears analogous to his concept of the 'anomalous event' which leads to paradigm shift, it is not the same and in fact falsification cannot exist. (Cf. ibid p.146f.) [7]

Reality seems lost and pragmatism the final justification. He writes that "notion of a match between the ontology of a theory and its 'real' counterpart in nature now seems to me illusive in principle."

7. Lakatos (1976/b, p.93) points out that Popper sees scientific change as rational, the logic of discovery; while Kuhn sees it as something mystical, a conversion.

(Ibid p.206.) Indeed he argues that facts and theories are not themselves distinct categories. (Cf. ibid p.66.) Hence, despite his remarkably valuable contribution to the study of scientific models, his relativistic concept of truth emerges to mar the whole. He becomes entailed in directionless shifts, for reality is purposeless. Nevertheless, if as he points out, paradigms are moulded not by the world -- then what does? What can be learned about the genesis of paradigms? It seems to me that it is all too easy to move from this final position of Kuhn to scientific scepticism. There is a knife-edge here between scepticism and knowledge, but a position of general scepticism seems to sit uncomfortably on the history of scientific activity, and in the scope of a Christian Theism.

10.4.3. Sir Karl R. Popper. Popper is a crucial figure both for his own formulation, and for his devastating destruction of the positivist position. His basic work 'The Logic of Scientific Discovery' (1972/b) preceded A.J.Ayer's 'Language Truth and Logic' by two years! Popper argues that: "The scientist aims at true descriptions of the world, or of some of its aspects, and at a true explanation of observable facts," but that he "can never know for certain whether his findings are true, although he may sometimes establish with reasonable certainty that a theory is false." (1972/a, p.114.) Scientific laws are therefore tentative inventions and not true discoveries for:

> "One cannot escape the fact that the standards and criteria of testing in any community of inquiry reflect cultural presuppositions. Methodological assumptions are themselves subject to historical variation." (1972/a, p.192.)

Popper thus strongly refutes the anti-metaphysical bias of the positivists, pointing out that metaphysical aspects have played an important role in the history of the development of scientific theories, and in trying to rid science of them altogether the positivists have finished up getting rid of science itself. (Cf. 1972/b, pp.19,36,38.) Thus he is led to develop his theory of demarcation of science from non-science. This is not to be confused, as the positivists do, with a demarcation between meaning and non-sense, but merely between the spheres of natural science and other theoretical disciplines such as ethics or aesthetics. (Cf. 1972/b, p.51.) In seeking this demarcation Popper is still trying to establish a corpus of science free from metaphysical factors. He accuses the positivists of opening the door to an invasion of metaphysics into the scientific realm.

(Cf. 1972/b, p.37.) Having realised the failure of positivism, Popper, and others such as Nagel and Hempel, still assumes two distinct levels in science. That is, a fixed observational-data free from any theoretical interpretation and forming an unproblematical lower level of unchanging objective data, describable in pure observation language (cf.15.3.3.2.); and another higher level of theoretical constructs seen as the products of man's creative imagination.

Popper formulates his falsification principle in this setting. [8] Now falsification has never been taken historically as a definite means of theory rejection. Newton's theory predicted a motion of the moon only half of that observed, and for sixty years this anomaly stood, far outside the limits of experimental error. But it was not considered to falsify the theory. More recently the advance of the perihelion of Mercury was regarded as an anomaly for eighty-five years (within Newton's system), until with the development of relativity it was taken as a disproof of Newton. But prior to relativity it had not been regarded as a falsification.

While it is impossible to conclusively verify a theory, Popper argues that it is not so difficult to falsify one. But care is needed here. Many, for example Kuhn, take this principle as the reverse of verification. But Popper clearly delineates his principle as different in character from verification. "My proposal" he writes "is based upon an asymmetry between verifiability and falsifiability; an asymmetry which results from the logical form of universal statements." (1972/b, p.41.) There can be no crucial disproof, just as there can be no final proof, for it is always possible to claim that the experimental results are not reliable. (Cf. ibid p.50.) Thus he denies what is attributed to him.

As part of his critique, Popper (and Kuhn) attacks the concept of an inductive process as the way of scientific method and points instead to a process of deduction within a given framework of presuppositions. But again care is needed, for he is not ruling out induction in terms of the dreams, intuitions, conjectures from whence theories arise.

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8. A good critical discussion of Popper's theory of falsification is found in Lakatos (1976). Here he criticizes Popper for adopting a naive methodological falsification and works towards a sophisticated methodological falsification.

Popper's notion of the truth is therefore something like this: our aim in the pursuit of knowledge is to get closer and closer to the truth, and in any given situation we may claim that we have made an advance, but we can never know if we have reached our goal. "We cannot identify science with truth..." (Popper: In Magee 1973/a, p.78.) Science is capable of making real discoveries and distinguishing between prediction of events of a known and an unknown kind. Instrumentalism cannot make this latter distinction.

Unfortunately I believe that Popper's position has been weakened by his remorseless allegiance to the uniformity of natural causes in a closed system. In an essay on the 'Sources of Knowledge and Ignorance' he validly points out that to have any confident knowledge of ultimate significance there must be a knowledge-source beyond man. He writes that: "No man's authority can establish truth by decree; that we should submit to truth; that truth is above human authority." (1972/a, p.29.) To have ultimate knowledge demands a supra-natural origin for truth. But Popper, as a humanist, is forced to reject this possibility, and he sadly and romantically concludes his essay with these words:

> "What we should do, I suggest, is to give up the idea of ultimate sources of knowledge, and admit that all knowledge is human; that it is mixed with our errors, our prejudices, our dreams, and our hopes; that all we can do is to grope for truth even though it be beyond our reach." (ibid p.30.)

He is forced to abandon the possibility of verification - you can say nothing about a thing, except what it is not. Hence with Popper we find that the concept of the external objective reality becomes dim, forced upon him by his failure to establish an epistemological base big enough to deal with the issues involved. But while his epistemological base is inadequate this does not prevent his contribution being of vital significance to the development of a Christian approach to these problems. There is an inner tension evident here: Popper desires after truth, knowledge, as a God-given creational instinct; but having rejected God he is bound to an all - pervading uncertainty.

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CHAPTER 11

INSTRUMENTALISM : ESSENTIALISM : REALISM

The scientific world has moved gradually from the objectivity of essentialism in the 17th century, through positivism, to more subjective views. No doubt few advocate the extreme idealism of Eddington, but scepticism and instrumentalism are widespread, often abandoning the very concept of truth. Those who strive after reality, such as Popper and Einstein, often fail to establish an epistemological base which accounts for the mystery of their existence. They are therefore left stranded from any hope of certainty. The crux of such scepticism lies in a failure to acknowledge the Creator who made the world and man, and who alone establishes the identity of man. Man, knowing his identity in the image of God and having the revelation of God, can attain to truth that is true even while limited.

The divergence of views surveyed indicates that there is that which lies beyond the structure and understanding of scientific concepts. There is a religious root which determines how a man views his scientific activity. By spotlighting different theories, or spheres of science, support can be mustered for various viewpoints. Realism seems suited to anatomy, while instrumentalism may seem suited to modern physics. It seems to me that theories have a potential of being refuted - and thence discarded (flat earth); or retained because useful (theories of light). On the other hand a theory can be verified provisionally (that light bends), or more conclusively pass into the realm of common-sense 'fact' (the earth is a rough sphere). Between these extremes of verification and refutation, theories remain in a middle-ground of uncertainty. While there can be no absolute verification/refutation there can be reasonable verification/refutation. I now wish to confine the discussion to the basic viewpoints of realism and instrumentalism. Essentialism will be utilised to highlight the other two views.

11.1. TWO EXTREMES : ESSENTIALISM - INSTRUMENTALISM

The following diagram (from Popper 1972/a, p.108.) provides a useful model for understanding the basic positions. Essentialism is represented by the total diagram: distinguishing the universe of essential reality - (i); the universe of observable phenomena - (ii); and the universe of descriptive language or symbolical representation

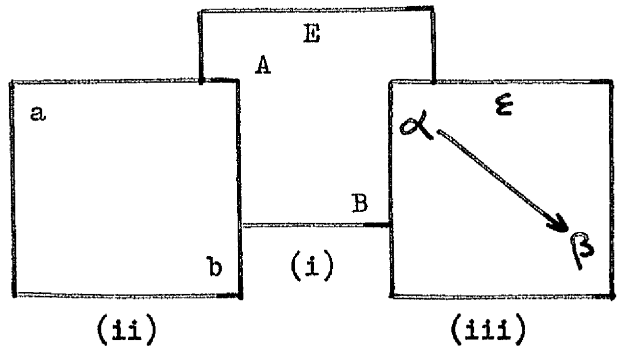

DIAGRAM III : Essentialism-Instrumentalism Model

- (iii). In Diagram III: 'a' and 'b' represent individual phenomena; 'A' and 'B' the reality behind these phenomena, with 'E' being their essential properties; 'α' and 'β' are the descriptions or symbolic representations of the realities, and 'ε' the theory describing 'E'. Thus from 'ε' and 'α', 'β' can be deduced and we can arrive at an explanation of why 'a' causes or leads to 'b'. Instrumentalism on the other hand wants to drop the concept of description and eliminates universe (i) from the diagram. Thus 'a' relates directly with 'α', and 'b' with 'β'; 'ε' refers to nothing, being merely the instrument that allows us to go from 'α' to 'β'.

11.2. THE GALILEAN VIEW OF POPPER (cf. 13.2.1.)

Against instrumentalism Popper puts forward the Galilean view, which, while agreeing that theories are instruments, asserts that they are mainly "descriptions of the world, or of certain aspects of the world." (Popper 1972/a, p.101.) At the heart of this view is the idea that scientists have made conjectures, myths or theories which though in striking contrast to the everyday world of naive experience, are capable of explaining aspects of the world of ordinary experience. Popper, however, does not wish to uphold that part of the Galilean view which aims at, and obtains, some ultimate explanation of the essences. Here the attack of instrumentalism is regarded as valid. Popper sets out the doctrines of the Galilean view as follows:

"(1) The scientist aims at finding a true theory or description of the world (and especially of its regularities or 'laws'), which shall also be an explanation of the observable facts. .....
(2) The scientist can succeed in finally establishing the truth of such theories beyond all reasonable doubt.....
(3) The best, the truly scientific theories, describe the 'essences' or the 'essential natures' of things - the

realities which lie behind the appearances." (ibid pp.103f.)

Both Popper and the instrumentalist reject doctrines (2) and (3), though for different reasons. Popper accepts (1), but the instrumentalist does not. Popper wishes to ammend (2) to a negative form - that theories can be beyond reasonable doubt refuted. I would wish to retain doctrines (1) and (2) as formulated.

11.3. ESSENTIALISM

This was historically dominant up until the last century, although the publication of Osiander's Preface to Copernicus' 'De Revolutionibus' indicates that there were those prepared to advocate theories on the grounds of instrumental usefulness. (Cf.2.2.3.3.) But it was not until recently that instrumentalism came to the fore (and many of the leading physicists accepted it - with the notable exceptions of Einstein and Schrodinger).

In essentialism theories are envisaged as representations of the real world of essences. Against positivism it asserts that the real is not solely the observable; against instrumentalism it asserts that valid concepts are true as well as useful; while against idealism it asserts that concepts represent structures of events that exist in the real world. Essentialism, as opposed to realism, aims at a total and ultimate explanation of the essence of things; "that is to say, an explanation which (essentially, or by its very nature) cannot be further explained, and which is in no need of any further explanation." (ibid p.105.) Here is a stress on the objective relationship found in nature: it is the character of classical physics that it describe without reference to the selfhood. The keynote is absolute objectivity. Science is an adventure of discovery and exploration as well as of investigation and construction of theories. Atoms and trees are both ultimately real, though they behave differently.

In criticising this position, it is obvious today that science does not, or at least has not yet, attained to anything of final general significance. Today most scientists recognise that the requisite of achieving an essentialist explanation is impossible for there is neither pure appearance nor pure observation. New theories arise and cause a reinterpretation of the old appearances and thus change the very character of what is perceived. Nevertheless I would contend that a theory is still a theory whether of low or high generality, and it seems to me that we can hold to the accomplishment of reasonable final significance in theories of low generality (cf. 15. 4.3.) Essentialism tends to block the formulation of new or better theories by assuming that it has reached finality. If the essence is found there can be no scope for fundamental theory revision.

11.4. INSTRUMENTALISM

Historically, though finding advocates in men like Osiander and Berkley, this follows on from operationalism. In contrast to more positivistic views, instrumentalism does not require that theoretical concepts correspond to observables; while in comparison to realism it makes no instances of real entities within these concepts. Instrumentalism considers that a theory is - not some summary description, nor a generalised statement of the relations between observed data - merely a rule for analysing and symbolically representing gross experiences. Thus it provides an instrument or technique for inferring observation statements from other observation statements (cf. diagram III).

Thus, while models may be provided, they in no way correspond to reality for they are simply convenient shorthand for getting experiences into order. Theories are useful tools; laws are maxims or directions to enable us to find our way about the scientific world. Theories as maxims or principles of procedure provide us with calculating devices with which to make accurate predictions; organising guides for controlling and directing research work; and practical tools for achieving control over a given field. Laws or theories bear no correspondence with reality (truth/falsity) for they are not discoveries with respect to essential reality. (Cf. Toulmin 1967, pp.121ff.) Rather they are inventions of the theoretician, patterns which he uses to order his experience. So the kinetic theory applied to gases allows us to go from P1.V1 to P2.V2 without actually asserting anything in fact about the world.

This has meant that any confidence in science as a clue to the mystery of reality has to some extent disappeared. The scientist has become merely a technical expert over an increasingly abstracted and specialised realm in which any relationship with reality in its composite meaning becomes virtually impossible. He is content to manipulate his mathematical abstractions, striving for greater unity and elegance, but forgetful of ultimate meaning and significance.

Science in this view is pragmatic. The motto is: 'Don't ask for its meaning - ask for its use.' This is strongly defensible for contradictory theories are held in many fields, and their use determined by the situation. Whether one or the other, or neither, is true is deemed irrelevant by the instrumentalist. But the realist will always try to resolve a clash of theories.

It does not follow that because a theory is instrumental that it is reduced to the status of a fiction. Indeed such a charge would be denied by an instrumentalist in that the concept of a fiction implies that a theory can be true - and for him questions of truth are irrelevant. However, theories can be assessed for superiority in terms of usefulness, much as one tool can be superior to another without any question of veracity.

This standpoint, then, allows more room for the observer than the essentialist position in terms of the imaginative creation of theories; and I find myself in substantial agreement with its positive attack on essentialism. The emphasis on the knower who records and organises selected data, who abstracts, idealises, constructs and invents, is to be welcomed as a positive contribution to the understanding of the role of scientific theories vis a vis reality. But I also contend that in what they negate several weaknesses become apparent.

11.4.1. Reductionistic. The instrumentalist viewpoint is highly reductionistic. Its rules lead nowhere in terms of explanation or real understanding of the world - indeed such a desire is excluded by its philosophical parameters. The idea of theories as merely some form of convenient shorthand is also misleading as theories display characteristics that go beyond this. What about theories where ideal concepts are employed and which are therefore not directly correlatible with experience; that have no pragmatic usefulness?

11.4.2. No Verisimilitude. (Cf.15.3.5.) Reductionism carries over into the abandoning of questions of truth/falsity. This ignores that body of theories which move into the world of common-sense acceptance, as well as the point that the development of any satisfactory new theory entails the integration of new data into the body of scientific knowledge.

11.4.3. Usefulness: Meaning. The criteria of usefulness is a reductionistic assessment of theory superiority. Copernicus' theory was ultimately better than Ptolemy's, not on the basis of greater usefulness alone, but on a better descriptive, explanatory and comprehensive power. It made more sense; it was basically closer to the truth - though not itself 'true'. Thus while instrumentalism can offer no objection to the existence of two contradictory theories if both are equally useful, this does not in effect equate with scientific practice. For although both will be utilised in the case of no new theory being available, or synthesis possible, the point remains that as long as this is the case scientists search for a theory which will resolve the contradiction.

Meaning cannot be reduced to use, which if not stated is implicit in this approach because 'use' refers to different situations which means that any essential meaning changes with the situation. Meaning and use do not exhaust each other because sometimes when we use concepts we have to specify the sense in which we are using them - and this implies a meaning prior to use; or we may know how to use a concept 'correctly', but yet not know its meaning. We can know how to apply the concept of entropy within thermodynamics but fail miserably to understand the implications and meanings of this concept in its overall physical and philosophical significance.

<u>11.4.4. Testability.</u> Scientific research, much of which is in practice aimed at finding evidence for or against a theory, undercuts the instrumental view. This undertaking would be pointless if a theory was not a genuine statement about reality, but simply a procedural policy. Even more serious than this is the preclusion of its adherents from admitting the 'physical reality' or existence of any 'scientific objects postulated by a theory' - though as to what physical reality actually is will be a debated point. (Cf. Toulmin 1967, p.121.)

The idea of testing assumes that there is something which can be affirmed or denied. It is therefore difficult to see just how in practice the instrumentalist can neglect falsification and stress application alone. Popper writes:

> "Instrumentalism can be formulated as the thesis that scientific theories - the theories of the so-called 'pure' sciences - are nothing but computation rules (or inference rules); of the same character, fundamentally, as the computation rules of the so-called 'applied' sciences..... Now my reply to instrumentalism consists in showing that there are profound differences between 'pure' theories and technological computation rules, and that instrumentalism can give a perfect description of these rules but is quite unable

to account for the difference between them and the theories. Thus instrumentalism collapses." (Popper 1972/a, p.111.)

The logical relationship between theories and rules of computation is not symmetrical. Indeed the manner in which the latter are tried out is quite different from the way in which the former are tested. The one is tried out, the other tested! The instrumental position cannot account for real tests which strive to prove or disprove, and subsequently cannot account for the phenomena of scientific progress. Thus "by neglecting falsification, and stressing application, instrumentalism proves to be as obscurantist a philosophy as essentialism." (ibid p.113.)

11.5. REALISM [1]

This holds that there is a reality external to man which he can approach in his scientific theories. It is the offspring of essentialism and basically an attenuated form of that position in the light of the development of science. In a sense there is often little practical difference between the realist and the instrumentalist in the laboratory. (Cf. Theobald 1969, p.123.) Historically the word 'realism' has carried several connotations, but it can be taken to stand for that view which posits a knowledge of a real world which exists quite independently of our cognition of it. Therefore it is opposed to idealism which suggests that the world is in some way dependent on mind; and opposed to instrumentalism in suggesting that our scientific theories are in the arena of truth and not simply pragmatic tools. For realism, despite the fact that our descriptions of the world are stamped by our minds, being is prior to knowing. This does not mean to say that the realist maintains that all hypothetical entities exist - some are real, some false, and often those accepted as false may be utilised for practical purposes.

The realist view can be set out as consisting of the following principles. (a) There are theoretical terms which can be utilised to make reference to hypothetical entities. (b) Some of these hypothetical entities are possible existing entities, that is, real things with qualities and operations in the real world. (c) Some candidates for existence are open to demonstration and are accepted as

1. Realism has been viewed in several ways: naive realism tends to essentialism; critical or sophisticated realism is popular today, but still remains caught in a closed universe; I prefer transcendental realism. (Cf. Bhaskar 1975.)

real. This does not necessitate all theories being regarded as pertaining to the real, but it does mean that this is the aim of all scientific inquiry. That which is accepted as instrumentally useful will be abandoned when a theory of comparable elegance offers closer understanding to reality. For some realists, intelligibility rather than observability becomes the stamp of the real. It is the very power to order that shows the correspondence of a theory with the real world.

It is in this context, and in opposition to essentialism and instrumentalism, that Popper offers a third way - of conjectures, truth, and reality.

> "This 'third view' is not very startling or even surprising, I think. It preserves the Galilean doctrine that the scientist aims at a true description of the world, or of some of its aspects, and at a true explanation of observable facts; and it combines this doctrine with the non-Galilean view that though this remains the aim of the scientist, he can never know for certain whether his findings are true, although he may sometimes establish with reasonable certainty that a theory is false." (Popper 1972/a, p.114.)

I believe Popper has gone too far here and that we can entertain a reasonable certainty that a theory is true - such as that the earth is a rough sphere. The aim, then, of science is not to describe only the so-called primary qualities (geometrical shape etc.) as the essentialist once did, but to view all qualities as equally part of constituent reality.

There are problems facing this position, especially if it falls into an uncritical approach which assumes some ultimacy in general scientific theories, which grants them autonomous existence. A critical transcendental realism is needed which allows room for the revelation of God, for the creativity of the mind, and yet also realises that there exists patterns of events that are not mental. There is also a need to provide a broad base for the concept of what is real. An atom is 'real' at a certain scientific level, but bears little correspondence to everyday life. A table is 'real' for most people as something they work at, eat off, etc., but this will have little significance for the reality that the atomic physicist pursues, while the joiner will view it from yet another perspective. (Cf Eddington 1930, pp.xviff.) I would draw attention to the concept of modality (cf. glossary) and note the interlacement and coherence of reality. In the final analysis things and events are to be analysed and understood in their meaning, not their realness.

11.6. AN EPISTEMOLOGICAL NOTE

It seems clear that with increasing specialisation, and deeper and deeper abstractions, the essence of reality is being lost. As man has driven ever closer to the fundamental structure of reality, he has been forced to give up the cherished hope of by himself understanding the world in which he lives; "whatever fundamental units the world is put together from, they are more delicate, more fugitive, more startling than we catch in the butterfly net of our senses." (Bronwoski 1973, p.30.)

Scientific objectivity as total disinterestedness is impossible. As Northrop recognises: "physics is neither epistemologically nor ontologically neutral." (1971, p.30.) Heisenberg argues that, stemming from the Greek dualism of mind-matter (or form-matter), there entered into Western thought a dichotomy that was never reconciled. (1971, p.73.) Flowing from this, God was separated both from the 'I' and the world in such a way that He appeared in the philosophy of Descartes only as a point of reference to help establish the relationship between the self and the world. The mechanics of Newton meant a model which for science effectively excluded God and self from the universe. It was thought possible to describe the world with no reference to its creator, and this swiftly was assumed as a necessary condition for natural science (cf. Laplace). But the advent of the new physics has meant a closer identification of the 'I' and the world once more; the objectivity once deemed necessary has gone. Perhaps it is time that God was put back into the picture, not as contained within the structure of creation, not as an appendix or opening fillup to research, but as its ground and existential upholder (cf. Colossians 1:15-20. Romans 11:36.).

The Humanist starts from some self-awareness, some autonomy of self or of the external world; he takes for granted certain 'temporal facts' not only as temporary but as ultimate starting points for all thought. But the distinction should be noted between immediate and ultimate starting points. 'Immediately' we start with ourselves, from the human heart and from the reality of the world around us. But this is quite temporal. There is also a point of ultimacy from which we can also relate - namely God and His revelation.

'Ultimately' the Theist realises that he is not alone in an alien universe, but knows the infinite, personal God who *made* the world and him. Starting from the Trinity, he has a basis for meaning and the communication of meaning (love) revealed through the work and word of God. God reveals Himself though not exhaustively; we are in His image and He is not some philosophic other. So there need be no loss of categories, but an attempt to integrate the whole of man's being in obedience to his origin.

God is the true personal universal above all other universals; but He also speaks about particulars, and therefore we have no fundamental problem as to universals and particulars. The Christian is called to start - neither from an abstract universal and make deductions, or from isolated particulars - but from God. If it is true that 'in him we live and move and have our being', then we cannot erect theories or arguments as though they had some being apart from God. Within creation, man and the external reality are made to go together, and because this is so, then men will exhibit this whatever their philosophical predilections. No man can escape the fact of his createdness or the general providence and common grace of God. Man cannot finally deny who he is, his essential mannishness before God. Nevertheless Theism's basic claim is that nothing can be known unless God can be, and is, known.

The Theist will seek to avoid the trap of looking outwards from himself as ultimate. He will seek to distinguish between reality and illusion; he will accept his finiteness and dependence, and therefore avoid the frustration of trying to build autonomous concepts. So (a) the external world, (b) my own internal world, and (c) the logic of that position I hold, will, under God, begin to approach one another.

This carries specific implications for any Christian approach to scientia. It will, in the recognition that scientia has a religious root, enable some of the modern dead-end problems to be avoided. The laws of science are after all God's laws not nature's laws, as though nature were some autonomous province. (Cf. ch.23.) The laws of reality are not merely something that man invents:

> "....but rather laws that he discovers more or less aptly, as God discloses his laws to the scientist. God's laws for physical things - which we term scientific laws - are understandable to us because God has made us in his image.

Yet they are not rationalistic in the sense that in principle we can comprehensively understand them, because God's ways are also above our ways. (Romans 11:33-36: Job 38:41.)" (VanderVennen 1975, p.110.)

We seek, therefore, the rule of God; not the rule of impersonal laws of nature.

The Christian approach seems to me to entail a recognition of the futility of any search for a rationalistic base for knowledge. There is a vast difference between the uniformity of cause and effect within a closed system and the uniformity of cause and effect in an open system. Thus essentialism and positivism are inherently fallacious in structure while the subjective approaches of instrumentalism and idealism are inadequate. When man tried to interpret reality within one modality of being he inevitably runs into a regressive reductionism (cf. Appendix E). The Christian in service before God will point out the essential unity, as well as the manifest diversity, of creation as a created order, and not just as something which happens to be there and which we can look at. Thus scientific theories will be examined, not only as they relate internally to other theories and externally to the physical world, but also in their place and relationship within the Christian belief in creation, and the law-structure for that creation.

So I believe we can move towards a tentative definition of scientific laws as man-made representations, of varying degrees of validity, either in word or mathematical symbol, of the constant patterns by which the personal, infinite God operates in ruling His creation. Thus, while maintaining a realist position as opposed to an instrumentalist, this helps distinguish between reality and our representation of it. But any formulation of scientific laws ever remains imperfect, at best symbolic representations, yet we can hold that they are intended to imply and reflect a degree of truth.

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CHAPTER 12

THE ONTOLOGY AND EPISTEMOLOGY OF THEORIES II

12.1. INTRODUCTION

Scientific theories enable us to satisfy three distinct needs: (a) to condense knowledge into workable forms; (b) to understand the world; and (c) to predict probable future courses of natural phenomena, and therefore control events. As noted, there has been a tendency to exclude the validity and explanatory power of theories and reduce this to manipulative control. The basic moral and philosophical problem is that of relativism/scepticism. Thus the choice between competing theories is reduced to an arbitrary utilitarian selection because it is held that there is no objective standard of truth. This view is held despite the point that often the utility or fruitfulness of a theory cannot be determined until the theory has been chosen and developed. It is my contention that theories are governed by a degree of truthfulness - they are either good approximations (reflections) of the truth of God's universe or a denial of that truth. In this chapter I wish to outline some views of the basic components of theories before moving on to a brief note concerning Christian perspectives on truth and theories.[1]

12.2. DIVERSE VIEWPOINTS OF THEORY COMPONENTS [2]

12.2.1. P. Duhem (cf.10.2.3.) Whewell had drawn the image of scientific progress as the confluence of tributaries into larger rivers, and Duhem acquiesced that successful theories bound together experimental laws into larger wholes. Duhem regarded theories as 'representing' groups of laws rather than attributing to them an explanatory function. This view was based on an idea of the structure of theories as axiom systems with rules of correspondence correlating the axiomatic terms with experimentally determined magnitudes. (Cf. Losee 1972, p.69.)

This is seen in the kinetic theory of gases where the axioms give relations of terms such as molecule, velocity and mass. The axiom system is linked to experience by means of the concept of the root-

1. These viewpoints are noted to give a 'feel' of the territory. I am not concerned to provide a critique of them as this would take up toomuch room, and would not pertain directly to the thesis.
2. A particularly interesting work here is W.Young (1967)

mean-square velocity of all molecules. Rules of correspondence relate this root-mean-square velocity with pressure and temperature. Duhem held that this theory was valuable because it bound together previously unrelated laws connecting the macroscopic behaviour of gases (the laws attributed to Boyle, Charles and Graham are deductive consequences of theoretical assumptions); but saw this as representative and denied that the model had any explanatory function. The model associated with a theory may have heuristic value but is not itself a premiss in the explanations given by a theory. Acceptable theories must give experimentally testable laws, but the basic presuppositions of the theory may include magnitudes which cannot be correlated with processes of measurement. Thus Duhem, like Whewell, contended that there were no irreducible facts devoid of theory.

12.2.2. N.R.Campbell. He made the crucial distinction between axiom systems and their application to reality as the basis of his analysis of the structure of theories. He saw a physical theory comprising two different sets of statements: (a) the hypothesis of the theory, which is a collection of statements which cannot be experimentally verified; and (b) the dictionary for the hypothesis which relates the former to magnitudes that can be empirically determined. Therefore it is meaningless to talk of the truth of a theory in itself because no empirical meaning is involved. (Cf. Losee 1972, p.136.) He further subdivides theories into mathematical and mechanical sections on the basis of differing formal structures. In the mathematical theory each decisive term in a hypothesis is correlated directly and separately with magnitudes that can be empirically determined (e.g. physical geometry). In the mechanical theory some terms in the hypothesis are correlated as above, but through functions of these terms (e.g. the individual molecular velocities in kinetic theory.)

12.2.3. R. Harré. In opposition to Duhem, Harré shifts the centre of investigation from the formal deductive structures of theories to the associated models, appealing for a Copernican revolution that:

> "....consists in bringing models into the central position as instruments of thought, and relegating deductively organized structures of propositions to a heuristic role only, and resurrecting the notion of the generation of one event or state of affairs by another. On this view theory construction becomes essentially the building up of ideas of hypothetical mechanisms." (1970, p.116.)

He distinguishes three aspects of a theory: (a) statements about a model; (b) empirical laws; and (c) transformation rules. This leads to a stress on the existential hypothesis indicated by a model, rather than a deductive structure which can be developed from descriptive hypotheses. Losee depicts his analysis of the structure of the kinetic theory of gases as follows: (1972, p.144.)

MODEL	TRANSFORMATION RULES	EMPIRICAL LAWS
Existential hypotheses 'There exist molecules' Descriptive hypotheses 'Collisions are elastic' ' $m_i v_i$ = constant'	Causal 'Pressure is caused by molecular impacts' ('If I then P') Model 'Temperature is the mean kinetic energy of the molecules' ('T if, and only if, KE')	$\frac{PV}{T}$ = constant . . . .

12.2.4. J. Losee. Losee himself suggests that we always need to distinguish the axiom system and the application of this to experience. He illustrates this from the 19th century, where Lobachevsky, Bolyai and Riemann invented axiom systems which were different from the Euclidean one. In the Euclidean system it is assumed that only one parallel line can be drawn through a point not on a given straight line; but the new developments made different assumptions. [3] Lobachevsky and Bolyai replaced it with the assumption that through a given point there are two lines parallel to a given straight line; and from this and the other axioms of their system, Lobachevsky deduced that the sum of the angles of a triangle would be less than 180 degrees, decreasing as the area of the triangle increased. For Riemann there were no parallel lines to a given straight line, and the sum of the angles of a triangle was always greater than 180 degrees, increasing as the area increased. Thus a formal deductive system 'A' had no grounds for claiming to be superior to a formal deductive system 'B'. (ibid p.132.)

Losee goes on, drawing from the work of Hempel, Nagel and Frank, to suggest that today there are three types of criteria of acceptability for scientific laws and theories. (a) The correspondence between a law/theory and empirical data; (b) the logical relationships that one law/theory may have with other laws/theories;

3. The Greeks were of course the masters of the abstractions of geometry and while Euclid came to the fore, others made many different assumptions and axiom systems. (Cf. Turnbull 1962, chs.1-4.)

and (c) the heuristic power, fruitfulness, of the law/theory. There are also extra-scientific considerations.

12.2.5. E. Nagel. Nagel distinguishes between experimental laws and theoretical laws, seeing the former as relating observables and being inductive in character, while the latter deals with what is not directly observed and is therefore basically deductive in character. (Cf. Nagel 1974, p.79f.) The question of the observable is a thorny one. Before space craft the other side of the moon was always in principle directly observable; on the other hand, alpha particles are not thus observed, we merely note the tracks left by them in a Wilson Cloud Chamber. To compound the issue, Nagel notes that all reports of observables are ultimately couched in some theory.

He makes another difference between experimental laws and theories in that the former are "without exception formulated by a single statement" while the latter are normally systems of related statements (ibid p.88.). He goes on to suggest that there are three major components of a theory. (a) A scientific theory is often pointed to by the materials familiar to experience or by certain features recorded in other theories. This means that there is an "abstract calculus that is the logical skeleton of the explanatory system, and that 'implicitly defines' the basic notions of the system." (ibid p.90.) (b) If a theory is to explain experimental laws it must be more than implicitly defined and a set of rules assigning empirical content to the abstract calculus is required. Theory must be related in some way to empirical reality or it cannot be tested. (c) There is an interpretation or model for (a) which fills out the abstract calculus in more or less familiar terms and visualisable concepts.

12.3. THEORY FORMATION AND SCIENTIFIC EXPLANATION

How are theories formed? Different philosophical traditions have emphasised different ways and it seems foolish to confine the discovery or construction of theories to any particular path. There is room for the inductive-ideal of Bacon, Mill and Hume which seeks to generalise from particulars to universals; and also for the deductive-spirit which postulates the derivation of verifiable observation statements from generalisations. The former is better seen, it seems to me, as the psychology of science; while the latter concerns the logic of science. But as well as these approaches there is ample scope for creative imagination, the leap of creative thought which neither induction or deduction can encompass. While there may be a definitive logic for testing theories once created, there would seem to be little room for logic in their creation. Popper of course argues that there is a logic of discovery. It is often the novel combination of ideas that leads to new theories, and Koestler indicates that creative imagination, in both science and literature, is frequently tied to the interplay of two conceptual frameworks. (cf. Koestler 1970, p.322.)

<u>12.3.1. Systematization.</u> Scientific theories seek to take some system, which can be anything from the universe to an atom, from a bird to an eco-region, and give an adequate description of it within the parameters of a particular discipline. They do not therefore examine concrete reality, but abstractions from that reality and are therefore never exhaustive explanations or descriptions. The scientific description of such systems aims at specifying the structure of the system by describing the sub-systems and their arrangements and connections. This in turn leads to the examination of the sub-systems and the recognition of a built-in limitation. No such investigation can ever be exhaustive but will seek to specify the properties of the system being examined using the fewest possible predicates.

Historically there has been differing views as to this process of systematization. Aristotelian systematization envisaged knowledge as ordered by arranging the objects of knowledge and simply using generalisations to facilitate this ordering process. The Galilean systematization sought to systematize the knowledge expressed in a set of generalisations by ordering the generalisations. (Cf. Harré 1967, p. 72.) Harré contends that a particular happening is explained when the conditions under which it happens are isolated (cf. ibid p.82.). A logical condition of this isolation being the existence of a generalisation(s) linking the happening to be explained with other events which could be settled on as whole/part causative of the happening. The formulation of Aristotle and Galileo, as well as the typically modern position of Harré, are inadequate from a Theistic point of view.

<u>12.3.2. Consistency.</u> Theobald contends that all "explanations must be reasonable, and they must be consistent with what we know..." (1969, p.104.) This may seem a fairly straightforward assertion, but care

is needed for if all theoretical postulations are bound by conformity to current knowledge there would be a stif ling of scientific advance. Could Einstein have developed relativity if he had made it consistent with known Newtonian mechanics?

12.3.3. Explanations.

12.3.3.1. As Predictive Deductions. It seems safe to assert that there are no general characteristics of all explanations, though a considerable number of people suggest that there must be a predictive element. But not all explanations are intended to predict - for example, historical explanations. Again, predictions are possible apart from explanation. I can safely predict that a piece of dry paper will burn if I put a lighted match to it - without in any way explaining the theory of combustion. (Similalrly with the assertion 'I will go to the theatre tomorrow' or Boyle's Law.) Conversely explanation does not imply prediction: "we can explain the phenomenonological laws of thermodynamics by reference to statistical mechanics, but we are not at the same time predicting them, because we know of them to start with." (Theobald 1969, p.105.)

Explanations seem to be deductive in nature and so are dependent on the premisses being better known (and true) than that which is to be explained. But then arises the problem that premisses themselves will be couched in some theory, which drives us back to the validity or otherwise of a given weltanschauungslehre. The problem that immediately obtrudes is that if the premisses were true and the deduction valid there is no room left for doubt or the overthrow of a theory. Yet obviously we do doubt; we do overthrow theories. Deduction, then, is best seen, not so much in the construction of a theory, but in the elaboration of the implications of sophisticated theories to bring them to a point where a comparison with observables is possible. Thus the basic relationship between theories and theory implication is deductive; while the relation between theory implication and observation is non-deductive. There is a logical gap between theory and data, for it must always be remembered that in a real sense theories do more than simply order the available data, they also create and select data, thus determining the meaning and significance of observations.

12.3.3.2. Are Limited. There is the basic impossibility of comprehensive explanation of wholes in terms of parts. In biology, for instance, it is impossible to reduce explanations to the physical aspects of the biological system. Life has no meaning in terms of physics; biology is meaningless in separation from life.

12.3.3.3. Levels of Explanation. In the biological discipline we can note the postulation by Simpson of distinct levels, or modes, of explanation (cf. Jeeves 1969, p.61.) (a) Explanations that answer the question how?, and concern themselves with the mechanisms involved; (b) explanations that answer the question what for?, and which seek answers concerning the function of an object; and (c) answers to the question how did that come about?, which is concerned with the history of organisms. Of these: (a) is often seen as reductionistic; (b) as compositionist; and (c) as basically irrelevant as far as physics is concerned. Simpson claims that explanations may be exhaustive at a particular level, but this never means they are exhaustive overall.

12.3.4. Analogies and Models. In the formation of theories, analogies and models play an important role, providing a fruitful source of theories although becoming dangerous and misleading if over-extended to assume all the characters present in new situations. An analogy is constructed on the basis of some observed or postulated similarity between two situations; while a model is simply a systematic analogy linking some phenomenon already known with one under investigation. There is a formal similarity in the equations of a mathematical model between the two sets of phenomena, though there may be no likeness of the phenomena themselves - the same differential equation describes the vibrations of an elliptical membrane and the motion of an acrobat. (Cf. Barbour 1968/b, p.158.) Well known examples of the use of analogies are the development by Huygens of the wave theory of light on the pattern of sound theory, and the development by Fourier of the theory of heat flow on the pattern of fluid flow in hydraulics.

Analogies and models have diverse forms and relationships to theories. Harré notes two: calling them micromorphs and paramorphs. (Harré 1967, p.86.) The former is after the manner of a pilot plant, where a small scale model is constructed as an exact representation of the actual or intended scheme. The paramorph on the other hand is based on parallel laws in different fields such that the process in one field (say mechanical) is represented in an analogous system (say electrical). Similarly, Nagel, drawing on Maxwell, divides analogies into two broad categories - substantive and formal. Substantive analogies relate a system of elements with specific familiar properties connected in known ways (laws for the system) to a model for the theory construction of a second system. The formal type involves a known, but abstract, set of relations rather than the more or less visualisable connections of the substantive analogy. (Cf. Nagel 1974, p.110.)

Analogies have a powerful heuristic role, but this can be variously interpreted within differing philosophical frameworks. Duhem and Campbell were both aware of this heuristic power; but while Duhem saw the assertion of a theory as merely that of a positive analogy, Campbell saw it as the assertion of a positive-plus-neutral analogy. Thus Duhem saw the development of the basic kinetic theory of gases to the van der Waals modification as a replacement of one theory by another, while Campbell saw the development as an extension of the theory. (Cf. Losee 1972, p.138.)

The idea of extension seems more popular than that of replacement and Harré lucidly expounds this viewpoint, seeing extension as either formal (where the logical consequences are drawn out by deduction) or informal (where the theory is extended by extending the model on which the theory is based). (Cf. Harré 1967, p.98f.) Two kinds of model-extension are noted - deployment and development. Deployment involves the addition of the description of a model of new predicates by analogy with a corresponding real situation. In development there is the superimposition of one model on another.

Returning to Campbell it will be remembered that he saw a theory consisting of a hypothesis and a dictionary, but he also maintained that a theory must be associated with an analogy. Any acceptable theory reveals an analogy to a system governed by previously known laws. Thus a theory "always explains laws by showing that if we imagine that the system to which those laws apply consists in some way of other systems to which some other known laws apply, then the laws can be deduced from the theory." (Campbell 1952, p.96.) The analogy is therefore drawn in the kinetic theory of gases between the molecules of the gas and a swarm of particles which are assumed to follow Newton's laws and experience collisions with no loss of energy. Thus Campbell saw an analogy as more than a heuristic device; it was an essential part of a theory. Hempel, while conceding the value of analogies, criticised this claim, maintaining that as analogies do not occur as premisses in any deductions of experimental laws they cannot be part of the structure of theories.

12.3.5. Review. An analogy can never be totally identified with, nor seen as, a complete description of some phenomenon for it is merely a simplified and limited setting forth of the relationships of phenomena with other phenomena. An analogy is only similar in some characteristics; models suggest only possible hypotheses. Analogies and models have indeed a heuristic value but care must be taken to keep inessential elements from coming to the fore. A model is not the theory itself. In the final analysis all scientific concepts must in some sense describe or explain physical systems to which they refer, and while analogies and models are useful to this end they are only means.

12.4. REVIEW

Several points can now be made. (a) There are clusters of possible explanations of any given phenomenon and a particular explanation will depend on how the event is abstracted from the concrete reality and examined. It is possible to give physical explanations of man as well as biological, psychological, social and so on, but no account ever explains man *qua* man. (b) It follows that different modes of explanation are not logical alternatives or competitors of one another. (c) We can extend this into the religious domain and point out that biological, social and psychological explanations of man's behaviour are not exhaustive, nor necessarily to be regarded as competitors of biblical affirmations concerning man. There can be no logical basis for claiming that a valid scientific explanation denies the activity of God, and this needs stressed against both the non-christian who would absolutize science in an endeavour to dethrone God, and the Christian who sees science as a threat to his faith.

12.5. CHRISTIAN PERSPECTIVE ON TRUTH AND THEORIES

The revelation of God includes both disclosures and discovery. Science is concerned with the discovery of the truths of God's creation as revealed in the natural order. More generally we think of revelation as the disclosure of God to man of Himself in His word and works. Whatever order and unification we discern in phenomena is a part of God's created order, determined and sustained in an ultimate sense by Him. The proper appreciation of this will prevent falling into the trap of extreme objectivism or subjectivism. Belief in the

Creator God and His revelation will provide a basis for confidence in the reality of the external world, and in the sensory and intellectual abilities of man to subdue and rule over creation. Man in his scientific activity is actualising the cultural mandate given to him — whether he recognises it or not (cf. 24.2.2.).

12.5.1. The Deficiencies of Non-Theistic Concepts. The scholastic error was to put truth simply in God's mind and deny any objective manifestation in the external world. But today truth as an absolute has been abandoned altogether. The Truth that alone makes all temporal truth possible involves a sharing in the fulness of meaning of the cosmos in Christ.

> "This means that we have once and for all given up the illusion of possessing the norm of truth in our own fallen selfhood. We have arrived at the self-knowledge that outside of the light of Divine Revelation we stand in falsehood.
>
> Any one who grasps this Divine Revelation with all his heart abides in the Truth. Abiding in the Truth frees our insight into the horizon of human experience from the prejudices of immanence-philosophy, and it also enables theoretical knowledge to be directed to the Truth. At the same time it cuts off at the root the overestimation of synthetic scientific knowledge, which remains bound within the temporal horizon." (Dooyeweerd 1969, Vol.II, p.564.)

Secular concepts, at most, see truth as a relation of correspondence sustained by a mental affirmation with noetic form, or shut up in the arena of verification/refutation. The basic fallacy is the absolutization of some aspect of the created order and seeking subsequent explanation of all things from that perspective. This can only lead to frustration and relativism. There is a general failing to appreciate that theories are man's attempt to reflect the ordering laws of God. In this failure the above views (cf.12.2.) seem caught in a Kantian dilemma of having some ding an sich which can never be finally explicated. This fails to realise that nothing exists by itself, but stands in interwoven (enkaptical — see glossary) relationship with the rest of creation and before the face of God. This is as true of scientific theories as devotions.

The idea of a god-of-the-gaps is absurd. But it should be noted that this idea is not only from distant centuries. Whitehouse writes:

> "I am myself inclined to think that the mystery of God's Providence lies deeper than the eruption into nature of such interference (sc. mind over matter) and I am attracted by the fact that scientific explanations and predictions rest now on 'the law of great numbers'; that fundamental physical laws are

statistical and not exact in the popular sense. Why this should be so is an interesting matter for speculation. It may provide a sufficient room to manoeuvre beneath the observable, regular processes, for the personal care of God to be actively exercised." (1952, p.121.)

The last sentence here is crucial for the idea of 'room to manoeuvre' suggests that things are more or less tied up scientifically but that God still has a little scope for action. This leaves God as Lord over a steadily dwindling territory, the explanation of the left-overs from scientific endeavour. But this is not the God who is there. When Jesus asserted that His Father 'Makes the sun rise on the evil and on the good, and sends rain on the just and the unjust'; or asked us to look at 'the birds of the air: they neither sow nor reap nor gather into barns, and yet your heavenly Father feeds them' (Mt. 5;45: 6;26.);He was not putting forward some claim which could be taken over and explained scientifically at a later date, nor was He presenting something incompatible with the physical manner in which the planets move or birds feed. Rather He was pointing to the ultimate truth that God is in existential control of His creation. 4

12.5.2. Truth as a Matrix. The Scriptural viewpoint seems to me to present truth as a matrix within which God's creation lives and moves and has its being. There can be nothing outside of His creation; while within it God reveals reality in ways bounded by His ordering law. No knowledge ever can be (or is becoming) in separation from God's law-structure (nomos -cosmos) of the universe. The word 'truth' in Scripture means stedfastness, certainty, reliability, and this

4. D.M. MacKay writes somewhere that: "But if once we recognise that at least most theological categories are not 'in the same plane' (in the same logical subspace) as most scientific categories, there is no longer any theological merit in hunting for gaps in the scientific pattern. Gaps there are in plenty. But....it would seem to be the Christian's duty to allow - indeed to help - these gaps to fill or widen as they will, in humble and cheerful obedience to the truth as God reveals it through our scientific disciplines...." This is an excellent statement although it does carry a latent confusion between 'religious' and 'theological' statements which will be returned to at a later date. Then MacKay goes on: ".....believing that to have theological stakes in scientific answers to scientific questions is to err in company with those unbelievers who do the like." (From 'The Christian Graduate' Vol.VI, 4, p.163.) There is a potential danger here of losing sight of the inherent religious foundation of science itself. Nevertheless the point that Christians are to seek to fill the gaps in scientific knowledge is valid.

unfolds the meaning of the injunction to 'stand in the truth.' The prerequisite to true theoretical reflection is a standing in the Truth. This can never be reduced to an atomistic concept of truth, or to a Kantian _ding an sich_.

12.5.3. Horizons of Knowing (cf. 21.1.1.) We need to distinguish different horizons or ways of knowing.

> "When it comes to human knowing, that integral act of the full bodied man apprehending objects with understanding, the first thing to be said is that the most fundamental, the largest, final horizon within which human knowing necessarily takes place is the Truth. No knowledge ever just is. The fact that an individual human subject gets to know an object structured according to creational order is all pointing directly to the Truth within which the whole operation is framed and which it is to embody." (Seerveld undated, p.3.)

While there are different horizons or levels of knowledge, these do not exist in watertight compartments. The Christian will never in a Scriptural way be able to compartmentalise his scientific activity from Scriptural truth. Each individual is a whole, his experience and thought being part of his whole life as a man before the face of the Lord, and any compartmentalisation will mean being untrue to himself, to creation, and to God. It will mean a schizophrenic existence. Our knowledge, in all its facets, is inevitably one web. Undoubtedly our knowledge has different dimensions in that God has varying holds on His creation - _inter alia_, in terms of special and general revelation - but He alone gives all individual things their identity. Individual identity which is ever interwoven with diverse and universal-wide orderings before Him; "For of him, and through him, and to him, are all things: to whom be glory for ever." (Rom. 11:36.)

MacKay (in Jeeves 1969, p.68f.) illustrates the complementary aspect of differing horizons of knowledge as follows: two people are sitting on a cliff top overlooking the sea; a light is seen flashing on and off out to sea. One of the men, a keen physicist who carries all sorts of scientific equipment in the back of his car, says that given a little time he will give a full account of the wave-length, emission rate, frequency, etc. of the flashing light. His friend, however, is worried because in his youth he learned morse. Eventually he works out that the light is telling them that the cliff they are sitting on is about to crumble into the sea. The physicist's account of the light, however accurate at its level, was quite lacking an integral knowledge of the significance of the light.

This is a very attractive analysis (cf. 16.5.2.2.), but I must contend that the two explanations are not complementary. The light in this context is qualified in meaning by the communication content and not by physical analysis. The meaning of the event is not given in the understanding of its frequency, emission rate, etc., but in the social import it bears. The danger that always confronts the scientist is of forgetting that his discipline abstracts from reality. Yet having said this I must also add that there is a kernel nucleus of modal irreducibility in each law-sphere (modality) which cannot be explained by reference to other spheres of being. But centrally we must determine of an event what is its primary qualifying modality and refrain from indulging in meaningless objectivity.

12.5.4. Theistic 'A Prioris'. To talk in a limiting way about truth it is best to start any discussion from biblical a prioris. Seerveld, a leading aesthetician, has written that:

> "According to the Scriptures, Truth is the way God does things. As God of Truth, Yahweh is the utterly stedfast, firmly established covenanting God who has staying power for ever and ever. His deeds show Truth in that they hold, have an ordering reality that is able to stand whatever traffic bears down on them. The Word of the Lord, at its very funding bottom, is epitomized by Truth because that Word God speaks, whether the Law at Sinai or the Commands in the beginning, is completely trustworthy, certain of fruit, effecting what will last. Wherever the Truth appears, there is a God-revealing, a faithful healing dynamic that enriches those who are responding to its development. This is why the biblical expression 'to stand and walk in the Truth' is pregnant with meaning." (Seerveld undated, p.1.)

Given this context and the idea of the differing horizons of truthfulness, it is important to distinguish the varying a prioris which bound our knowledge and require our obedience. Seerveld presents three theses which may usefully be adapted here (ibid pp.3-4.). (a) The root-law of truth which establishes the knowledge man attains as true if, and only if, it develops Christ's Lordship of the cosmos and pleases Him. (b) The cosmic-correctness which assess the knowledge man gains as correct if, and only if, the relative states of affairs known are kept relative, related to the rest of the cosmos in proper context and relationship. (Cf criticism of MacKay above.) (c) The criteria of accuracy which holds that knowledge obtained by man is accurate if, and only if, the subject's knowing conforms with the law-structure related to a specific feature or function of a knowable object.

Under (a) we discern that knowledge achieved is true if it developes Christ's Lordship of the earth and sets forth His redeeming presence (cf. - all things are redeemed, Eph. 1;22. Col. 1;20.). True knowledge leads into the Truth, but also will have a critical awareness of the sin that permeates all human knowledge. Yet it will lead to true truth and give an edifying thrust. Under (b) we note that knowledge is considered correct under specified limiting conditions. Man's ambition to integrate reality about himself tends to make him mistaken about reality so that he absolutizes or minimizes what he knows beyond its rightful place. But as Calvin pointed out, knowledge must serve God or it becomes an idol. Correct knowledge is constrained by the cosmic order. Under (c) we see that the consequence of true-God-directed discernment is accurate knowledge.

One of the most widespread ideas today is that true and false are characteristics only of propositional statements, or that to say something is 'true' is merely to give some "concessive signal like 'yes, yes', the cat is on the mat." (ibid p.2.) This reduces truth to the manipulations of logical properties and linguistic analysis/ conundrums, stiffling any penetrating discussion of the wider implications of truth. Truth is not an attribute of things or events, sometimes present, sometimes lacking. Hence 2 + 2 = 4 is not a truth in itself, because <u>in itself</u> it is meaningless. All things exist and are meaning only as they stand in relation to creation, and to their Creator.

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CHAPTER 13

THE METHODOLOGY OF SCIENCE I : 'THE' SCIENTIFIC METHOD

Chapters 10 to 12 concerned various perspectives of scientific theories vis a vis reality. I now wish to look more closely at the relation of theories to scientists, or how theories are derived. Much light can be shed on an understanding of science by studying the processes whereby hypotheses are first discovered/invented; and how they are established and confirmed into the corpus of scientific knowledge (cf. ch. 15). There are no simple answers as to how theories originate, although it is widely believed that 'the' scientific method is an entity which governs all scientific processes.

At the outset the concept of 'the' scientific method must be regarded as fallacious, if only for the reason that competing views of it are presented by differing philosophies. Chapters 10 to 12 indicated no consensus of what science itself is; so it is even less likely that there will be a consensus of methodology. Priestly suggested chance was the key to discovery; Planck that the process was simply an extension of common-sense; some highlight the interaction of observation and experiment; others the collection of 'facts'; others inspired creativity; while yet others contend that there is no such 'thing' as 'the' scientific method. Bridgman asserts that:

> "The scientific method, as far as it is a method, is nothing more than doing one's dammedest with one's mind, no holds barred. What primarily distinguishes science from other intellectual enterprises in which the right answer has to be obtained is not method but the matter." (1950, p.370.)

13.1. 'THE' SCIENTIFIC METHOD

In popular thought scientific method is seen as the empirical collection of facts with as little bias as possible, which yields under inspection some order from which a hypothesis can be formed, tested and, if sufficiently verified, pass to the status of a scientific law. This idea is widespread even among practising scientists who often have little philosophical or historical awareness concerning their own discipline. It is believed that this scientific method, of sitting down with an empty mind before the facts, is the only road to truth. Thus many defend this viewpoint – that there is a particular and definite scientific method peculiar to science – and claim it as the sole route to knowledge of value/meaning.

One of the reasons for this view is that only the successes of science are looked at, only the publications that have endured. This tends to indicate linear progression. But the history of science is filled with a multitude of dead-ends, glorious failures which make the reality of science a maze and not a line.

13.1.1. P.B. Weisz. I take two examples of this popular view. The first is from a text on biology which I quote at length.

> "Everything that is science ultimately has its basis in the scientific method. Both the powers and the limitations of science are defined by this method. And wherever the scientific method cannot be applied, there cannot be science..
>
> All science begins with observation, the first step of the scientific method. At once this delimits the scientific domain; something that cannot be observed cannot be investigated by science....It is necessary, furthermore, that an observation be repeatable, actually or potentially...
>
> ....the second step of the scientific method is to define a problem. In other words, one asks a question about the observation....To be valuable scientifically, a question must be relevant and it must be testable....
>
> ....the third step of the scientific method. This involves the seemingly quite unscientific procedure of guessing. One guesses what the answer to the question might conceivably be. Scientists call this postulating a hypothesis....The scientist will not know whether his guess was or was not correct until he has completed the fourth step of the scientific method, experimentation. It is the function of every experiment to test the validity of a scientific guess....The result of any experiment represents evidence; that is, the original guess in answer to a problem is confirmed as correct or is invalidated. If invalidated, a new hypothesis, with new experiments, must be thought up.....
>
> Experimental evidence is the basis for the fifth and final step in the scientific method, the formulation of a theory.... Every good theory has predictive value..." (Weisz 1961, pp4-8.)

This is very neat and rigorous. It is the 'Baconian Bucket' (cf. 9.3.2.1.). Here is displayed a total allegiance to a specific scientific method which follows the pattern - observe, define a problem, form a hypothesis, experiment, formulate a theory.

13.1.2. D.L. Dye. Writing specifically from a Christian angle this scientist also holds firmly to 'the' scientific method which he describes as consisting of - observation, generalisation, and verification by further observation (1966, p.19.). Here observation, which assumes a reality to be observed in the interaction of the knower and object, is characteried as quantitative description -

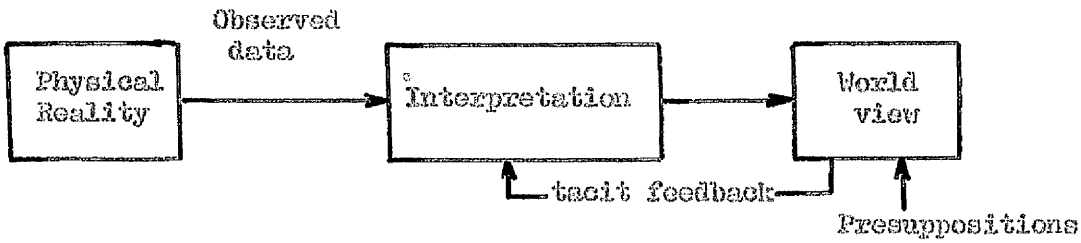

DIAGRAM IV : Dye - A Materialist World view

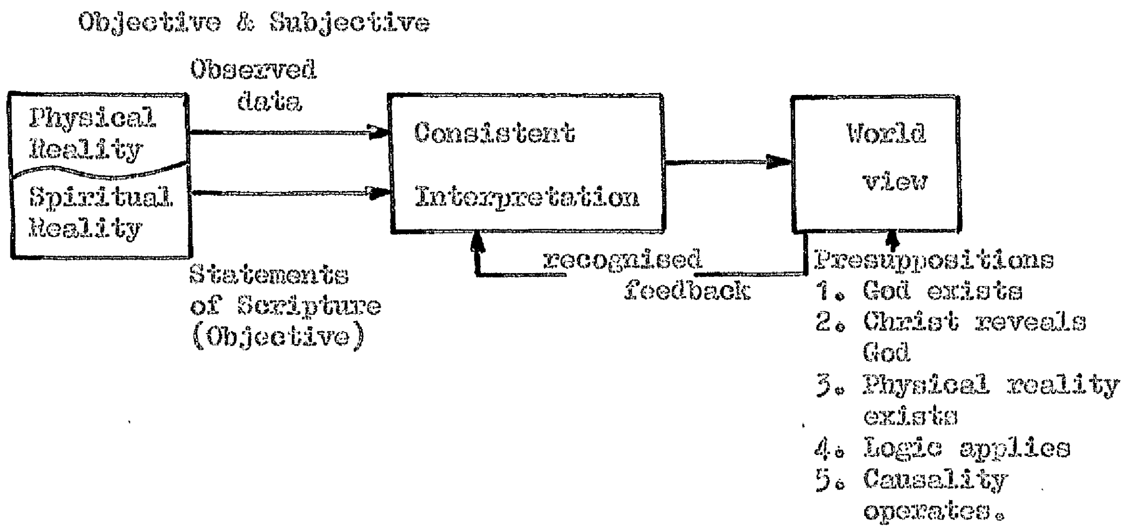

DIAGRAM V : Dye - A Christian World view

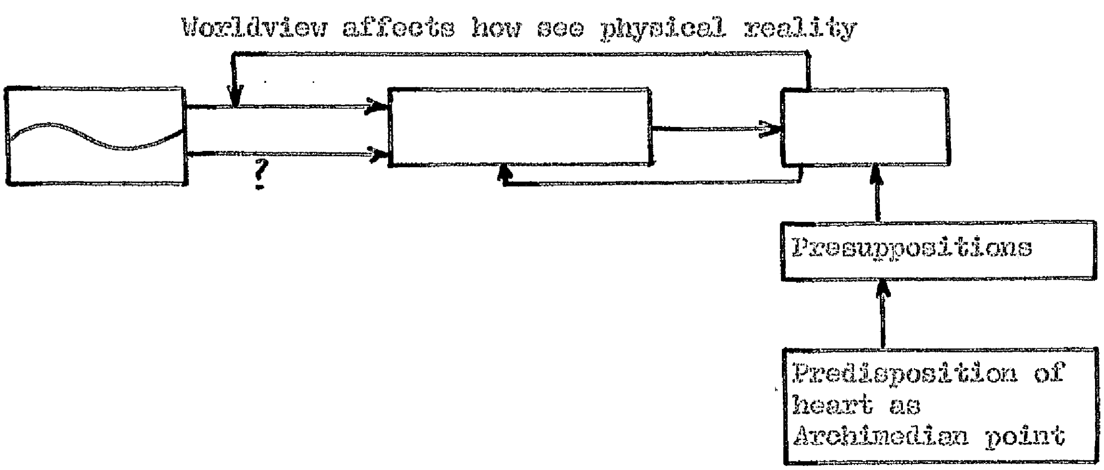

DIAGRAM VI : My Revision of Diagram V

though he allows the necessity of some context, the guidance of some prior hypothesis. Generalisation assumes that logic applies to the description of physical reality; while verification assumes the veracity of operating causal laws. To review this position thus, immediately indicates the underlying philosophical issues which challenge any concept of neutrality. Dye, however, maintains that the basic attitude is 'Let's see what happens if...' (ibid p.32.) and that this contains no article of faith or commitment. He writes:

> "With our intellects we organise our perceptions into consistent patterns – the scientific method is a means to this end. Integration requires a world view that supplies some meaning to the consistent, but philosophically neutral, descriptions of the physical reality in which we are immersed." (ibid p.103.)

For Dye, meaning, purpose and interpretation are meta-scientific and there is a substratum of scientific fact available to exposure by the scientific method which is a-philosophical (cf. ibid p.119.) (Cf. Popper's 'basic statements' – 15.3.3.2.) Dye sets out two models (cf. ibid pp.71,76.) – the materialist and the Christian (Diagrams IV and V). I contend that they reveal a serious flaw in that they assume that observations are not conditioned by presuppositions, education, or expectations. So I propose that for a similar model to be acceptable it should be ammended as shown in Diagram VI. The objectivity demanded in Dye's models seems to me an illusory dream. Total objectivity, even at some basic level of observation, is untenable in the light of the history and philosophy of science.

<u>13.1.3. Conclusion.</u> I present the conclusion of chapters 13 and 14 at the outset. <u>It is erroneous to regard scientific method as a simple, readily applied, highly general and sufficient criteria to validly establish a theory, for this is untrue to the history of science, to the philosophy of religious commitment, and to the psychology of knowledge.</u> I am therefore sympathetic to Polanyi when he writes:

> "Theories of the scientific method which try to explain the establishment of scientific truth by any purely formal procedure are doomed to failure. Any process of enquiry unguided by intellectual passions would inevitably spread out into a desert of trivialities. Our vision of reality, to which our sense of scientific beauty responds, must suggest to us the kind of questions that it should be reasonable to explore." (1973, p.135.)

This is no negation of the general progression of science, or of the necessity for the ordered collection of <u>selected</u> data, and the systematic expression of this in descriptive terms by theoretical laws.

13.2. AN HISTORICAL RÉSUMÉ (cf. 4.5.)

Care is needed so that the past is not transposed into the present system of understanding, for different eras have had different basic concepts which constrained thought. The early period up to Kepler believed in systems of numbers and the configuration of geometric structures; subsequently there was the dominance of the concept of mechanically constrained masses in the Newtonian worldview; and today the dominant belief in mathematical invariance. But it must always be remembered that in different frameworks of thought the same range of experience takes the shape of different 'facts' and evidence. Therefore Bacon, Newton, Descartes etc. can not be charged with inadequacies from the perspective of the 20th century, but only from within their own context.

13.2.1. The Galilean Method (cf. 11.2.) Aristotle followed a qualitative method in his biological work, but with Bacon, and further with Galileo, the experimental method became quantitative. These two approaches are quite disparate, and the 17th century evinces a totally new process of investigation, a 'paradigm' change in methodology which would facilitate the reinterpretation of data into a new framework. Galileo was concerned with the role of mathematics in science, and this was new (not to be confused with the Pythagorean approach of harmonies). This new view, encompassing an experimental-mathematical method, led to the subsequent developments of modern science and technology. Needham (1956, p.30f.) suggests that this new method, which he calls the Galilean, had the following steps:

(a) Selection, from the studied phenomena, of specific aspects which can be expressed in quantitative terms.

(b) The formulation of a hypothesis involving mathematical relationships between the observed quantities.

(c) The deduction of certain consequences from (a) which are within the range of feasible verification.

(d) Observation, followed by change of conditions, followed by fresh observations - that is, experimentation which embodies as far as possible measurement in numerical magnitudes.

(e) Acceptance, or rejection, of the hypothesis. An acceptable hypothesis serves as the starting point for fresh theories.

This basic procedure was not confined to Galileo, but was typical of the new worldview arising from the Renaissance and Reformation.

13.2.1.1. The Craft Component. The above is in marked contrast to that of the craftsman whose approach is outlined thus:
(a) Selection, from the phenomena studied, of specific aspects.
(b) Observation, followed by change of conditions, followed by further observation - i.e. (d) of the Galilean method.
(c) Formulation of a hypothesis of a primitive type.
(d) Continued observation and experimentation which is not too strongly influenced by the concurrent hypothetical considerations.

Needham sees this as the 'empirical component' of the Galilean method.

13.2.1.2. The Speculative Component. This element was found in Western Europe from the middle of the 12th century onwards.

(a) Selection from the detailed phenomena under discussion of features which seem to be common to all, complete enumeration being seen as unnecessary because of faith in the uniformity of nature and the representativeness of samples.
(b) The induction of specific principles by reasoning from the essential content of these features.
(c) Deduction of detailed consequences of this hypothetical principle (synthesis).
(d) The observation of the same and similar phenomena, leading to verification/falsification by experience.
(e) The acceptance/rejection of the hypothetical principle formulated in (b)

This is, very briefly, Needham's reconstruction. From about Galileo onwards the empirical and speculative components came together in a creative synthesis of the craft and the theoretical (cf. 1.6; 3.5; 6.1.2.) Added to this was the intrusion of the mathematical component. The scientific spirit here stood for reason over emotion; it was a "means of discovering new phenomena, and of formulating new theories." (Mason 1962, p.602.)

13.2.2. Baconian Empiricism (cf. 4.5.2; 9.3.2.1.) Modern scientific methodology often points to origins in Bacon who advocated an empirical approach which endeavoured to unite craft and scholarship. His method has been held up ever since as the 'royal road to science'; the marriage of the empirical and rational in a creative synthesis. However, Bacon was ever suspicious of deductive procedures and is the proponent par-excellance of the inductive method which he saw aimed at power over nature as well as understanding. Undoubtedly this emphasis on the craft/empirical is one of the reasons for the dominance of the industrial revolution in Britain as opposed to the more rationalistic outlook of the Continent. Empiricism led directly to industrial techniques (cf. Mason 1962, p.281.) His method, then, is briefly - the collection of as large a body of facts as possible in a given area, the listing of negative instances and the degrees of comparison of features, thus leading to 'latent configurations' and 'latent processes of Nature' being uncovered.

This method has by no means died out and is still prevalent today (cf. 13.1.) Popper, perhaps not entirely fairly, characterises this as the 'bucket method'. Nevertheless it still exercises tremendous power in the scientific world and someone like Ritchie Calder can hold it up as the scientific ideal (cf.1968, pp.12,13.)

13.2.3. Cartesianism (cf.4.5.1.) Descartes stood for rationalism against the Baconian emphasis on the empirical and inductive. He criticised Bacon for starting from particulars, contending that we must start from general principles and deduce consequences.[1] Experiment was merely something to decide between rival views/theories. The Enlightenment saw the Cartesian method being extended from science and metaphysics into the social sciences and philosophy. Here it was believed that doubt and criticism would purge obscurity and rebuild the world scientifically. This was, however, a Cartesianism tempered by empiricism. Laplace stands as the great enthroner of this objective scientific method whose legacy lingers on. With the rise of the other sciences - biology, chemistry, geology etc. - there arose emphases of method in identifying, ranging and classifying analytically, as seen in men like Condillac, Linnaeus and Lavoisier. In chemistry, Lavoisier set forth the virtue of orderliness and systematic analysis with such success that though he discovered nothing of importance, he stands as possibly the founder of modern chemistry.

13.3. THE 20th CENTURY

With the demise of the hard mechanism and objectivity of Laplace a pool of uncertainty has arisen and with it a new emphasis on the

1. Critical of Bacon and Descartes was Huygens, who realised that the former did not sufficiently appreciate the role of first principles and mathematics, while the latter failed to appreciate the true nature of experiment. But empiricism prevailed, especially in the Royal Society which in the beginning had unbounded enthusiasm for the most trivial experiments.

subjective. This is complicated by the continued existence of various strands of hard objective methodology (cf. 13.1.) While we can talk of the modern method being mathematical, to say this is more to describe the content of science than any particular set of rules for engendering theories. Merton comments:

> "Science is a deceptively inclusive word which refers to a variety of distinct though interrelated items. It is commonly used to denote a set of characteristic methods by means of which knowledge is certified; a stock of accumulated knowledge stemming from the application of these methods; a set of cultural values and mores governing the activities termed scientific or any combination of the foregoing." (1972, p.66.)

Though this chapter maintains that absolute objectivity is impossible, and that there is no such thing as 'the' scientific method, nevertheless there is a universal ethos connected with science that sets it, when followed consistently, in a sphere of qualified objectivity - as opposed to, say, the subjectivity of aesthetics. This is a difference between normative and objective spheres of being (cf. Appendix C). There are pre-established criteria which science must remain faithful to; there is a consensus involvement that precludes, in part, individual particularism. This communal aspect whereby science is a matter of common property and belief does not necessarily decree that what is accepted is the best possible theory from the alternatives available - though in general this may be so. There is in science a degree of disinterestedness and organised scepticism that is foreign to other spheres of life such as politics and ethics. But this disinterestedness is not absolute. It would seem safe to state that any real examination of scientific activity, or understanding of the philosophical issues involved, leads to the conclusion that there is a spectrum of ways for theory construction. There is no one method, despite the contention of Weisz (13.1.1.) and Dye (13.1.2.).

13.3.1. E. Wilson (1952, pp.21-35.) sets out a modified Baconian procedure which is of particular interest as his book is intended to guide students of the sciences in the methodology of their chosen discipline. He contends that we begin with selected observations, rejecting at all times any prior authority as an ultimate basis for truth. He notes that observation will involve selection and states that it should lead to description. There are undoubtedly human predilections involved but the public nature of science will sift these out. Following observation, there is a possibility for the construction of hypotheses, the floating of trial ideas by induction from the facts. From the hypothesis, certain deductions can be made which will be tested - by agreement, difference, concomitant variation etc. - for acceptance or rejection.

<u>13.3.2. K.R. Popper</u> (cf. 10.4.3; 11.2; 15.3.) strongly refutes the above methodology and sees Bacon as presenting the mind as passively receptive of external stimulii from which it formulates and orders hypotheses. Popper maintains, on the other hand, that theories are first formed in the mind. Only then do we seek data to verify/falsify them. So he has more sympathy for the deductive Cartesian approach and comments sympathetically of Abelard who said that it was only by doubting that we came to the real questions of life (cf. Davies 1975, p.25.). Popper's theory is analagous to the operation of a searchlight seeking to track an aeroplane (cf.9.3.2.3.).

<u>13.3.3. M. Polanyi</u>, like Popper, stands out against the concept of objectivity, positivism and 'the' scientific method. His thesis is that there can be knowledge apart from knowers and that this personal aspect is pervasive and inescapable, even when not explicit (cf. 21.1.1.). He notes a degree of objectivity in the public nature of science but points out that <u>this public is not the public at large</u>, but merely a certain section with a specific training and committed to specific models. The public may be reduced in effect to a consensus of only two or three specialists in a given area.

Behind theories lies the skill of the researcher, the expertese he has acquired over the years, the techniques he has mastered, the order and beauty he seeks. The question that must be asked is therefore 'How are we to distinguish between subjective belief and truth?' Polanyi answers that we need not fall into a subjective trap, for the scientist should be committed to understanding reality external to himself, while always aware that he may be wrong even in the most rigorous experiment or observation. The future will endorse this commitment. But: [2]

> "....as human beings, we must inevitably see the universe from a centre lying within ourselves and speak about it in terms of a human language shaped by the exigences of human intercourse. Any attempt rigourously to eliminate our human perspective from our picture of the world must lead to absurdity." (1973, p.3.)

2. This recognises the Archimedian point of the human heart, without acknowledging the Arche - cf. 20.1.3.2.)

In general terms, Polanyi suggests a threefold procedure - a stage of preparation, of illumination, and of verification. In the first we recognise the situation and appreciate the problem; in the second there is discovery by experiment, intuition, chance; while the third establishes the status of this illumination. (Poincaré added another stage between the first and second - incubation.)

13.4. DIVERSE INSTANCES OF THEORY FORMATION

There is always the danger in utilising historical material to select only that substantive to a case and ignore that which is not suitable. Nevertheless I hope the material utilised here will indicate the diversity of features operating in the formation of theories. Such diversity negates any 'one best way' to discovery.

13.4.1. Theory Preceding Observation. The occurrence of this undermines the idea that science starts from observation/experiment and then forms hypotheses (cf. 13.1.). Newton predicted the motion of the moon's perigree which for 60 years stayed at only half the observed value. This situation prevailed until 1750 when Clairaut showed that his value was satisfactory, his theory correct, and that it was the mathematical application of his theory which had been erroneous. Charles Darwin formulated his theory of atoll-formation in a purely deductive spirit long before he ever visited a coral reef. The suggestion by Pythagoras (532 B.C.) that the earth was round and Bion's prediction of the midnight sun in the Arctic, both preceded experiment. Harvey, in formulating his theory of the circulation of the blood, postulated capillaries which were not discovered until much later. In 1916 Einstein postulated that light should be bent and retarded in the gravitational field of the sun. The bending effect was first confirmed by Eddington in 1919; and the retardation was not observed until 1967 when Shapiro achieved this effect by reflecting radar signals off Mercury when it was nearly behind the sun. Again we can think of Rutherford's Dispersion Formula (1911) where, from the distribution of alpha particles, he was led to propose the existence of the nucleus - but not until the advent of the Geiger counter and other developments was evidence produced and the nucleus established. Planck intuitively arrived at his Radiation Formula, but not until two months later was he able to present a theoretical proof where he introduced the idea of quanta.

In the 1870's when Mendeleev was arranging the chemical elements according to their atomic weights and finding that they grouped together in distinct families, he came across a gap in the sequence. At the third column of his arrangement he had no known element to fit in. He solved the problem by interpreting it as a gap, making this choice because the next element - titanium - simply did not have the properties that would fit the same horizontal family as boron and aluminium. By opening a gap he could place the later elements in the right columns and rows - but he had no observational or experimental corroboration for this step of assuming missing elements; it was simply a conjecture, a scientific inspiration.

13.4.2. Theory from Dreams. In 1865 Kekule, on the basis of a dream, suggested that in aromatic chemistry six carbon atoms were linked into a ring that persisted intact through many chemical reactions which changed certain atoms attached to the ring. He had been working on the problem and getting nowhere. Falling asleep, he dreamt of a snake which curled into a ring and siezed its tail and on waking applied this to his problem. It worked!

Nor is this an isolated incident. Otto Loewi, professor of pharmacology at the University of Graz, awoke one night with a brilliant idea and reached out for pencil and paper to jot down a few notes. Next morning he was aware on waking that he had had an inspiration through the night, but to his frustration could not decipher his notes. By bedtime he had been unable to recall anything. But during the night he again awoke with the same flash of insight - and this time carefully recorded it. "The next day he went to his laboratory and in one of the neatest, simplest and most definite experiments in the history of biology brought proof to the chemical mediation of nerve impulses." (Beveridge 1961, p.71.)[3]

13.4.3. Theory from Accident. 'Chance' (fortuitous circumstances) plays a considerable role in the history of scientific discovery. Perhaps the best known example being the discovery of penicillin by Fleming. Polanyi comments that: "Accident usually plays some part in discovery and its part may be predominant." (1973, p.120.) Obviously chance favours the prepared mind, and Beveridge contends that probably the majority of discoveries in biology and medicine lie in this category. Associated features being the infrequency of

3. Beveridge (1961) is a classic book on the diverse types of theory formation/discovery.

opportunities, the ability to grasp an opportunity when it makes itself available, and to note the clue and interpret it correctly.

Interestingly it was not a physicist but a physiologist – Luigi Galvani – who discovered current electricity. Having dissected a frog and left it on a table near an electrical machine, someone else touched the nerves of the leg with a scalpel and noted that this caused the leg muscles to contract. A third person noticed that the action was excited when there was a spark from the electrical machine. When Galvani's attention was drawn to this he investigated and followed it up to discover current electricity.

In 1822 the physicist Oersted at the end of a lecture happened to bring a wire, joined at its extremities to a voltaic cell, to a position above and parallel to a magnetic needle. At first he purposively held the wire perpendicular to the needle but nothing happened; then by 'chance' he held it horizontal and parallel. He was astonished to see the needle react. Reversing the current he found that the needle deviated in the opposite direction. So the path was opened for Faraday to invent the electric dynamo.

Another example is von Rontgen's discovery of X-rays. When he made this discovery he was experimenting with electrical discharges in high vacua and using barium platinocyanide with the object of detecting invisible rays – but had no thought of these rays being able to penetrate opaque materials. By 'chance' he noticed that barium platinocyanide left on the bench near his vacuum tube became fluorescent although separated from the tube by black paper. At least two other scientists were close to this discovery but failed to make the vital connections – for if Rontgen's apparatus had produced X-rays, then a number of other researchers must also have, for some time, been producing them. Curiously, Lord Kelvin greeted this discovery by claiming it to be an elaborate hoax.

13.4.4. Clarification of Terms. Confusion may exist in some branch of science and only be resolved in conjunction with a clarification of terms. The atomic theory of chemistry, established by Dalton in 1808 was generally accepted very quickly. Yet for nearly fifty years while it was widely applied it remained obscure. Thus it was something of a revelation to scientists when Cannizaro in 1858 distinguished precisely the three related conceptions of atomic weight, molecular weight, and equivalent weight – which prior to this had been used in an indeterminately interchangeable manner. Thus from confusion this aspect of chemistry passed into clarity and coherence.

13.4.5. Elegance and Beauty. [4] Elegance and beauty may on the surface seem far removed from the normal concept of scientific theory formation. Yet they are virtually universally accepted by philosophers of science as a valid and important criteria of theory formation and assessment (cf.15.4.3.). Polanyi writes that: "Nowhere is intellectual beauty so deeply felt and fastidiously appreciated in its various grades and qualities as in mathematics..." (1973, p.107.) In mathematics, the most objective of all sciences, the style of proof, its elegance, is often regarded as important to its merit as the truth of the theorem proved.

It was partly for aesthetic reasons that Louis de Broglie, in his doctoral thesis, introduced the concept of ascribing wave characteristics to ponderable particles. His examining professors were doubtful whether to accept this device, which lacked evidence and was purely for reasons of intellectual beauty, and wrote Einstein for advice. Einstein recognised the validity of the approach and de Broglie duly received his degree.

* * *

It is hoped that these illustrations, in their diversity, will indicate that historically, science reveals no single objective method of discovery.

13.5. ASPECTS OF METHOD

13.5.1. Preparation. No matter what field of theoretical work a person is engaged in they are dependent on preparation prior to actualising research. At one level, before any experiment or hypothesis can be pursued, there must be some form of immediate preparation; but even deeper and more significantly there is the preparation involved in long years of study and reading which makes them qualified in their field - training which will have conditioned their thinking to certain patterns. Preparation involves a selection of interest within a chosen discipline, and in the particular periodicals etc. which are read and studied regularly. Beveridge points out that at the frontiers of research this background

4. In a private survey I carried out only 3 out of 79 did not reject beauty as a characteristic of theory formation; and 4 out of the 79 alone retained elegance. Most were professionally qualified.

of training, while obviously necessary, can be a hindrance. Too much reading shuts the mind to a particular pattern of commitment and leaves the researcher closed to the possibilities before him. Reinforcing this suggestion is the fact that many great scientific breakthroughs have come from men new to a particular field. Crossing from one field of research seems to yield fruit, and here we can cite Galvani, Fermi, Pasteur and Dalton. Bessemer claimed that he made his crucial breakthrough to the cheap production of steel because he approached the problem with no fixed ideas which biased his mind. (Cf. Beveridge 1961, p.2.)

<u>13.5.2. Observation.</u> Scientific theories do not necessarily follow from direct investigation (cf. 13.4.1.). Often it is the unexpected factor or the prolonged incubation of disconnected ideas in the mind, quite apart from experimentation, that bears fruit. The incubation of clear thought, rather than haphazard experiment/observation is the pathway of science. But having said that it must be noted that science often proceeds by trial and error. The experimental facet is very much of the essence of science as it has developed. This marks it off from the Greek period and is one of the benefits of the Reformation mentality. Einstein claimed that "all knowledge of reality starts from experience and ends in it." (1973, p.270.) But this can only be agreed to by a Theist as long as the reservation concerning special revelation be held over against it as also dealing with true knowledge and reality. The claim holds in the sphere of general revelation with little difficulty as long as we include the experience of the selfhood. Nevertheless, and Einstein would be among the first to agree, an axiomatic basis of general principles from which specific deductions can be made also lies at the heart of science. These aspects - the free invention of the mind, the thought experiment, and personal commitment; and the empirical examination of theory - exist in creative tension (cf. 14.1.)

I challenge any reduction of methods in science to starting with observations alone, the collection of 'facts'. Observations are undoubtedly crucial, but at all times they are subject to the limitations of men. This not only means that they can be erroneous, misunderstood or warped because dressed-up for communication; but that in the beginning a selection of what to observe is involved. As Cohen and Nagel note, science is never satisfied with psychological certitude. "No single proposition dealing with matters of fact is beyond every significant doubt." (1961, p.394.)

Science is not objectively interested in all 'facts'. When Tycho Brahe noted the appearance of the new star in 1572 it was an observation of immense importance for the science of his day. It was crucial in undermining the Aristotelian framework of the crystalline spheres. On the other hand, when the noted physicist Friedrich Kohlrausch declared that he would be pleased to accurately determine the speed of water running in the gutter, he totally misjudged the nature of scientific value. Accuracy of observation has little to do with the value of that observation. Eddington's confirmation of Einstein's theory of the bending of light was not particularly precise - but it was significant. (Cf. Polanyi 1973, p.137.)

Even behind the objectivity of the most rigorous observations, it must be realised that selective laboratory manipulations are at work which exclude certain variables in favour of others; and that the scientist will, in general, select for testing a hypothesis of high probability. Both selection and observation which govern any experiment are personal acts. They therefore have subjective involvement. At each step the scientist decides to isolate this feature, to exclude another, and therefore all data is <u>a priori</u> theory laden. Neither must we forget that as well as the scientist being subject to human fallibility he is also subject to sin.

<u>13.5.3. Experiment.</u> There is the need to confirm 'facts' and theories for, although I reject absolute empirical objectivity, correspondence with external reality is necessary. In the final analysis no theory that is a flagrant breach of what can be observed or experimentally confirmed (in limits) can stand as an acceptable theory.

At the best of times experiments are never conclusive proof of anything but merely tentative verifications. Beveridge, as a practising scientist, notes that "all scientists know from experience how difficult it is to make an experiment come out correctly even when it is known how it ought to go." (1961, p.25.) In the realisation of this, the door is opened to the possibility of theories that go beyond the evidence, that do not equate with current data. Thus one commentator writing on Einstein noted that he "refused to let the 'facts' decide the matter." (Bernstein 1973, p.82.) Einstein could hold to a view despite anomalies in it and in the face of opposing theories that seemed to have better evidence. Science is shot through with confidence that is despite of, not because of, the evidence.

It should also be noted that apparently rigorous experiments can be quite mistaken and deceptive - such as Needham's famous flask experiment which appeared to prove spontaneous generation. Indeed it is features such as this that tend to lend support to the Popperian approach to science as a progression of falsification rather than by verification. Interestingly science is now of such a nature that no public verification of theories is really possible. At the frontiers of theory formation the likelihood is that only a very few are qualified to understand a theory and only they can test its veracity. They are trained people, with particular predilections that have been schooled into them, and this must raise serious philosophical and psychological questions against the concept of any consensus approval being final.

13.5.4. Failure. Approaching any given theory several areas of possible dissatisfaction are readily discernible. There is the immediate possibility of a failure to account for all the phenomenon which should be covered. There is a failure area concerning the power of prediction, aesthetic satisfaction, and generality. Failure is not, of course, uncommon to science though this seems often forgotten. The history of science reveals that failure predominates and that scientists spend long years pursuing illusive chimeras which never bear fruit.

Nevertheless theoretical failure, or experimental anomaly, is not valueless and the reaction to a specific experimental or observational anomaly need not be the rejection of the attendant theory. A contrary case might merely follow in the law being upheld and the anomaly noted (e.g. Newton with respect to tide and moon); or in the general retention of the law but recognising new limits (e.g. Boyle's law and its modification by van der Waal); or the postulation of some new ideal situation; or in the formation of some new generalisation to cover the old law and the anomaly. This latter resultant may involve some change of paradigm. But there is no simple process of methodological falsification.

13.6. THE RATIONALITY OF SCIENCE

It must not be thought from the above that scientific discovery pursues a haphazard course of guess, accident, failure and intuitive leap. Science is a rational activity where reason and experiment are bound together in creative harmony. One without the other creates a stultified science. But there must be no absolutizing of either for this leads to the classical failure of rationalism/ empiricism.

13.6.1. Analogy - plays an important part in scientific thought and is valuable in suggesting clues or hypotheses and in helping to understand phenomena and occurrences we cannot see. Despite its wide use it is often misleading and never proves anything. Often, however, a problem in one field (say mechanical) can be solved by setting up the analogue of the problem in another (say electrical).

13.6.2. Induction. Two main themes of reasoning are induction and deduction - the former going from 'facts' to theories, particulars to generalisations; and the latter the reverse. It seems to me that both play an important part in creative and routine science. In the creative formation of theories induction takes its place alongside the creative and intuitive guesses of scientists that transcend the bounds of the purely deductive approach from first principles. The problem of induction is that there are no uninterpreted facts and that often facts are confused with their interpretation.

The inductive ideal has been pursued by Bacon, Hume and Mill and possesses an intellectual attractiveness in the easy manner in which universal patterns are conceived out of generalisations from past experimental sequences. Despite this I feel that induction should be limited mainly to the psychology of science and that its value has been greatly overrated by writers expounding 'the' scientific method. However I would not wish to be as extreme as Popper when he says, equating 'naturalistic' with 'inductive' theories of science:

> "(sc. I) dispense with the principle of induction: not because such a principle is as a matter of fact never used in science, but because I think that it is not needed; that it does not help us; and that it even gives rise to inconsistencies.
>
> Thus I reject the naturalistic view. It is uncritical. Its upholders fail to notice that whenever they believe themselves to have discovered a fact, they have only proposed a convention. Hence the convention is liable to turn into a dogma. This criticism of the naturalistic view applies not only to its criterion of meaning, but also to its idea of science, and consequently to its idea of empirical method." (1972/b, p.53.)

While there is an element of truth in this it seems to me that induction can play a useful, if limited, role and that a philosophical basis for its validity can be derived from a Theistic epistemology. So I disagree with Popper and Einstein when they contend that logic is necessarily deductive, feeling that this would require an impossible degree of objectivity and that it is inconsistent with the historical existence of this method of reasoning. As science cannot be tied to logic, neither can logic be confined to deduction.

13.6.3. Deduction. The deductive procedure, possibly more than the inductive, can lead to unexpected conclusions. By means of the premisses assumed and rules of logic followed, conclusions at variance with what might be expected can be encountered. This is, as it were, the discovery procedure of deduction - there is also a confirmation procedure, or truth aspect, where deduction comes into its own. It is the deductive spirit that leads to the relating of systems of generalisations - though these generalisations may have been reached by other methods.

Consider the elementary laws of kinematics. Here we have a deductive system of symbols that is interpreted as the kinematic laws. Thus starting with ($v = u + at$) and ($s = ut + \frac{1}{2}at^2$) we can by the ordinary rules of algebra deduce another law which eliminates 't'. Hence ($v^2 - u^2 = 2as$). No new hypothesis is forthcoming, but various predictions can be made and various potential new models can be deployed which may lead eventually to new generalisations.

In the final analysis induction and deduction have an interwoven role in the models of scientific inquiry, and both are only utilised to their full potential when coupled to creative imagination. Often breakthroughs have come from men who were not tied to pursuing some rigorous logic, but who were capable of allowing their minds to interplay two conceptual frameworks. Logic has its place, and it is an important place, but it does not mean that total objectivity is ever possible. "The dispassionate intellect, the open mind, the unprejudiced observer, exist in an exact sense only in a sort of intellectualistic folk-lore;...." (Beveridge 1961, p.90.)

Whether induction or deduction is advocated, first principles must be established from which to work, from which conclusions can be derived. Einstein - a deductivist - writes:

"The theorist's method involves his using at his foundation general postulates or 'principles' from which he can deduce conclusions. His work thus falls into two parts. He must first discover his principles and then draw the conclusions which follow from them....The first of these tasks, namely, that of establishing the principles which are to serve as the starting point of his deduction, is of an entirely different nature. Here there is no method capable of being learned and systematically applied so that it leads to the goal. The scientist has to worm these general principles out of nature by perceiving in comprehensive complexes of empirical facts certain general features which permit of precise formulation." (1973 p.221.)

Einstein, of course, exemplifies the thought experiment in much of his theory formation. He typifies the extra-empirical aspect of modern science and the deductive spirit once these principles are established. But first principles need to be formulated in the beginning.

13.6.4. Hypothesis. It is of the nature of hypotheses that they should lead to new experiences or experiments as well as new observations - for both are conditioned by what is being sought. In pursuing hypotheses it follows that a persevering faith be found in the propounder of a theory. History reveals many examples of this spirit - Copernicus, Kepler, Newton, Faraday, etc. - which labours for years before producing the result it seeks. But such perseverence and commitment must never degenerate into blind dogmatism overriding all evidence which might count against anhypothesis. The caution of Popper that all good scientists should discard one good hypothesis each day before breakfast is a salutory reminder that science is littered by the wreckage of discarded ideas.

Cohen and Nagel suggest seven points in the relationship between hypotheses and scientific method (cf.1961, pp.392ff.). (a) There are no set rules for getting hypotheses; (b) hypotheses are required at every stage of any inquiry; (c) particular truths are not necessarily germane to the topic being examined; (d) the choice of hypothesis is unlimited; (e) it is convenient, especially in embryonic stages, to have different hypotheses to choose from; (f) the deductive elaboration of hypotheses is not the sole purpose of scientific method; and (g) no hypothesis which states a general proposition can be demonstrated as absolutely true by any method of scientific logic. Though having said all this they write in their conclusion: "Scientific method.....is the most assured technique man has yet devised for controlling the flux of things and establishing stable beliefs." (ibid p.391.) Such is the power of the mythology that there is a specific scientific method.

One problem can be noted. X-rays cannot be examined in the same way as directly accessible features of life. How are these rays to be distinguished from fast moving particles? Von Laue made the suggestion that crystals, if they were in fact lattices of regularly spaced molecules, would serve as diffraction gratings of the requisite fineness to defract the rays - a standard test of a wave. So he demonstrated defraction of X-rays. But this cannot be seen as a direct demonstration for it depended upon the acceptance of another model - the lattice model of crystals. "Indeed," writes Harré, "in X-ray crystallography the situation is almost reversed for the wave-model of X-rays is now taken for granted and the structure of crystals investigated by means of the diffraction patterns they form." (1967, p.153.)

13.7. STATISTICAL METHODS

Before passing to the attitudinal side of scientific methodology I note the rising influence of statistical methods, especially in the fields of mechanics as inaugurated by Clerk Maxwell in the last century. Thus a subject like thermodynamics is today taught from both the classical and statistical viewpoints, though the weight of practical application may still seem to favour the classical approach - which is not to say it is preferred. Except under very rare conditions of impact, collisions would be bound to alter the velocity of particular molecules. But in a steady-state, distribution of velocities from zero to infinity must follow some definite law. We can therefore describe a system by computing what portion of the molecules would be at each velocity. What seems a real weakness of this is that there is a theoretical possibility (probability), though very small, that when you put a kettle of water on to boil the water will freeze!

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CHAPTER 14

THE METHODOLOGY OF SCIENCE II : ATTITUDES

I now turn to a more personal angle - the subjective features of a scientist's character which are involved in his scientific activity such as honesty, integrity, enthusiasm, humility, single-mindedness, patience, judgement, curiosity, hope and joy. Not all of these immediately appear as relevant to scientific research.

14.1. APPARENT PARADOXES

14.1.1. Basic Commitment v. Systematic Doubt. In studying scientific methods it is well to bear in mind the reasons men have for entering scientific pursuits. Einstein contended that the motive was often nothing other than the desire to escape from the hopeless dreariness of life and the snares of our own desires (cf. 1973, p.225.). As well as these negative reasons he also cited the (creational) mandate (of God) for man to overcome the world, to rule and have dominion, to fashion simple and intelligible pictures of the universe. To this must be added simple curiosity, the desire for knowledge.

These reasons, and no doubt others, have led scientists to exhibit a commitment to their work, an obsessive driving force that makes them persevere no matter the hindrances (cf. Madame Curie). It has been maintained that obsession with a problem is the mainspring of all inventive power and the advice given to rise in the morning, eat, live and dream about a problem. This obsessive feature means that although the scientist is often portrayed as the totally honest and open-minded researcher willing to alter his views as the evidence dictates, this is not quite so:

> "Though the scientific enterprise may be open-ended, whatever this application of that phrase may mean, the individual scientist is very often not. Whether his work is predominantly theoretical or experimental, he usually seems to know, before his research project is even well under way, all but the most intimate details of the result which that project will achieve. If the result is quickly forthcoming, well and good. If not, he will struggle with his apparatus and with his equations until, if at all possible, they yield results which conform to the sort of pattern which he has forseen from the start." (Kuhn 1972, pp.80,81.)

Yet coupled with commitment is doubt, the acceptance of ignorance. Humility lies in the heart of all great scientists. Newton openly confessed that he did not pretend to know the cause of gravity;

Descartes made methodological doubt the key to his whole philosophical approach. Merton (1972, p.77.) suggests organised scepticism as both a methodologic and an institutional mandate; the idea of suspended judgement, the 'wait and see what the facts will reveal.'

14.1.2. Common-Sense v. Speculation. Turning from one paradox we come to another - common-sense and speculation. Einstein was guided by an aspiration to liberate science from the traditional common-sense assumptions concerning space and time. He was led to replace them with an openly artificial framework where the assumption of absolute rest was replaced by that of the absolute constant velocity of light.

> "Brushing aside the protest of common sense as the complaint of mere habit, he adopted a vision in which the electro-dynamics of moving bodies were set beautifully free from all the anomalies imposed on them by the traditional framework of absolute space and time." (Polanyi 1973, p.144.)

Yet while speculation is obviously a necessary ingredient of scientific research, or it will never get anywhere, it always needs to be held in creative tension with common-sense. Speculation about time loops into the past obviously infringe basic common-sense and the problems of me murdering my mother when she was only two are obvious.

14.1.3. Corroboration v. Openness. A third creative tension exists between an openness to new solutions which are often guessed without evidence, and the necessity of corroboration. The scientist is engaged in a search for corroboration of his speculations one way or another, either of their truth or falsity. But even if a solution is not met, or before it is reached, there is a firm conception of what it should be. It is widely reported that Gauss claimed; "I have had my solutions for a long time but I do not yet know how to arrive at them." (e.g. In Polanyi 1973, p.131.) Or as Polanyi puts it: "Scientists - that is, creative scientists - spend their lives in trying to guess right." (ibid p.143.)

If rigorous pursuit of a specific objective scientific method was the key to scientific breakthroughs, then it should logically follow that the experienced scientist should make all the new discoveries. But it often is the young researcher whose mind is untrammeled with long years of work, or the man coming from some other field, who makes vital breakthroughs. Dalton was not a chemist, nor even especially interested in that topic. He was a meteorologist interested in the physical problems of the absorption of gases by water, and of water by the atmosphere. Thus he approached chemistry with a different set of parameters and made his crucial contribution to that field.

14.1.4. Detachment v. Passion. Passion and detachment do not seem to mix very well in the popular concept of science, but the historical reality is different. After all it is people who must carry on the work of science. So A.M.Taylor can write:

> "The history of science shows us, again and again, great discoveries made by passionate adherence to ideas forged in the white heat of imagination. It shows us, slow construction, brick by patient brick, of a scientific edifice, often in complete disregard of apparently conflicting evidence. It shows us bold imaginative leaps made in the dark, in unjustified anticipation of success, only later to receive astonishing experimental confirmation. The three attributes of commitment, imagination and tenacity seem to be the distinguishing marks of greatness in a scientist." (1966, pp.4,5. my emphasis.)

It is interesting that scientists themselves clearly recognise this passionate involvement in their subject. Kepler could talk of the 'sacred fury' that drove him on through the long years of his quest for precision in his astronomical theories. (Cf. Polanyi 1973, p.7.) Nor is this some scientifically detached passion. Not only do dreams, conjectures and leaps of inspiration play important roles, but scientists become passionately involved. A good example is an incident between Pasteur and Guerin over the topic of smallpox vaccination. One day Pasteur had been criticising Jenner (who had made important contributions in this field) at the French Academy of Medicine, and provoked Guerin to certain sarcastic remarks. This in turn violently provoked Pasteur and the spectacle that followed can hardly be described as edifying or an example of disinterested scientific objectivity. The rather staid members of the Academy found themselves forced to physically separate two heated Frenchmen - one of whom was past eighty (Guerin) and the other (Pasteur) sixty and partially paralysed by a stroke. Guerin went as far as to later issue a challenge to duel, but Pasteur declined the invitation. One commentator writes of Pasteur, concerning another incident, that he was; "Passionately involved, as always, in the results of his work (he had little use for cold scientific detachment.)" (de Kopp 1972, p.74.)

Joy, ecstasy, passionate involvement - all part of being human, and all brought to science by those engaged in unravelling the secrets of God's creation. This emotional involvement is perfectly natural.

An extreme preoccupation with a problem imposes an emotional strain and the discovery of a solution which releases from that strain comes as a great emotional joy. Some have claimed that such emotion, while present, in no way affects the outcome of scientific research. But this appears to be a denial of history and what man is as man. (Cf. Beveridge 1961, p.144.)

Nevertheless the natural sciences, dealing as they do with the objective modes of being (arithemtical, spatial, kinematic, physical, biological and psychological) as opposed to the normative, possess a controlling degree of detachment. There is no idealism, no surrender to subjectivity (cf. 14.1.6.).

<u>14.1.5. Imagination/Intuition v. Experience.</u> What is the origin of a scientific theory? Debate has raged and it seems there is no simple answer. Theories come from intuitive leaps of the imagination, inspiration, induction and conjectures, as well as from more observational and experimental approaches. But theories which are unifying generalisations can never logically follow from our experiences of a few particular events. Normal research is bound by its paradigms to particular ways of looking at things and it often takes a flash of intuition to give birth to some new paradigm or theory.

Dewey suggested that productive thinking first becomes aware of a problem; that there then springs to mind a possible solution and only then does logic take over. This 'springing to mind' occurs all the time and is not a deliberate voluntary act. (Cf. Beveridge 1961, p.53.) It is something that happens to us rather than something we do, and it seems a strength of certain individuals to be more receptive to these flashes of insight. Some seem more capable of thinking in new categories and possessing an ability to discriminate between valid and nonsensical ideas. Lord Keynes attributed the pre-eminence of Newton to his well-developed 'muscles of intuition' (cf. Bernstein 1973, p.137.).

There would appear to be no simple connection between experiment/ experience and theory. Intuition and free creativity in the mind of the scientist is seen to frequently play a decisive role, and this spirit, this feeling of how the universe should be, plays a more important role in formulating the axiomatic structure than the results of any particular experiment. As Einstein remarked of the universal elementary laws from which we deduce our vast complexes of scientific theory - "There is no logical path to these laws; only intuition, resting on sympathetic understanding of experience." (1973, p.226.) I believe it is crucial that intuition be accepted, but would add that it must be seen, as Einstein notes, to relate responsibly to experience, even if not bound by it.

Poincaré (1914) tells how after a period of prolonged and intense mathematical work he went for a journey into the country and dismissed this work from his mind. Yet it was there the insight came that the transformations he had used to define Fuschian functions were identical to those of non-Euclidean geometry. On another occasion he relates how, baffled by a problem he gave it up and went to the seaside. One day out walking the crucial flash of insight came to his mind.

Beveridge recounts of Helmholtz telling how, after investigating a problem in all conceivable directions and getting nowhere, "happy ideas came unexpectedly without effort like an inspiration." (1961, p.69.) Indeed he found as a general rule that ideas did not come to him when he was tired or when working at his table - but often in the morning after a night's rest, or during the slow ascent of a hillside on a sunny day, ideas would flow in his mind. Intuition, inspiration and hunch are therefore seen as integral in the origination of theories, and this is not confined to a few eccentrics but is revealed in the lives of the great men of science, such as Newton, Dalton and Faraday.

Imagination is, of course, dangerous if left unfettered and I am not advocating blind obedience to every whim that enters the head. But these men were trained in science, were rigorous in thought, observation and experiment, and could therefore take the illusive hunch and translate it into the world of science and pursue it until it yielded up its secrets. Many ideas were wrong; but many led to crucial steps forward - and even failures could lead to discoveries at a later date. [1]

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1. A survey of scientists by Platt and Baker (the reference is, I think, 'The Relationship of the Scientific 'Hunch' Research' in the 'Journal of Chemical Education' 8 (1969), 1931) found that of answering scientists 33% reported frequent, 50% occasional, and 17% no assistance in their work from the phenomenon of intuition. 7% went as far as to claim that their intuitions were always correct! Though I would suggest care here: the correct tends to be remembered, the erroneous forgotten.

It seems safe to conclude that intuition does play a part in science and that it is especially fruitful when a person turns from intensive work to other activities. For intuitions a certain degree of emotional sensitivity would seem a requisite, as well as the need of contemplation and freedom from interruption. None of this obviates a foundation in the experiences and observations of life. The precise observation and the carefully planned and executed experiment still remain at the heart of scientific activity.

14.1.6. Objectivity v. Subjectivity. So far this chapter may seem to be lending itself to some subjectivistic understanding of scientific methodology and indeed the weight of illustrative material has been in that direction. This is a deliberate selection of material to highlight the subjective involvement in scientific activity. However science exhibits a greater degree of objectivity than the normative disciplines such as theology, ethics, economics, aesthetics etc.. The scientist is dealing with a real world and must eventually relate to external reality if he is to succeed (this is not to say that the normative disciplines don't do this also); he has an objective foundation in reality as opposed to a normative foundation in reality. Scientific laws and theories do not decisively coerce reality, but it seems to me that the patterns which the scientist uncovers may be a valid reflection of the order of creation, and the rationality that God has imparted to His creation. But any such objectivity is qualified in the methodology of science precisely in that that methodology incorporates a strong aesthetic function. And aesthetics is normative and not objective.

14.2. THE AESTHETIC ELEMENT

There is an undoubted aesthetic appeal in science for here is unfolded a comprehension of the world which is not obviously personal. But aesthetic appeal goes beyond mere formal attractiveness and comprehension, and is something that man imposes on his theories as a criteria for their formation. He cannot escape the power that intellectual beauty and refinement have to reveal the truths of his universe. The question must be faced as to why the laws of science should exhibit such harmony and beauty.

Sadly this aspect is neglected (as is much of the material in this and the preceeding chapter) in practical university science courses. The articulate content of science is successfully conveyed to students throughout the world, but all too often they are given no insight into the "unspecifiable art of scientific research." (Polanyi 1973, p.53.) [2] This has been ignored and they are left with vague notions of some objective scientific method as the key to research. But science does not stand in isolation from the sphere of aesthetics. There is a scientific taste which can be best described as a sense for beauty, or aesthetic sensibility. (Cf. Bernstein 1973, p.133.) In any given situation this may be reliable, or not, depending on the individual; one simply feels in his mind that a particular line is worth following, perhaps even without being able to articulate why. There is an apocryphal story about Einstein that well illustrates this. He was once shown a very powerful physical theory which accounted for all the known facts in a certain field. To the annoyance of the author, so the story goes, Einstein after glancing at a few pages handed it back with the remark that the theory could not be any good as it was not beautiful enough. (Cf. Harré 1967 p.131.) Beauty, then, is of considerable importance as a criteria for theory formation and acceptance, and few mathematicians would contest that one of the features at the heart of mathematics is its cold and austere intellectual beauty. A mathematician, like the painter and poet, creates patterns which conform to an aesthetic ideal, which fit together in harmonious relationship.

Some commentators are unhappy with this claiming that only scientific criticism should be allowed to determine the validity of a theory. But as I hope is becoming clear, this would necessitate an absolute objectivity that is neither possible nor desireable. We cannot avoid the fact that the aesthetic element is integral to theory formation and acceptance, and that a particular language is utilised by scientists concerning their theories and experiments. A language which sees the patterns that emerge, and the experiments themselves, as elegant, pretty, neat, beautiful, or as clumsy, ugly and dull.

<u>14.2.1. Elegance.</u> Experiments and theories may be termed elegant because they consist of few steps; steps which are uncomplicated; or utilise some ingenious device to render a conclusion. This term cannot be equated with simplicity for it goes beyond that description. To understand the appellation of 'elegance' we must turn to its root

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2. I can fully testify to this. On completion of my honours science course I had virtually no awareness of the history or philosophy of my subject, and probably adhered to 'the' scientific method.

meaning. It is derived from the Latin 'elegans', meaning chosen skillfully or carefully. Thus we call a proof elegant as well as simple when skill has been shown in choosing the simple proof. It is therefore the exercise of a skill as well as the simplicity of construction that leads to this form of aesthetic satisfaction.

<u>14.2.2. Simplicity.</u> When we are faced with two equally explanatory scientific theories how are we to choose between them? Is there a way to choose? Einstein replied:

> "I answer without hesitation that there is, in my opinion, a right way, and that we are capable of finding it. Our experience hitherto justifies us in believing that nature is the realisation of the simplest conceivable mathematical ideas." (1973, p.274.)

Of course simplicity is a relative term and it must not be thought that science should or could be reduced to the simplistic. Rather it is the difference between the complex and complications. Theories may be complex, but there is no need for them to be overburdened by unnecessary complications. As Polykarp Kusch was accustomed to telling his students: 'If it isn't simple, it isn't physics.' (In Barzun 1964, p.116.) Even from a mundanely practical aspect it is clear that everyday decisions are taken in the laboratories of the world on the basis of simplicity. (Science theses are shorter than most others!)

<u>14.2.2.1. Aspects of Simplicity.</u> The use of simplicity seems to me to have several related concepts - aesthetics of course, but also the economic and social. A theory may be considered simple because it contains few parts in its structure or because its structure is put together in the easiest manner - this without primary aesthetic reference. In both instances the word 'simple' is used in making judgements of description such that it is really the economy of parts and labour that is implied. Another aspect is the ease of understanding by others which simplicity induces - the social side.

<u>14.2.2.2. Criteria of Simplicity.</u> From a functional point of view several criteria of simplicity operate in selecting generalisations, which lead to arithmetical economy as well as aesthetic simplicity. There is the criterion of <u>integral numbers.</u> If for an experiment on Ohm's law we got the experimental result - $V^{1.01} = IR$, then we would be quite happy to express this as - $V = IR$. Another criterion is that of <u>best fit.</u> A series of experimental results could be

related by different lines on a graph. For instance a sine wave and a straight line can be drawn through a given set of points. But other things being equal the investigator will assume a straight line extrapolation (cf. 15.4.2; 15.4.3.). There are the criterions of the lowest power and the reduction of observables. The first impinges on the arithmetical sphere and the latter on the economy of variables. Thus experiment may yield, $aV^8/I^8 - bV^7/I^7 \ldots\ldots h = 0$. This would again be converted to the simpler $V = IR$ form.

It is often said by scientists that in any alternative, other things being equal, the simpler has a higher probability, that it stands a better chance of being confirmed. Einstein epitomised this concept when he wrote that:

> "....these fundamental concepts and postulates which cannot be further reduced logically from the essential part of a theory which reason cannot touch. It is the grand object of all theory to make these irreducible elements as simple and as few as possible, without having to renounce the adequate representation of any empirical content whatever." (1935, p.134.)

14.2.2.3. Nature 'Is' Simple. Simplicity seems corroborated by the simple patterns of nature and not merely as an aesthetic imposition by men. There is a strong correlation between simplicity and symmetry, and nature itself seems to tend to symmetry (which is aesthetic and economic). This is a result of the 'band' distribution of attractive forces. These forces occur in four basic bands ranging from the strong, short-range forces to the weak, long-range forces.

> "This natural non-random distribution of forces into bands must result in our finding a relatively simple behaviour of matter, and certainly no simple behaviour could be expected if there were a rather smooth, continuous distribution of forces." (Davies 1975, p.86.)

Symmetry is revealed, for example, in the construction of the snow-flake and other crystal structures. There is a general tendency to contraction within each band; therefore gravitation keeps the stars roughly spherical, liquids are pulled by inter-molecular forces into spherical drops, and matter is concentrated into apparently symmetrical atomic nuclei. Forces within the atomic nucleus are so powerful, and of such short-range that this explains the usual finding that the rate of radioactive decay is independent of all other features. Now and then there may be evidence of slight overlaps with the next band of forces, thus leading to slight deviations from the simple law - this occurs with beryllium 7 whose rate of radioactive decay changes by roughly 0.1% when its atoms are incorporated into certain chemical compounds. "The elegant simplicity of nature and of many scientific theories, noted by Poincaré....thus stems from the 'band' distribution of forces in nature." (ibid p.91.)

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It must be concluded that aesthetic factors are both inherent in nature and sought for by man. This must not be seen as preempting the empirical and analytical side of science but as standing in creative synthesis.

14.3. PERSONAL REQUISITES

Anyone engaged in scientific pursuits will obviously need an educated mind gained through long and rigorous training, and a degree of practical skill to use that knowledge. The one without the other is useless. But this necessary background can stiffle creativity by binding to a particular paradigm, and often the decisive break-throughs are dependent on additional attributes of personality and congruence of events. But whatever the case, some form of scientific apprenticeship has to be served before a person will be capable of the intuitive insights that characterise the great men of science. The Pascall's of this world who can manage with little or no training are exceedingly rare!

Davies (ibid p.19f.) relates three basic criteria for scientific creativity which have been arrived at after recent research. (a) It would appear that an I.Q. of 120 or more is necessary, implying good powers of reasoning and memory; (b) an ability to associate ideas, a creative imagination; and (c) certain personality characteristics are required such as the observation that many scientists who are acclaimed as successful are fairly dominant, and have the capacity to channel large amounts of energy into the effort in hand. But the problem of these features is that they do not appear to differentiate between the requirements for success in science and other aspects of life. There is therefore little peculiarly scientific about them.

Another feature which can be noted is the ethical requirements placed on all researchers. Science never stands in isolation from morality. This is true concerning specific areas of research - such as weaponry and genetics - but it also holds true that honesty in reading measurements and in reporting them is required. Integrity of memory and judgement are called upon in each person. At all times "a knowing, ethical, dependable, integrated, rational self is a necessary part of the scientific method." (Ramm 1971, p.40.)

It is in this connection that the ideal of scientific disinterestedness has received several recent setbacks. The 'New Scientist', in the wake of the exposure of Sir Cyril Burt's carelessly interpreted figures, sent out a questionnaire to examine the question of intentional bias in research.[3] A considerable number (about 200) of instances of intentional bias were thus collated which indicated that scientific research was not as disinterested as perhaps has been generally contended.[4] One significant result relates to the outcome:

> "What happened to the intentional biassers? In the vast majority of cases (80 per cent of total), the answer to question 9 was nothing. A qualification frequently included was the response 'promoted'. Dismissal occurred in 10 per cent of cases and reprimand in 3 per cent. Two per cent gave 'don't know', while 'investigation still in progress', 'funding withdrawn', 'denied a reference', 'demoted', and 'suicide' each occurred in less than 1 per cent of cases." (Roberts 1976, p.469.)

14.4. 'THE' SCIENTIFIC METHOD REVISITED

The idea of the scientific method is widespread and can be summarised in the following general statement. The whole-hearted acceptance of the scientific method is the only reliable way of reaching truths. Several features in such a statement need to be noted. It asserts that scientific method is the 'only way' to truths; that in fact results have become secondary to a commitment to the method; that we should accept this assertion of the 'only way' by faith, for we are not encouraged to question it; and lastly that truth has been reduced to 'truths', to bits of knowledge. This view consistently sees truths with no overall integration (cf. 12.5.). But as Coulson notes: "The relationship of truth to a pattern means that truth, including scientific truth, must ultimately be thought of as a whole, and not as 'a bit here and a bit there.'" (1971, p.61.)

This naive statement of scientific method epitomises a blind faith which I hope will be untenable in the light of the preceding discussion — although we must be aware that it is nevertheless widely adhered to. This prevalence is seen in the spread of the so-called scientific

3. Cf. New Scientist 2 Sept. 1976, p.481f; 11 Nov. 1976, p.330f; 25 Nov. 1976, p.466f.
4. A recent book by M.J.Mahoney (1976) examines the psychological imperatives on scientists and amasses evidence that everyone from Newton to Galileo doctored their data to fit their ends (theories).

method to other disciplines such as theology. Alan Richardson, for example, applied 'the' scientific method in the field of apologetics, claiming that induction was of the essence of this method. (Cf. 1963, p.40.) This spread seems to be due to an uncritical acceptance of the dogma of 19th century science; and while science has gone on beyond that stage other disciplines often have not noticed this.

Different concepts of science will inevitably lead to different views on the method involved, and one writer comments: [5]

> "There is .....the crucial problem of what is meant by the word science. For some this means that nothing can ultimately lay claim to the qualification scientific unless it is something statable in terms of quantitative formula. But for many this goes much too far. Seeing that in their science this is an unattainable ideal and wanting to qualify their work as scientific nevertheless, they state that the primary mark of all science is that it must be empirical. But this only intensifies the problem, for now the term empirical appears to share a number of conflicting meanings. Some say that this clearly excludes ethics, aesthetics and history from the sciences. Those engaged in such fields raise an angry protest. They say that anything will do, so long as it is testing hypotheses by impartial observation. But what is impartial observation? Is that observation by the senses? Can it only be direct or is indirect observation via instruments also possible? And how about experiment? Is that essential to testing hypotheses? If so, can anything scientific ever be said about specifically human behaviour." (Hart 1968, p.51.)

The only way out of this problem seems to be to assert that scientific method involves many facets with at root a theoretical examination of the subject matter of a discipline which is as unbiased as possible. I would accept this. But what exactly is it saying? I fail to see anything especially scientific about it for this has reduced scientific method to the level of any careful thought process. The only resolution would be to see science as scientia, which it is, but this thesis adopts the normal connotative meaning of science/ scientific as referring to the natural sciences. Therefore I would assert that <u>there is no distinctive scientific method capable of definition, but rather a diversity of processes that, singly or in conjunction, lead to scientific theories/discoveries.</u> Methods are used of analysis and synthesis, of deduction and induction, of founding and demonstration, of systematising and casuistry, of description, explanation, evaluation, definition - involving on the personal side hope and joy, patience and frustration, as well as aesthetic appreciation and endeavour.

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5. Cf. Hart (1977) for a brilliant analysis of the impassé of rationality today.

Further it is clear that no process of verification can actually establish truth for this is a question essentially related to that of knowledge and meaning (cf. 12.5; ch.21.) It would appear that truth as such is beyond verification, for truth:

> "....is a matter of the stand I take and of the direction in which I go in that fully integrated intimacy of experience called knowledge. Knowledge and truth, as the Christian unverifiably knows, are matters of the fear of Jehovah and of being rooted in Jesus Christ. This is where we must begin if we want to solve these problems. Begin! This means that we do not <u>first</u> have some concept or idea of what knowledge and truth are and <u>then</u> wonder what on earth these can have to do with the fear of Jehovah and the love of Jesus Christ. For if these ideas or conceptions were conceived from that origin, they probably have little to do with it."(Hart 1968, p.55.)

This assertion by a Christian professor of philosophy is amply borne out on the general philosophical front by scientists such as Einstein, Heisenberg and Godel. Mention has already been made of relativity and indeterimancy (cf. ch.8; 10.3.4; ch.27.). Godel's Incompleteness Theorem shows that while the rules of the predicate calculus are complete, the incompleteness theorem proves that within each theory, which includes 'Z' and is based on the predicate calculus, the decision problem (for the predicate calculus and the formulated formal theory in it) is unsolvable. Thus he presented two theorems: (a) if 'Z' is consistent, then there exists within 'Z' a statement such that neither the statement nor its negation is provable within 'Z'; (b) the consistency of 'Z' cannot be proven within 'Z'. Einstein's theory of relativity, Heisenberg's principle of uncertainty, and Godel's theorem of truth amply illustrate that in matters of theory there is always the theoretical possibility of error even when it seems practically excluded, for all three seem to indicate a general principle that the ideal of science to isolate material so that all determinative factors are under control is not only a theoretically unattainable ideal, but impossible in principle.

It must always be remembered it is 'I' who am asking questions, no matter what the theoretical discipline - an 'I' which cannot be examined by 'I'. It follows that all data is from the beginning theory laden; that there are no uninterpreted facts; and that there is no clear line between observation and theory. So, not only does the practice of science differ from the formal logical analysis of 'the' scientific method , but also despite protests of objectivity we find scientists coming to their work with many different presuppositions.

What, then, can be said of scientific method? In answer to this question Cohen and Nagel suggest that as a method it must be guided by the discovered 'facts', that these 'facts' cannot themselves be discovered without reflection; that knowledge cannot be equated with the brute immediacy of our sensations but that sensory experiences set the problem for knowledge. They go on to note that every inquiry needs selection which in turn requires some "hypothesis, preconception, prejudice, which guides research." (1961, p.392.) They conclude:

> "There is therefore no sharp line dividing facts from guesses or hypotheses. During any inquiry the status of a proposition may change from that of hypothesis to that of fact, or from that of fact to that of hypothesis. Every so-called fact, therefore, may be challenged for the evidence upon which it is asserted to be a fact, even though no such challenge is actually made." (ibid p.392.)

This makes their allegiance to 'the scientific method' in their conclusion even more remarkable (cf. 13.6.4.). In short there is no specific scientific method. This does not mean that specific methods will not appear at certain stages in science as characteristic -- for instance it would seem that chemistry has often found itself closely tied to methods of nomenclature (cf. Gillespie 1967, p.233.).

Nagel, expounding how there is no set of rules for discovery or invention, goes on to tell us that scientific method "is the persistent critique of arguments." (1974, p.13.) But this is to assert nothing distinctly scientific. It merely reiterates the basic approach of all abstractive thought. It seems to me that if we want to talk of 'the scientific method' then we must find something peculiarly scientific in that method. And this is exactly what seems to be lacking. There is however a methodological difference between theoretical thought and ordinary concrete awareness. This is the difference between abstractive and pre-abstractive thought. (Cf. 19.7.3; 21.1.4.)

It is consistent with the history of science that scientific method be seen as a shadowy entity. Scientists use any method that comes to hand from the whole range of theoretical thought, and are even aided by that which comes from without the processes of theoretical thought -- accident, guess. Science is not tied down by objective facts; indeed its conclusions inevitably go beyond the established facts.

It follows from this that attempts to change paradigms take on much more of an appeal to reorientate faith than a setting forth of some objective demonstration of the evidence which must be accepted. This is Kuhn's paradigm 'conversion'. While 'normal science' generally knows the finished outline from the start and will find ready acceptance for its deductions; frontier science will find hostility and resistance to the ideas it puts forward in as much as they do not belong to the current paradigm. So without entering into the veracity of Velikovsky's ideas we have there the reality of the scientific community carrying on a personal hostility towards him. But such was the problem that Galileo, Copernicus and a host of others faced. Even X-rays were ridiculed when first announced.

Science is not a linear progression under the auspices of some relentlessly applied method which ensures inevitable progress, but rather a crossword puzzle. In that puzzle, when a problem is solved it no longer presents a barrier, it closes a gap, changes the appearance of the rest of the puzzle (cf. Eddington 1930, p.352.). Not only is science not a linear progression, but history indicates a loss of certain knowledge and skills. So we have the pathetic attempt, with the aid of modern knowledge and technique, to reproduce one single violin of the quality that Stradivarius turned out as a matter of course.

The thrust I wish to make is to point out that once again we are driven back to the area of religico-philosophical commitment, to an area of faith. So we must be on guard against the claim that much of modern science stands beyond metaphysical questions. Science as well as theology rests at its centre on a religious view of life (cf. ch.20.). Science never determines value, meaning or purpose but rests on a belief in order, law and unity in the midst of diversity. The only alternative to this is chance and caprice. But whatever the modern viewpoint, the historical reality is that modern science rests on a heritage going back to the 16th century. This heritage which forms the base for science was set up by men who firmly believed in the Creator, and saw themselves as endeavouring to reveal the 'divine orderliness' (cf. ch.3.). It is necessary not to confuse a model for understanding the world with the world itself!

It seems to me quite wrong to see scientific methods as something that can open up the world, and then bring God in at the end as a kind of Christian benediction. For the Christian, and therefore I must argue to be true to reality, it is necessary for God to be worshipped at the outset. He must be there at the very start of all our thought, all our investigation, and He must remain central throughout even if not at the forefront of consciousness. There can be no antithesis between 'science' and 'religion' (man's life is religion), nor can they be separate realms — though the spheres of science and theology are different. It is God's world that the scientist seeks to explore; it is His truth that he seeks to unfold. This must mean that unless a true religion stands at the base of science, unless the individual scientist knows the reality of God, then something is going to be lacking in his vision. True insight and knowledge are excluded from those who would deny God. As Coulson puts it:

> "Science itself must be a religious activity.....I want to be able to look at science, its methods, its presuppositions, its basis, its splendid success and its austere discipline; and then I want to be able to say: Here is God revealing Himself for those with eyes to see." (1971, p.44f.)

Certainly we must not minimize that common grace (cf. 24.2.1.) allows the unbelieving scientist to make a valid contribution to science, but only the believer can understand the final significance of any theory within the framework of God's creation.

Science does not uniquely determine value, meaning or purpose; it does not explain origins. Thus we must accept the basic limitation of science and of any theory. As Godel has indicated no theory is itself capable of proving all that it contains. It follows that any absolutizing of that which is relative is to enter into philosophical meaninglessness as well as theological nonsense. (Cf Stoker 1973, pp. 144-152.) It is the paradox of science that so often the great and profound is simple and economic; and it is a faith of science and the methodologies of science that simple and economic patterns of description and explanation should be uncovered to reveal the complexity of our universe. Scientific activity is governed by man's rationality as that reason bows down before its Origin.

14.5. REVIEW

Scientific processes therefore contain the following elements which do not in any way define it as a methodology. There is testedness with experience and the exclusion of dogmatic authority; openness to fresh evidence by minds which are not closed nor prone to wild speculation; a principle of conservatism whereby we do not jump from the established corpus of theories unless required to do so; a mathematical base; a recognition that scientific method is merely to be defined as abstractive thought, tentative and never final; and an openness to intuitions. The process here advocated is that of (a) conjectures, speculations, inductions which will lead to hypotheses, guesses, from which (b) consequences are deduced, (c) observations made and (d) attempts to disprove the unity of consequences and observations. Scientific hypotheses gain credence, not merely by finding verification, but by repeatedly avoiding disproof.

In step (a) scientific creativity is required which is subject to no routine method but open to the imagination and intuition of the trained and fertile mind. There is therefore obviously a tension between detachment and involvement and any absolutizing of either leads to sterility. As fallen creatures before the Creator no man can have a pure intuitive insight, yet man is to be over creation, to discover and rule. Therefore God has implanted in man the right to induce, to dream, to conjecture and from this to build a science that brings creation into subjection and glory and honour and power to the Creator. But always there are limits on man. There is the limit of his finiteness which means that he can never establish by himself within creation a true universal; there is the limit that in science no one man can operate alone; that he can never be certain that he has all the pertinent data. But in essence all observations are preceded by hypotheses which are rooted in a non-inductive worldview. All things in a man's thought are governed ultimately by how he stands religiously before God.

As for the scientific method, I leave the closing words (even if somewhat extreme) to the physicist John Ziman.

> "We used to believe in an elixir called 'scientific method' which, if sipped in the right frame of mind, would permit us some glimpse into that ideal world named 'truth'. Alas, this comforting positivist doctrine is no longer tenable....
>
> Having lost the anchors of 'scientific method' and the 'principle of induction' we are adrift on that raft of interlocking, trussed up bundles of contradictions and misconceptions - the group of human minds constituting the contemporary scientific community." (1972.)

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CHAPTER 15

THE AXIOLOGY OF SCIENTIFIC THEORIES

15.0. INTRODUCTION

I now turn to the axiology, or evaluation, of scientific theories. When we think of experiences/theories it is obvious that they fall into different categories. A law like Boyle's, which describes certain relationships between pressure and volume, can be observed and measured directly; whereas the Second Law of Thermodynamics cannot be observed directly. Ordinary experience is of concrete things and events (cf. Eddington 1930, p.xvif.). Our concrete experiences of a man, or a table, is not cut up into separate experiences of some overall mathematical unity, aspects of physical mass, biological growth, aesthetic form and so on. Our experience of the man, or table, is integral and enkaptic (cf.21.4.4.). However in scientific thought we investigate first-order abstractions - physical, biological qualities and functions - and find that these enable us to derive second-order abstractions of the world which allow us to distinguish any type of quality from all other types. These second-order abstractions are 'hows' not 'whats'; they exist in some conceptual framework and their adoption is a decision in the arena of philosophy and faith. Any scientific discovery gives new knowledge concerning our universe and opens up a new vision concerning it. This vision, as Polanyi points out (cf. 1973, pp.3f, 142f.), is both more than and less than knowledge itself. It is less than knowledge for it is a guess; yet it is more for it is a foreknowledge of things yet unknown and perhaps as yet inconceivable. But this vision is the guide for the interpretation of all future experience until it is confirmed or overthrown.

Polanyi (1973) cites as criteria for the acceptability of theories the facets of certainty (accuracy); systematic relevance (*profundity*); and intrinsic interest. To these he adds his general discussion on the subjective element. Davies (1975) suggests as criteria - generality; simplicity; precision; testedness; and refutedness.[1] Popper (1972/a; 1972/b; 1973/b) suggests primarily the testability in a potential situation of refutedness, but also utilises concepts such

1. A.Tarski suggests explanatory power; simplicity; and known truth content - which seems to cover Davies' criteria in a similar way.

as empirical content; explanatory power with respect to previous data; simplicity; and verisimilitude. Einstein (1973) points to the general fit with facts, and to a quality of inner perfection. Perhaps one more criteria should be mentioned as many see it as of overriding importance – fruitfulness. The snag is that it can only be assessed in retrospect. As Hogben notes, advocating this as the sole criteria (the obvious one from the instrumental viewpoint):

> "Contemporary judgements upon the importance of new theories are ephemeral. The pre-eminent criterion of abiding achievements in the realm of theoretical science is their social fruitfulness, and this we can only recognise in retrospect." (1956, p.1079.)

But one wonders what the social fruitfulness of Copernicus or Kepler or even Einstein might have to do with the validity of their theories, and even with their acceptance by the scientific community?

Evidently, then, there is no consensus concerning the main attributes of a theory, or what criteria are relevant and should be used in determining the validity and acceptability of any given theory. To concentrate the discussion I shall focus on the positions of Barbour, Popper and Davies. But before turning to the attributes of theories a word is in order concerning social criteria.

15.1. SOCIAL CRITERIA

In our modern society scientific and technological research are governed by the money forthcoming from various bodies. The question therefore arises as to what criteria are utilised in deciding where and how to spend money. Weinberg suggests that there are internal criteria as to how well a particular branch of science is carried out, and external criteria which ask why a particular line should be pursued. (Cf. Rose & Rose 1971, p.213.) Concerning the internal aspects there are the related questions of the ripeness of any given field for scientific exploitation; and the competancy to do so. Concerning the external criteria there are involved questions of technological, social and scientific merit, the technological and social benefits that may accrue from a particular line of research. This view sees science as governed largely by political and pragmatic factors centred on the utilitarian side of science such that pure research becomes stifled.

15.2. I. G. BARBOUR (Cf. 17.1.)

Barbour reduces the criteria by which a theory may be evaluated to three areas - agreement with observations; the internal relationships between concepts; and the comprehensiveness it displays (cf. 1968/b, p.144f.).

15.2.1. Observational Fit - concerns the relation of a theory to the available data. A theory must cut across the observable world at some point if it is not to remain meaningless. Quite validly he notes that: "Empirical agreement is a crucial property of any acceptable theory." (ibid p.145.) Thus he argues that from the laws of planetary motion plus information concerning present positions, we can calculate future planetary events, which can in turn be checked with theory to provide verification or refutation.

15.2.2. Internal Relations.

15.2.2.1. Consistency - refers to a desired absence of logical contradictions. Logical consistency is a required, though not sufficient, condition for a statement to be identified with physical reality. It is perfectly feasible to make logically consistent statements that are manifestly false, or do not refer to reality. Apart from this principle of consistency (or non-contradiction) it is impossible to think or talk about the world.

15.2.2.2. Coherence - refers to the fact that a theory must satisfactorily fit into the larger body of scientific theories and laws; what Margenau calls the 'multiple connections' between concepts within a theory and with other theories accepted as valid. However I would question if this (or consistency) is purely an internal criteria. There are internal and external consistency and coherence.

15.2.2.3. Simplicity - according to Barbour:

> ".....signifies the smallest number of independent assumptions (for example, the Copernican theory was simpler than the Ptolemaic in requiring fewer assumptions which were ad hoc - that is, not derivable from the fundamental structure of the theory.)" (ibid p.145.)

He notes however that simplicity is wider than this and points to Cohen and Nagel's reference to 'an incalculable aesthetic element.' Thus Einstein was not bound by data or any apparently crucial experiment of his day (e.g. Michelson-Morley), but sought "rather for the symmetry of frames of reference in electromagnetism.....used only experimental facts that had been known for fifty years." (ibid p.145.)

15.2.3. Comprehensiveness. I find Barbour unclear at this point. His two aspects under this heading do not seem adequately distinguished.

15.2.3.1. Initial Generality. He sees under comprehensiveness the initial generality of a theory; its "ability to show the underlying unity in apparently diverse phenomena." (ibid p.146.) But this seems to involve aspects of coherence and consistency.

15.2.3.2. Fruitfulness. Secondly he considers fruitfulness or fertility: "the value of a theory for suggesting new hypotheses, laws, concepts, or experiments." (ibid p.146.) He relates this to Margenau's concept of 'extensibility' and Toulmin's concept of 'deployability', seeing the basic issue as being that of refinement or development of a theory. But while fertility of a theory may have important social, political or technological implications, I find it difficult to see what it has to do with criteria for determining the validity of theories. To emphasise this is to tend to instrumentalism (which Barbour rejects) for under fruitfulness we can regard as final, theories which are false from the outset.

15.2.4. Additional Features. In concluding his discussion Barbour makes three points. (a) The relationship of theory to data is not simple for in any single theory a whole network of ideas and concepts is bound up. So it is never possible to test a single theory in some crucial experiment. (b) It follows that no theory can ever be finally proven true. All that can be said is that it gets closer to the known data; that it displays better agreement and is more coherent and comprehensive than rival theories. But certainty is never achieved, and he cites the instance of the chemist Arrhenius receiving the Nobel prize for work in the electrolytic theory of dissociation, and the same prize going to Debye for showing the inadequacies of Arrhenius' theory. (c) Finally he notes that there is a wide variety of influences on the scientist for, after all, it is men who select and formulate theories. Personal judgement enters the estimation of data and the importance given to various aspects. Therefore he concludes that the criteria he has listed "may not yield any clear-cut conclusions." (ibid p.148.)

15.3. K. R. POPPER

At the outset it needs to be noted that Popper is not interested in words and their meanings, but in problems. He is not interested "in making the meanings of words 'precise', or in 'defining' or 'explicating' them." (1972/a, p.401.) This frees him from becoming bogged down in a linguistic debate and enables him to drive through to essential questions. Essential questions for Popper relate theories to truth. "I regard only statements or theories and the questions of their truth or falsity as important." (ibid p.402.) Popper assumes a "realist and objectivist point of view." (1972/b, p.111.) He aims at truth:

> "For our aim as scientists is to discover the truth about our problem; and we must look at our theories as serious attempts to find the truth. If they are not true, they may be, admittedly, important stepping stones towards the truth, instruments for further discoveries. But this does not mean that we can ever be content to look at them as being <u>nothing but</u> stepping stones, <u>nothing but</u> instruments; for this would involve giving up even the view that they are instruments of theoretical <u>discoveries</u>; it would commit us to looking upon them as mere instruments for some observational or pragmatic purpose." (1972/a, p.245.)

But it is an aim that can never be scientifically resolved. There is a distinction to be drawn between seeking truth, getting closer to truth, and actually finding it. (Cf. ibid pp.3-30.) It is a remnant of the essentialist (cf.11.1; 11.3.) approach that seeks to define words or concepts in a definite and precise manner; it is tied to the idea that we can prove or justify the truth of a theory. [2]

I have grouped the following discussion of Popper's position round the following - fallibility; relevance; content and probability; testedness; and verisimilitude. The Popperian approach suggests primarily the testability of a theory in a situation of potential refutedness, but also utilises concepts of empirical content, explanatory power with respect to previous data, simplicity and verisimilitude, and these I hope are adequately covered.

<u>15.3.1. Fallibility.</u> While scepticism and relativism are to be

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2. This approach fits the Dooyeweerdian approach that each mode of meaning has an irreducible and undefinable nucleus or kernel. However although we cannot define in an essentialist manner it is necessary that we make distinctions if problems are to be solved and confusions avoided. Back of this is the undeniable facts that whatever the theoretical activity engaged upon, man needs a point of view. If I am asked to record what I am now experiencing I shall be confused by the diverse possibilities of this ambiguous request. Am I to report that I am now typing; that I hear voices outside; a car drawing up; the constant ticking of a clock; the content of the voices I hear; or that these are extraneous noises and distract me from the task in hand? The list is endless, and even if the request to report could be carried out it would only lead to a collection of unrelated statements. Science needs a point of view and theoretical problems.

opposed as philosophical bases for approaching science or morals, there is nevertheless an element of truth in them. This kernel is the simple fact that there is no general criterion of truth (within the cosmos). While the choice between theories is not arbitrary, while there is objective truth, while there are ways of deciding that one theory is nearer to the truth than another; it remains that we do err in our choices, we make mistakes, we miss the truth, or fall short of it. We are fallible. Popper illustrates this with reference to the discovery of heavy water and heavy hyrogen - first separated by Urey in 1931 (cf. 1973/b, Vol.II p.374.). Before this nothing was more settled and definite in the field of chemistry than our knowledge of water and its constituents - H_2O. Water was actually used for the 'operational' definition of the gramme. After Urey's discovery it was seen that what was believed a chemically pure compound was in effect a *mixture* of chemically indistinguishable, but physically different, compounds - with various densities, boiling points, freezing points, despite the fact that previously water was used as a base to define all these points. We must conclude that science is fallible because science is a human activity. So there can be no absolute scientific certainty or authority.

15.3.2. Relevance. Science must endeavour to give systematic interpretation of phenomena and not merely accumulate unrelated descriptive generalisations. We therefore at all times seek for information that is interesting and relevant to the end for which we strive. So theories are subsumed under projected goals and exhibit a highly selective status within the range of possible theories. Popper comments: "we prefer an interesting, daring, and highly informative theory to a trivial one." (1972/a, p.217.)

15.3.3. Content.

15.3.3.1. Content and Probability. In an essay on 'Truth, Rationality, and the Growth of Scientific Knowledge' (ibid pp.215f.) Popper presents several theses, the first of which is that "we can know of a theory, even before it has been tested, that if it passes certain tests it will be better than some other theory." (ibid p.217.) This is based on the content of the theory and the potential satisfaction or progressiveness before testing. His study of content is based on the simple concept that the information of the conjunction 'ab' of any two statements 'a' and 'b' is always more than, or at least equal to that of any of its components. Thus writing 'Ct(a)' for the content of a statement 'a', and 'Ct(b)' for the content of 'b', and 'Ct(ab)' for the content of their conjunction, we have:

$$Ct(a) \leqslant Ct(ab) \geqslant Ct(b) \qquad .....(1)$$

which is in contrast to the corresponding law in the calculus of probability where the inequality signs of (1) are inverted:

$$p(a) \geqslant p(ab) \leqslant p(b) \qquad .....(2)$$

The two laws (1) and (2) together state that as the content increases so the probability decreases:

> ".....content increases with increasing improbability.....This trivial fact has the following inescapable consequences; if growth of knowledge means that we operate with theories of increasing content, it must also mean that we operate with theories of decreasing probability. Thus if our aim is the advancement or growth of knowledge, then a high probability cannot be our aim as well: these two aims are incompatible." (ibid p.218.)

Thus if content is of importance in our theories the above strikes a death blow at the idea that scientific theories aim at as high a probability as possible. This leads Popper to conclude that:

> ".....since a low probability means a high probability of being falsified, it follows that a high degree of falsifiability, or refutability, or testability, is one of the aims of science - in fact, precisely the same aim as a high informative content." (ibid p.219.)

Thus only a highly testable or improbable theory is worth testing. This is seen historically in that the progress of science has been to increasingly more general theories which have a logically lower probability factor. The more open a theory becomes to testing the more it is open to refutation and therefore improbability. The theories of Kepler and Galileo were united and superseded by Newton's theory which was more general and more testable. Similarly the theories of Fresnel and Faraday were united and superseded by Maxwell; while Newton and Maxwell were in turn superseded by Einstein. But severe tests equally may lead to refutation, and even where this is not achieved, confirmation may not be achieved either. Lavoisier's famous experiments which indicated that the volume of air in a closed space decreases while a candle burns, or that the weight of iron-filings increases, do not confirm the oxygen theory of combustion - but they do tend to refute the older phlogiston theory. Thus it would seem that science progresses from problem to problem of ever increasing depth and complexity while starting all the time from problems and not from observations, though observations may give rise to a problem.

<u>15.3.3.2. Basic Statements.</u> But to return to the question of empirical content — ECt. This appellation is given justifiably, according to Popper, to what he calls 'basic statements'. This is seen, he argues, from the fact that when the empirical contents — $ECt(t_1)$ and $ECt(t_2)$ — of two empirical theories 't_1' and 't_2' are related such that:

$$ECt(t_1) \leqslant ECt(t_2) \qquad .....(3)$$

holds, then the measures of their logical contents will also be related such that:

$$Ct(t_1) \leqslant Ct(t_2) \qquad (4)$$

also holds.

This is based on a class of statements which are assumed to have "<u>an unquestioned empirical character.</u>" (ibid p.386.) This is, of course, Popper endeavouring to establish a ground of non-metaphysical statements on which to build science. This must be questioned for Popper himself has to relax his 'unquestioned' empirical statements such that they too are up for question. Popper does in fact criticise the empiricist view of absolutely given perceptions or observations of data which can be built on as if on solid rock. All observations and perceptions are in effect themselves interpretations. Nevertheless we must establish some set of basic statements which are not called into question all the time. So he writes: "Every test of a theory, whether resulting in its corroboration or falsification, must stop at some basic statement or other which we <u>decide to accept.</u>" (1972/b, p.104.) If this is not done we become caught in an infinite regress. For Popper these basic statements must satisfy the following conditions: (a) given a universal statement with no initial conditions, no basic statement is deducible; (b) nevertheless, a universal statement and a basic statement can contradict one another. This is only feasible if we can derive a negation of a basic statement from the theory it contradicts. From this and (a) it results that a basic statement has a logical form such that its negation cannot also be a basic statement. "Basic statements are therefore...statements asserting that an observable event is occurring in a certain individual region of space and time." (ibid p.103.)

However experience never provides justification of a basic statement. "Experiences can motivate a decision, and hence an acceptance or rejection of a statement, but a basic statement cannot be justified by them - no more than by thumping the table." (ibid p.105.) This is related to the point already made that any observation is set within the matrix of some worldview, some category of selection and interest (cf. 12.5.2; 12.5.3.).

Hence Popper differs from the 'conventionalist' in asserting that statements decided by agreement are not universal but singular; and from the 'positivist' in asserting that basic statements are not verified by immediate experience but are rather, logically speaking, accepted by an act of choice. The conventionalist accepts universal statements governed by a principle of simplicity (aesthetic motives are crucial) but for Popper the prime concern is the severity of tests, though not the verification of tests as for the positivists (cf. ibid, p.109.). We cannot verify 'here is a glass of water' because 'glass' and 'water' are dispositional terms denoting physical bodies which exhibit law-like behaviour. So he concludes:

> "The empirical basis of objective science has nothing 'absolute' about it. Science does not rest upon solid bedrock. The bold structure of its theories rises, as it were, above a swamp. It is like a building erected on piles. The piles are driven down from above into the swamp, but not down to any natural or 'given' base; and if we stop driving the piles deeper, it is not because we have reached firm ground. We simply stop when we are satisifed that the piles are firm enough to carry the structure, at least for the time being." (ibid, p.111.)

And in a 1972 Addendum to this he adds:

> "(1) My term 'basis' has ironical overtones: it is a basis that is not firm. (2) I assume a realist and objectivist point of view: I try to replace perception as 'basis' by critical testing. (3) Our observational experiences are never beyond being tested; and they are impregnated with theories. (4) 'Basic statements' are 'test statements': they are, like all language, impregnated with theories." (ibid, p.111.)

But whence now the 'unquestioned empirical character'? (1972/a, p.386.)

It is necessary to bear in mind that the data of experience is always interpreted in the light of theories. Popper acknowledges the insight of Kant in pointing out that our perceiving of a thing occurs in a total situation or context. Indeed to argue that there must be some uninterpreted data, some ultimate material, does not take into account that the process of interpretation is in part physiological. Thus even for Popper, the idea of the existence of uninterpreted data is a theory and "not a fact of experience, and least of all an ultimate, or 'basic' fact." (ibid p.387.) So his basic statements are not statements of uninterpreted data but facts seen in the light of theories - "they are soaked in theory, as it were." (ibid p.387.)

<u>15.3.4. Testedness.</u> (Cf. ibid p.390.) As already noted the question of testedness occupies the centre of the stage for Popper. He concludes that the criterion of progress of knowledge is tied to the increase of its testability; and also its explanatory power with respect to evidence known and unknown. It will be remembered that the thesis he is presenting is that we can know of a theory, even before it has been tested, that if it passes certain tests, then it will be better than some other theory.

There are according to Popper certain requirements for getting nearer to the truth. (a) Any "new theory should proceed from some <u>simple, new, and powerful, unifying idea</u> about some connection or relation between hitherto unconnected things or facts or new 'theoretical entities'." (ibid p.241.) (b) Any new theory should be independently testable, not only explaining all the explicanda it was designed for, but also having new and testable consequences: it must yield predictions which have not so far been observed. This is necessary to enable fruitful explorations and advance. (c) Popper sees as a separate requirement that a good theory should pass some new and severe test. The number of tests carried out is, of course, irrelevant. The law of diminishing returns applies to repeated tests of the same nature as the collapse of the Newtonian world-picture amply indicates. But this third requirement is seen as necessary to the advance of science. As well as helping to eliminate ad hoc and trivial theories it is supported by the following arguments. Firstly if we have an independently testable theory, which happened to be true, then it would yield successful predictions which though not sufficient conditions for the truth of a theory are nevertheless necessary. Secondly if it is the aim to strengthen the verisimilitude of theories, then it is necessary to seek to reduce the falsity content <u>and</u> strengthen the truth content. So his third requirement is divided such that it is required of a good theory that it have successful predictions and that it is not refuted too soon.

<u>15.3.5. Verisimilitude.</u>

<u>15.3.5.1. What is Truth?</u> Popper's answer is that an "assertion,

proposition, statement or belief is true if, and only if, it corresponds to the facts." (1973/b, Vol.II p.369.) This, of course, leaves the problem as to what are the facts. It is necessary to see that knowing what truth means, or under what conditions a statement is termed true, is not the same as, and must be distinguished from, having a way of ascertaining whether a specific statement is true or false. Truth is wider than linguistical precision for Popper.[3] He also rejects criterion philosophies claiming that:

> "I believe that it is the demand for a <u>criterion of truth</u> which has made so many people feel that the question 'what is truth?' is unanswerable. But the absence of a criterion of truth does not render the notion of truth non-significant any more than the absence of a criterion of health renders the notion of health non-significant. A sick man may seek health even though he has no criterion for it. An erring man may seek truth even though he has no criterion for it." (ibid p.373.)

Here Popper fails to distinguish 'The Truth' from scientific truths. There may indeed be no general internal criterion as he and Tarski claim for truth, as long as by this is meant scientific formulations. But it cannot be extended to the concept of the Truth, and it is precisely here that Popper's acknowledgement and rejection of the role of revelation becomes decisive (1972/a, pp.27-29.)

Scientifically speaking a statement is true for Popper if it corresponds to the facts; it is nearer to the truth if it corresponds more closely than some other theory. A statement 'a' therefore gets closer to the truth than a statement 'b' is, and only if, its truth content increases without a corresponding increase in the falsity content. Thus Newton is nearer the truth than Kepler, though this does not make his theories 'true'.

<u>15.3.5.2. Truth and Content: Verisimilitude V. Probability.</u> Popper envisages three schools of philosophical approach. The first is that of the verificationists or justificationists who contend that, more or less, what cannot be supported by positive reasons is not worthy of belief or consideration. Then there are what he terms "the disappointed justificationists - the irrationalists and sceptics." (ibid p.288.) There are many here today. His third category, to

3. While I would point to the need to seek for the full orbed truth of the interwovenness of the whole of creation as meaningful only in the face of the Creator. It is feasible that a linguistic 'lie' may be 'true' in terms of its ethical, juridical or pistical components.

which he himself belongs, is that of the 'falsificationists' who concentrate on the question of evidence for or against in the arena of principle. (Ironically the resurrection and ascension, to name but two religious events, are in principle open to testing.) The thrust of this school is basically that we can give positive reasons which would justify the belief that a theory is true. The Theist would not assent to this as a criterion of truth, though it could be adhered to as contingent to scientific activity.

The task of science is the search for truth (true theories) though it is not just any truth but interesting or relevant truth that is sought. We seek truth that will have a high quotient of explanatory power, which logically implies that it is improbable truth (cf. 15.3.3.1.). In the search it is crucial to clearly distinguish between objective truth and subjective belief. There is an objective character to theories and Popper contends that his idea of verisimilitude, truthlikeness, or approximation to the truth, is an objective idea that "must be sharply distinguished from all such subjective ideas as degrees of belief or conviction, or persua s ion; or apparent or seeming truth, or plausibility, or of probability in any one of its subjective meanings." (ibid p.402.) [4]

Popper, however, wishes to use the original subjectivist term of verisimilitude (as in Cicero) "in the objectivist sense of 'like the truth'." (ibid p.404). The idea of verisimilitude is therefore the idea of a degree of truthlikeness, of better or worse correspondence to the truth; or of greater or less likeness or similarity to truth. This allows for degrees of truthlikeness, the idea of one theory (Newton) being nearer to the truth than another (Kepler) which in turn is nearer than another (Ptolemy). Popper carefully delineates this idea as a semantic one and not an epistemological or epistemic idea. (ibid p.234.)

In connection with verisimilitude the main problem is the realist's problem of truth - the correspondence of a theory to the facts, that is

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4. He notes the confusion of truthlikeness and probability is a traditional one, tracing its history through Homer, Xenophanes, and Parmenides. He sees the transition from the Platonic paradigm to the copy (the idea of the changing and becoming world made by the creator as a copy, likeness, whose original is the eternally unchanging Being that Is) as similar to Paremides' idea of the transition from the Way of Truth to the Way of Seeming. In Parmenides, he suggests that doxa (opinion) stands in direct contrast to aletheia (truth) and is associated disparagingly to mortals. (ibid p.399f.)

with reality, and here it is crucial to keep the objective concept of verisimilitude to the fore. It must be kept free from subjective ideas. Truth is finally allied to correspondence with reality and Popper helpfully summarises the relationships between the objective and subjective views of scientific knowledge in the following table (ibid p.227.)

Objective or logical or Ontological Theories	Subjective or Psychological or Epistemological Theories
truth as correspondence with the facts	truth as a property of our state of mind - or knowledge or belief
Objective probability (inherent in the situation, and testable by statistical tests)	Subjective probability (degree of rational belief based on our total knowledge)
Objective randomness (statistically testable)	lack of knowledge
equiprobability (physical or situational symmetry)	lack of knowledge

Popper thinks of the right-hand-side of this table as 'a lapse', a mistake, though he recognises a comparable table where the epistemological side is not based on error. Thus (ibid p.228.):

truth	conjecture
testability	empirical test
explanatory or predictive power	degree of corroboration (that is, report of the results of tests)
'verisimilitude'	

However, in our scientific activities we must not confuse a corroboration with absolute truth value, for corroboration can only occur with respect to some system of basic statements.

15.4. CRITERIA

The above discussion of the views of Barbour and Popper indicates the complexity of this area; that any formulation is highly subjective and dependent on what features are conceived to be important.

15.4.1. Testability. This will impinge on questions of refutedness and precision. Not only should a scientific theory be testable, but it should preferably be easily tested, within limits, by relatively few experiments. If millions of tests were generally necessary our scientific textbooks would be full of theories awaiting some degree of comprehensive testing. Thus simple theories which have been well tested successfully over some range of variables are looked for, and when found called 'laws' even though they may be broken when tested over greater ranges or in new situations. The number of confirming tests is irrelevant (cf. Newton's theories of motion). We can observe the sun on thousands of occasions without observing an eclipse, but it would be foolish to hold with high confidence that the path of the moon never lay between earth and sun.

It is therefore clear that the assumption of the adequacy of measurement can be misleading. This assumption can mean that given enough data we can eliminate an infinite number of hypotheses, leaving a finite number from which we can select, say by some method of simplicity ordering. But the use of purely empirical methods can only justify the usage of rational numbers in describing results, which fails to account for the occurrence of hypotheses integral to science with irrational numbers in their expression - 'π' and 'e' cannot be readily explained by observational data.

Similarly the assumption of non-statistical methods, outside of the statistical approaches, is misleading, for it assumes that a scientist drawing the best fitting curve has only one set of results to follow. This ignores the difficulty of repeated experiment by the same, or another, scientist which may present more than one set of data. Scientific activity seems more aligned to the testing of deductive inferences than to the induction of simple generalisations, such as given by the postulation of some best-fitting curve.

In any scientific measurement there is always a margin of error - as an engineering student I well remember working in the metrology laboratory and measuring the same object in different ways, with different tools, and obtaining many incompatible results (Cf. Gayler & Shotbolt 1968). Say we obtained a measurement of 5.5 with an experimental error of $\pm$ 0.1, then all subsequent measurements between 5.4 and 5.6 are in agreement! So we concluded that indefinitely many theoretical facts were consistent with a given set of experimental conditions. It would therefore seem clear that testing is not adequate by itself as a criteria of theory validity and that some compromise should be, and is, sought between simplicity and fit of data.

> "There is no need to seek rigour here; simple laws of mechanics are not taken to be disconfirmed by the experiments conducted in sophomore lab sections, where experience quickly confirms that few sophomore experimenters ever produce observational data that coincides with what the already expected theories of

physics predict." (Ackermann 1961, p.129.)

Experiment can disprove theory -- but so what?

<u>15.4.2. Safety: Strength: Simplicity.</u> How are we to choose between hypotheses of unequal strength? It is all very well to say that simplicity decides between theories of equal strength, but when they are unequal such a criteria is not so obviously valid. Caution would seem to indicate that we choose the weaker of two theories, the hypothesis that asserts the least, because it is less likely to fail. However, such an approach quickly degenerates into absurdity by settling on theories which tell us nothing -- their beam is too broad in terms of the searchlight analogy (cf.9.3.2.3.). Do we then turn to the strongest theory not falsified by the evidence but going beyond immediate evidences? The problem here is that for every hypothesis strong enough to go beyond the evidence there is an equally strong opposing hypothesis (cf. ibid p.129.) This combines to indicate that questions of safety and strength, though desirable qualities in some degree, are not competent criteria of choice between theories of unequal strength. Strength and safety only can be decisive between theories of equal simplicity, though they have non-decisive weight elsewhere.

This brings us back to the question of <u>simplicity</u>.(Cf.14.2.2.) This concept is central, to some degree, in nearly all the views I have come across. <u>But simplicity is, in this context, a paradoxically complicated phenomenon.</u> It cannot be reduced to mere brevity of expression; nor can it be a reduction of all factors to known predicates as this would inevitably exclude anything new; nor is it a question of an hypothesis alone, but the context of the theoretical structure.

Some (e.g. Popper) have endeavoured to formulate a workable rule of simplicity as a criteria for making inductive inferences. This sees simplicity ordering in terms of the number of parameters in the equations being seen as possible hypothesis with respect to some set of data. On this definition the expressions: $y = Ax$; $y = A.\sin x$; $y = A.\log(1 + x^2)$; are all equally simple. There is only one arbitrary parameter, 'A'. Similarly the following are more complex, having two arbitrary parameters: $y = A.x + B.x^2$; $y = A.\sin Bx$.

But there is a numerical simplicity and subjective intuition that envisages $y = A/x^2$ as simpler than $y = A/x^{1.9876}$; or $y = Ax$ as simpler than $y = A.\log(1 + 4.1x^2 + 0.21 \sin x)$, even though all have only one arbitrary parameter. It is an area where common sense has a role and we must beware of trying to reduce the sphere of aesthetic norms to the numerical or analytical. An apparent dilemma for simplicity ordering is that while 1/3 is earlier in one scale than 1/10, 0.1 is earlier than 0.3333.... in another.

The problem of simplicity can be further seen in the question of curve-fitting. In the normal model a satisfactory hypothesis is seen as a curve passing through, or near to, each point in a plane or graph. Obviously we can draw an infinite series of such curves, but science seeks the best? most useful? true formula? and the tradition has been that the simplest curve is the one that should be sought. But Ackermann objects that there is an implicit assumption of continuity here which limits the functions available in an a priori manner.

> "The difficulty is the following: If the results of experimentation are taken quite simply to be points in a plane, there does not appear to be any reason why the curve drawn through them should be continuous, except that most scientific laws to the present have, as a matter of fact, been continuous.... Polynomials, of course, are continuous curves, and attention to them exclusively seems to promise hope for an application of the intuitive notion of drawing the 'smoothest' curve through a set of points as a possible explication of inductive simplicity." (1961, p.127.)

Popper seems certainly to think in terms of polynomials to the exclusion of other functions; yet all scientific functions are not polynomials. But it seems easier to ignore functions such as $y = \sin x$; $y = \log x$; and $y = e^x$ when considering simplicity in terms of curve-fitting.

In summary: some balance must be maintained between fit and simplicity, while noting that in science: "The laws and theories for which there is indirect evidence often are 'more simple than' the alternative interpretations that are in closer agreement with observational evidence." (Losee 1972, p.161.) Simplicity will include economic as well as aesthetic elements related to symmetry, small integers and paucity of assumptions. However, as the logically simpler theory is not always the mathematically most simple, debate will continue and definition will be difficult. Nevertheless there is considerable agreement in practice as to what constitutes a simple theory. Davies (1975, p.80f.) lists the following as examples of simple theories involving few parameters and small, integral powers: Avogardo's Law; Inverse Square Law; Radioactive Decay Law; Constancy of Mass of Electron; Ohm's Law[5]; Hooke's Law; Gas Law etc..

15.4.3. Basic Criteria. The rest of this chapter will adopt the criteria advocated by Davies (1975) - generality, simplicity, precision, testedness and refutedness. What follows is a summary of his 1975.

Generality, 'g', or the unification of existing concepts within a theory is tied to the idea that the greater the unification then the more basic that theory is held to be. Simplicity, 's', has already been mentioned. Precision, 'p', involves the predictions that can be made. The following list of predictions are in decreasing order of precision: x = A; B > x > A; x > A; x is significant; some x may occur in the next few years. Testedness, 't', concerns the number and range of tests with respect to relevant experiential conditions. Refutedness, 'r', is a measure of the doubt experienced in 't' and refers to inconsistency with established data. Because a theory has been refuted does not mean it is necessarily wrong, or that it should be discarded. For Davies a hypothesis has approximate rating $g \leqslant 1.5$; $t < 2.5$: laws have ratings of $t > 4$; $g \geqslant 2$; $s \geqslant 3$.

15.5. CONFIDENCE ODDS (Davies 1975, ch.5.)

The confidence we have in a given theory is not simply a measure of its consistency with data, or tied to the idea that it has somehow been 'proved'. At the same time it is clear that we hold some theories with much more confidence than others, and this depends on several factors - the integration of 'g', 's', 'p', 't' and 'r'. If we think of the weather we may be moved in Britain to entertain a low confidence in predictions by experts on the basis of frequent refutations, yet in other parts of the world we might be impressed by the precision of predictions.

Confidence in theories is obviously related to external features related to testedness and refutedness. Therefore:

Confidence Odds on (C.O.O.) = f(t)/f(r) ....(1)

The factor 't' is in the numerator as high 't' with success will increase confidence; while 'r' is in the denominator as any 'r' will decrease confidence, though a little 'r' may be acceptable and not

5. (from p.305) Ohm's Law (the electrical current flowing through a body at constant temperature is proportional to the applied voltage) is accurate for metals and solutions of salts in water. However, certain oils show considerable deviations and predictions have been found not to hold. Ohmic theory has been modified to a more complicated theory in such conditions (though we still hold to Ohm's Law as true for most applications.)

overthrow the theory. Now, while we can, for example, calculate mathematically how much more probable Newton's theory became after the discovery of Uranus in the predicted place, we cannot mathematically calculate the probability of an initial theory. In equation (1) the weighting given 'r' is strong because any refutation will considerably weaken our confidence, while 't' is not so strongly weighted. We accept a little 'r' in practice as in the unexplained discrepancies in the motion of Uranus and Neptune.

Now include 's' in equation (1) such that it appears in the denominator - the higher the simplicity the less likely we are to have, or expect to have, accurate predictions. High simplicity can fall over into over-simplification. Similarly we include 'p' in the denominator as the narrower the beam (of searchlight) the less likely we are to pinpoint our object. If we reduce the precision required we can become more confident that prediction and experimental result will agree. Next we turn to generality. Theories which try to encompass a very wide range of concepts in one theory are of low confidence. It seems unlikely that history can be explained solely in economic terms, or that all human relationships are to be understood on the basis of sexual behaviour. Such sweeping generalisations no doubt lead to simple or elegant theories, but their ability to predict accurately is correspondingly impaired. Thus 'g' also comes into the equation in the denominator such that:

$$C.O.O. = f(t)/(f(g).f(s).f(p).f(r)) \quad \ldots\ldots\ldots(2)$$

It is necessary to sharpen (2) by combining it with:

> "....two speculative and rather subjective assessments, firstly of the form of the functions, and secondly of the numerical values to insert in these. As Bertrand Russell expressed it, 'logic and mathematics will have to be supplemented by certain extralogical principles.'" (Davies 1975, p.98.)

Davies gives to each of the attributes - g,s,p,t,r - an assigned value within the limits 0 to 5. This is, of course, highly subjective and not very precise. These values will be determined by our own world-view and how it interprets the world, our belief in consistency and our expectancy of regularity. Having determined these magnitudes Davies correlates the confidence odds by the formula:

$$C.O.O. = \frac{1000 \times 10^{2t}}{10^{g} \times 10^{s/2} \times 10^{p} \times 10^{4r}} \quad \ldots\ldots\ldots(3)$$

According to Davies this equation is an explicit version of equation (2) arrived at by trial and error. Trial and error gives an empirical evaluation by checking with respect to general belief. The equation:

> "....is purely empirical; rather similar to the Reynolds number in fluid flow....The strong dependence on the term r corresponds to Popper's heavy weighting of 'refutedness' against a theory. The relatively low dependence found for the simplicity (s/2) may be compared with finding that, because of the bands of forces in nature, there exist many simple theories which make fairly correct predictions, so that high simplicity s in a theory reduces only moderately in our confidence in it." (ibid p.164.)

While equation (3) gives a subjective probability in terms of the C.O.O. theory, it is not an expression of normal mathematical probability. Rather it covers the prior, subjective probability that we entertain concerning consistencies and regularities in nature and our beliefs in relation to this.

In relation to mathematical probability theory we can derive a comparison in the change of probability with the empirical equation (3), and we write the latter in a way applicable to a new test:

$$\text{C.O.O.} = \text{prior subjective probability} \times (10^{2\Delta t}/10^{4\Delta r}) \quad ....(4)$$

A logarithmic relation is needed to relate the credibility to the confidence odds - that is credibility between 0 and 1 to the figure of confidence. When C.O.O. is very high our degree of confidence tends to 1 and we consider a theory to be 'true'. The converse applies. Davies therefore proposes the empirical relation:

$$\text{Degree of Confidence} = 0.05 \log_{10} (\text{C.O.O.}) + 0.50 \quad .....(5)$$

and by substituting from equation (3):

$$\text{D.O.C.} = 0.50\ (2t - (g + s/2 + p + 4r)\ ) + 0.65 \quad ....(6)$$

15.6. INNER PERFECTION

This refers to intellectual elegance and aesthetic quality, as opposed to its utilitarian or fertility quality. It is less interested in any relationship to observations as in the confidence of a theory where testedness and refutedness are critical. The attribute of precision also enters in that between theories of equal simplicity the one which has the more definite claims is taken to be superior. Hence:

$$\text{Inner Perfection} = f(g).f(s).f(p) \quad ....(7)$$

In similar fashion to the C.O.O. the inner perfection is made explicit in the following equation:

$$\text{Scientific Inner Perfection Rating} = g^2.s.p /200 \qquad \ldots\ldots(8)$$

where the factor 200 is arbitrarily chosen to place the ratings on a scale from 0 to 1.

> "For Newton's theory, for relativity theory, and for atomic theory, for example, the 'inner perfection' will be high, because the unification of concepts, the simplicity and the precision of the predictions are all high for these theories. For astrological theories, on the other hand, the generality and precision are both low, so the 'inner perfection' of such theories is low." (ibid p.101.)

15.7. REVIEW

It is evident that scientific theories are evaluated with respect to internal and external factors. The truth of a theory is related not to reality in the first instance, but to the axiom system in which it is placed. Thus the shortest distance between two points is a straight line for a Euclidean system, and this is true within that axiomatic framework. But it is not necessarily true to reality. Scientific truth relates to questions concerning the consistency between theory and observation and experiment, taking into account the other diverse criteria that have been mentioned. But absolute truth is not determined by scientific means; science can neither prove nor disprove its existence by appealing to observation.

It is however incumbent on us to make this distinction consciously and not be blinded by any scientific claim to give absolute truth. Science deals with aspects or modes of being/meaning, and not with concrete reality in its enkaptical wholeness. In the arena of our existence and in the face of God we can, and do, have truth which has been revealed to us. This is Popper's stumbling block - that an ultimate source of knowledge necessitates revelation (cf. 1972/a pp.27-30.) - but it can be no obstacle to the Theist. God is there and has spoken in His works and words, therefore we can know true truth truly. He is there and He is not silent.

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POSTSCRIPT TO PART II

I hope Part II has indicated that there is no one perspective on science, no one conception of its character or method. Thus, despite the general incantation and appeal to 'the' scientific method, there is no such thing. This suggests that there is no neutral standpoint even in the most objective of sciences, that there is no ultimate objectivity that can be appealed to for there are always problems of perception, value, validity, axiom systems and worldviews. This implicitly points to the hidden foundations that this thesis is concerned to highlight. It seems to me that positivism is a non-starter today; that there is a metaphysical basis to all scientific thought and character. Out of my brief survey of the ontology, epistemology, methodology and axiology of science I would suggest that scientific thought roots back to a 'religious' motive in the 'heart' of man. There can be no autonomy of theoretical thought, only a pretended autonomy or assumed autonomy, for faith undergirds all thinking. In the final analysis science cannot be isolated from the coherence of life, and while theoretical abstractions from the coherence of reality are made it is only when theories are placed back into the concrete coherence of reality that they possess meaning and significance.

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PART III

THEOLOGICAL STANCES CONCERNING SCIENCE

PREFACE

In giving a flavour of attitudes vis a vis science I am aware of excluding thinkers from Roman Catholicism, Marxism and Eastern Mysticism. Even within Protestantism I am conscious of omitting several important contributions. The choice was to say very little about a considerable number of theological stances or to review a few in more detail. Having decided that the latter option would be more fruitful it meant the exclusion of the thought of men such as L. Gilkey (1959; 1968/b; 1970), A.Richardson (1963; 1968; 1974), W. Pannenberg (1976), E.Mascall (1956), M.Jeeves (1969), B.Ramm (1971), V.Polythress (1976) and many others.

After a generalised survey (ch.16) I concentrate in chapters 17 to 19 on four basic responses. Chapter 17 deals with I.G. Barbour and H.M. Morris and seeks to reflect diverse theological options. Barbour is a self-confessed Liberal and Process theologian; while Morris is a self-confessed Fundamentalist. Chapter 18 reviews briefly the thought of T.F. Torrance who seems to me to present a more balanced approach than the extremes of chapter 17. Chapter 19 concerns what is known as the 'Reformational Movement'. It is partly historical and is included for two reasons: it is the tradition within which I locate my own thought; and it provides a suitable bridge into Part IV.

One final word: if there appears to be undue concentration on conservative thought this is due to the fact that non-conservative sources are often guilty of rejecting this position out of hand without examination. This is intellectual dishonesty, not to mention academic snobbery, and I have sought to redress this situation. There is also, in defence of a conservative weighting, a wider corpus of literature dealing with the question of science 'and' religion/theology/Bible in the conservative position than in any other.

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CHAPTER 16

GENERAL SURVEY

16.0. Introductory Review.

So far we have looked at a little of the historical and philosophical foundations of scientific activity in faith and religion. I now wish to turn to the response made to the question of the relationship between science and religion. Several models of this relationship have been posited (cf. 9.4.). There is widespread allegiance to the warfare model, which though waning in the academic world is still a powerful popular myth. The divorce model is held by many today and is enhanced by the methodological approach of Bohr and/or linguistic analysis which seeks to divide science and religion into complementary realms/languages. The concept of symbiosis sees an enkaptical relationship between science and belief; that science itself is a religious quest which is of necessity based on certain pre-scientific assumptions.

A cursory glance at the relevant literature quickly reveals a great diversity of viewpoint from Liberal and Neo-Orthodox through typical Evangelical to Orthodox Reformed. Within these basic theological divisions, and cutting across them with apparent abandon, we find the influence of existentialism, linguistic analysis and other secular philosophies.

16.1. DIVORCE DUALISMS (cf. 9.4.2.)

16.1.1. Neo-Orthodoxy. Neo-Orthodoxy, existentialism and linguistic analysis all combine to separate science and religion into separate compartments such that by definition there can be no conflict (or compatibility for that matter) between the two. Neo-Orthodoxy emphasises a distinct revelation such that God is known only as revealed in Christ and acknowledged by faith. Karl Barth denied the very concept of a distinct general revelation and natural theology through his equation of revelation and reconciliation; any search for a re-creation which did not imply reconciliation being seen as cut off from grace. For Barth general revelation and natural theology were inseparably united, although Brunner did not go all the way with this (cf. Berkhouwer 1971, pp.21-61.) It seems to me that we can, and should, make a distinction between general revelation and natural theology in that God has revealed Himself through His creation and in making man in His own image; whereas natural theology is concerned with the attempt to arrive at God deductively from the evidences of creation as a result of autonomous rationality (cf. 5.2.)[1] I question Barth's claim that nature does not reveal God and would tentatively suggest that when he and others are faced by passages like the 'nature Psalms', or Romans chapter 1, their eisegesis dominates their exegesis. They claim that science deals with finite causal relations within the temporal processes while revelation deals with the meaning of personal existence and the status and significance of world processes. But it does not follow that science is of little consequence for theology, or that theology should more or less neglect that realm. Such a distinction forgets that it is man who engages in theology and science, and man is ever a creature of God called to bring all things into the service of the Kingdom. It forgets that at heart man is religiously directed for all of his living, and that therefore certain scientific statements can be incompatible with the Christian revelation. It is a tragedy of our century that so often theology has abandoned or retreated from whole tracts of man's living. It nearly seems a god-of-the-gaps mentality which has secured a final realm from the invasion of scientific discovery by erecting a field of investigation which is by definition exclusive of science. Yet, the Neo-Orthodox stress on the sovereignty, transcendence and purposefulness of God is a valid corrective to the Liberal immanentisation of God.

16.1.2. Secular Philosophies. Concomitant with the above, though having a more diverse appeal, are the secular philosophies of linguistic analysis and existentialism. In the Anglo-American culture Wittgenstein still exerts a powerful influence and much of modern philosophy follows the spiral of linguistic analysis. Different spheres have been attributed with their own distinct languages. So scientific language is seen as used for prediction and control, an instrument for yielding results; while religious language is seen as divorced from the world of observations, free from testing. Genesis is not true physically or historically, but we are to act as if the world were a creation for this gives us the appropriate attitude.

The other dominant philosophical influence which cuts across theological positions is existentialism. There are, of course, distinctive theistic and atheistic branches of existentialism (cf.

1. The crux of this is the relationship of nature and grace. For an excellent brief analysis see Veenhof (1978) -cf. Appendix A.

Sire 1977, ch.6.). Here we find a stress on religious involvement as against scientific objectivity - the distinction of I-Thou and I-It. Gilkey actually argues that religious questions are always existential! But this loses the ontological reality that stands prior to any existential reality.

16.2. SYMBIOTIC QUEST (cf. 9.4.3.)

Both Neo-Orthodoxy and existentialism seem to reduce nature to less than it really is; both seem caught in a dualistic motive of grace-nature such that for the former, nature merely takes on the status of an unredeemed backcloth against which the drama of redemption is played out, while the latter sees it as unredeemed and impersonal. The corrective to this is a unified motive which will see the totality of creation - spiritual and material - under the guiding and controlling hand of God. God made all things and considered that they were 'very good'; and that which He deems 'very good' should not be reduced by man to a backcloth for some higher sphere of his own categorisation. We therefore need to seek a unified worldview; we cannot rest content with a dichotomy in our existence which threatens to tear us apart.[2] The Sovereignty of God as creator, the doctrine of creatio-ex-nihilo, the continuing providence of God, and the idea of man's calling to labour as well as to worship, all seem to point up the need for a coherent interpretation of all of life and thought. J. D. Bettis writes:

> "The scientific enterprise of explaining becomes especially dangerous when it leads to schizophrenic dishonesty. Dishonesty results when this reductionism produces a cleavage within a person between the meaning of an event for him and its scientific meaning. Then one says, 'as a sociologist, I must say that we have here an example of social stratification, but as a religious person I must say that we have here evidence of the hand of God at work'. He has removed himself from the data into a compartmentalized schizophrenia." (1969, p.7.)

This search for a unified motive is not confined to any theological label. Both Harvey Cox (1968), a modern liberal radical, and E.Schuurman (1976), a reformed orthodox, note that technology and scientific development are possible only on biblical premisses. Cox claims that "the biblical faith (is) an indispensible precondition without which contemporary scientific technology is unthinkable." (1968,

2. See 'Nature and Grace in Bavinck' by Veenhof (1978) for the thesis that grace is neither hierarchically above, nor abolishes, nature, but affirms and restores it.

p.261.) It is the biblical view of creation and man's place in it that 'disenchanted' the world of nature, saw the worth of human work, and the possibility of change. Technology is a culturally formative power which helps to define and shape the world in which we live, as well as condition our perception of that world. But it is the biblical doctrine of creation out of nothing that frees the world from benign and demonic forces. Again the biblical faith clearly indicates the call to man to offer up all his labour to God, whether mental or physical. Man is a unity; not merely a soul in a body.

Yet technology and science are not ends in themselves within the biblical worldview. They can only be evaluated within a context. They are not self-sufficient. It is only the introverted and myopic technologist who drives on regardless of the consequences. It is not just any activity that is welcomed before God but solely that which is to His glory and purpose. It may be asked what science or technology glorifies God. In general I think we can say that certain activities clearly fulfil the cultural mandate, while others (such as representing man as a mere mechanism) are hostile to God's revelation. Within creation technological science aims to dominate in creative self-expression as man seeks to unfold his imageness of God, as he reflects on his divine origin and given humanity. (Cf. Schuurman 1977, pp.41-63.) Within fallen creation technology will also assume the aim of liberating man from servitude to matter. This warns of the need at all times to be aware that we deal not simply with creation, nor yet fallen creation, but with a creation that has fallen and now stands under the redemptive work of Jesus Christ.

> "Hence the alert Christian, alive to the full implications of the Christian vision of man, will look on technology with a restrained and carefully qualified optimism, seeing it as at once a great potential good for man by nature and yet in the hands of fallen and selfish human nature an almost equally potent instrument for evil." (W.N.Clarke S.J. 1968, p.292.)

16.3. THE WORLD COUNCIL OF CHURCHES

The W.C.C. project on 'Science and Faith' has pooled diverse theological opinions to make certain general recommendations. Much of what is said in their official organ - Anticipations - is reflective of this diverse background and similar to the cries of many in the secular arena (perhaps because often the two are one and the same). Nevertheless it is easy to concur with the need to beware the increasing invasion of the individual's privacy by modern technology and the increasing control of radio, television and major publications by a few powerful people; and in the call to choose simplicity of design coupled with ease of mainte nance and a general lowering of the overall impact of science on the environment. Much technology is undoubtedly destructive and the church is called to stand against this.[3]

The following are some of the problem areas listed in recent W.C.C. reports - automation; the loss of unskilled work (to which we could add the loss of skilled work); genetics; ecology; nuclear power; weaponry - nuclear, biological, chemical, subliminal; anthropology; and over-population.[4] Much of this concern locates in ecology. To take an example we can refer to food production. The current problem is that availability and distribution to areas of greatest need do not equate. Under the direction of economic market forces surpluses in the West are stored or dumped while others starve. In this sense technology calls mankind to greater responsibility. Man could not be blamed for famine on the other side of the globe when the tools of production and communication were not sufficient or efficient. But now.....!

At this point the basic weakness of the W.C.C. can be noted - namely in adopting a problem-centred approach and a utilitarian theology, while lacking any coherent or systematic philosophical critique or basis. Its voice is a confused one, reflecting conflicting philosophical and theological options. It is a theological coalition attempting to integrate secularism (cf. 16.6.) and theism.

Yet it would appear that technology has tended to an universal character which transcends ideological boundaries. It has become a complex system governing human living with an effectiveness that demands rigid subordination of men to time as determined by the rhythm of the machine-economy, which in turn is governed by the impersonal logic of production and consumption. Thus it leads to a loss of the intrinsic creational value of nature, of the aesthetic and mysterious dimensions, and returns full circle to a distortion of individual identity. But

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3. Cf. Anticipations, May 1974 No.17 to May 1976 No.22
4. To these I would add the dangerous motivating philosophies and side-effects such as depersonalisation, the impersonality of power, the utilitarian logic, the powers of science, technology and organisation (cf. ch.26.), the subordination of family life to the rhythm of machine-economy, the suppression of freedom by regimentation and state.

positively science has improved health, raised living standards and created more leisure. So as theologians respond to science and technology they must note the currently widespread response in the secular arena which is asking questions suppressed in the euphoric optimism of earlier generations. (But they must not simply echo these questions and tag on a religious veneer.)

Out of the loss of confidence in science has arisen within the scientific community a new sense of social responsibility, a wider recognition of the limits of science as a way of knowing and an interest in the new ethical concerns arising from man's increasing power over nature. Ethical problems include: the traditional ones of abortion and euthanasia; the question of experimentation on human foetuses, including the transplantation of ova fertilised outside the body; the artificial prolongation of life by mechanical means where formerly the patient would have died; organ transplants; sex control of offspring; genetic engineering - for example in the direct manipulation of genes to replace defective ones with the attendant danger of unintentional change; behavioural control via drugs, electric stimulii, psychosurgery and other methods of psychological modification of the personality.

Certainly this W.C.C. concern with ethical guidelines is to be welcomed. We can do many things, or shortly will be able to do so, but what we can do and what we should do are not synonymous. Before any ethical guide can be given a valid worldview must be established if we are not to be left to a vague attempt to muddle through. We need a worldview that will present a unified motive for thought and action, which will guard against all reductionism and materialism, and facilitate a profound study of the questions of meaning, truth and ultimate value. The W.C.C. reports often seem diffuse in this arena.

16.4. INADEQUATE RESPONSES

Several responses may be referred to as inadequate - but helpful in highlighting what will be for me a valid response.

16.4.1. Positivism. Despite the changes in the philosophy of science we find in many quarters a longing for good old-fashioned scientific positivism among theologians. For example D. Evans tells us that: "A scientific assertion should be logically neutral, comprehensible impersonally, and testable by observation." (1968, p.111.) To maintain credibility he then weakens this tight statement so that 'assertion' is used 'loosely', and 'objective assertion' means one whose truth or falsity is 'in principle' establishable by "maximal inter-subjective agreement." (ibid p.111.) Neutral means the opposite of self-involvement and scientific language should be neutral (cf. Part II.). This is necessary, he argues, because if it were not so scientists would disagree on the basis of personal commitments. But is this not precisely what does happen - scientists do disagree, and they do so on the basis of basic commitments to different paradigms? Later we find that Evans tells us that: "Scientists rightly seek a language which is as neutral as possible...." (ibid p.113.) But there is the world of difference between claiming neutrality and seeking to be 'as neutral as possible'. Indeed Evans himself notes that even scientific training involves attitudinal training such that no pure observation can be made. Despite this, he wishes to cling to his basic thesis of the neutrality, impersonality and observability of science in distinction to religion which is deemed to be self-involving, not logically neutral, and neither impersonally comprehensible nor testable.

But surely the root of Christian belief is in historical events, in a God who has acted in a real way, presenting a truth which is true whether or not the individual believes it. In fact Evans negates (he even notes he is doing so) the fact that religious faith, like scientific faith, is in principle testable against reality. Further problems arise because he equates religion with theology. All of life is religion (cf. 20.1.) although there is a specific abstractive discipline known as theology which has as its distinctive study God, as opposed to the distinctive areas of study of physics, biology, history etc. - which is not to say that theology is exclusive of physics, biology or history, and vice versa.

<u>16.4.2. Romanticism.</u> A second distortion is seen in the almost pagan reverence for nature that has sprung up in some quarters concomitant with the ecological movement. While it is certainly right to question the grievous misuse of nature today, nevertheless the natural world is there for man to dominate, cultivate, build up and preserve.

Another form of romanticism is the idea that scientific technology solves all ills given enough time - where the machine replaces Christ as Saviour. This is a naive approach that underestimates the depth and complexity of the political and social ramifications of technology and science today. Technology must never be seen as solving problems but simply as giving man a means to certain ends. Man himself must decide, under God, how he will work this out in culture.

16.4.3. Status-Quo. A third distortion is the longing to adopt the status-quo. Unfortunately the church all too often is seen as a resistor to change in society. Change is not necessarily good in itself, but neither is the status-quo.

16.4.4. The New Biblical Theology. T. Derr in 'Ecology and Human Liberation'(1973), a W.C.C. publication, looks at man's relation to nature and some of the views that have arisen in the face of the modern situation. He notes a new biblical theology that has arisen which seeks to reinterpret the Bible away from the older traditional understanding and make it say things hitherto unnoticed. To the command to love God and neighbour has now been added a third command - to love nature. Man is called to love his environment and deliver it from pollution; nature is seen to have inalienable rights. But it would seem that a proper understanding of creation and the cultural mandate (cf. 24.2.) would be a better approach here. Indeed the motive for this reinterpretation seems to come from outside the Bible altogether, being an example of the world dictating to the Word how it should be interpreted rather than allowing the Gospel to speak to the world. Nevertheless the motive of the revisionists to achieve relevance seems attractive. But we cannot re-do theology for every cultural whim that comes along, nor can we simply feed our Bibles through a specific 20th century grid and come up with what it has been saying all along. It is all very well to see the worth of nature in Luke 12;24a, but the point of the verse is only seen when we read it in its whole context: "Consider the ravens: they neither sow nor reap, they have neither storehouse nor barn, and yet God feeds them. Of how much more value are you than the birds!" (Lk. 12;24. RSV.)

Derr goes too far in his criticism by seeking to reduce nature as exclusively for the benefit of man; and viewing passages such as Romans 8;18-25 in a purely personalistic context.

16.4.5. The Remystification of Nature. (Cf.16.4.2.) Here the basic aim resides in hostility to our technological society and a quest for a return to nature as the realm of the sacred. Technology is seen as demonic, the work of man; nature is seen as sacred, the work of God. Here we can place such diverse movements as the counter-culture; romantics, like Walt Disney, who tend to pantheism; and deism. This view is more of a grass-roots reaction than a serious theological option. It is evidenced in the love to get away from it all, to get 'back to nature' - replete usually for such camping trips with the latest technological labour-saving devices! More seriously could be considered great religions, such as Taoism (but it is caught in quietism and social inactivity).

16.4.6. Process Theology. I.G. Barbour (cf. 17.1.) along with L.C. Birch (1968; 1975; 1976.) makes this a powerful force, especially in the W.C.C.. At its roots stands the figure of A.N. Whitehead who presented a theory of pan-psychism with an exceptionally limited concept of God. Reality was seen as a continuous flow of events such that a natural law was evinced to describe a relatively stable, recurring pattern in a process, but did not establish any infallible behaviour of some particular entity. 'Being' tended to lose out to the process of 'becoming'. This obviously has difficulties in squaring with the biblical view of God and creation, not to mention common-sense. It is difficult to see how pan-psychism applies to a stone - and the answer that the mental qualities are so low that they become insignificant is unconvincing. Again, all things are seen as having free choice against God - but what about stones? God is so limited as to be nearly unrecognisable as such. He is neither omnipotent or omniscient, so immanent in the world that He has lost all transcendent qualities. Some even see God as carrying out a series of experiments to try and get things 'right', thus moving the cosmos from a primitive to a higher evolutionary state.

It is very difficult to reconcile this with any form of traditional theology. The whole concept of biblical dessacralisation and historical reality is swept aside in a return to pan-psychism. Also swept aside is the uniqueness of man and the sovereignty of God who no longer can prevent evil even when he wants to. God cannot exist apart from the world which takes on an eternal dimension - Barbour attacks the concept of creatio-ex-nihilo - and becomes immanent within its processes. Thus all imagery such as 'Maker' and 'Potter' is excluded.

Not all process thinkers are of course as radical as this.

Birch sees man as spiritually unique while holding to his continuity with nature in biology, mind and culture; while Barbour tries to close the gap he recognises between process philosophy and Christian theology. It is difficult to worship the process God. Overall it would seem to me that there is a basic incompatibility between the philosophical premisses of process thought and the Christian faith as revealed in the threefold Word of God.

16.5. CONSERVATIVE-EVANGELICAL RESPONSES

Barbour confidently asserts that conservatives treat the Bible as a scientific textbook (cf. 1968/a, p.4.); then, having written them off, claims that "Scriptural literalism is no longer a major issue between science and religion." (ibid p.5.) The first idea is erroneous. Some evangelicals say categorically that the Bible is a scientific textbook; others state that it is not; while others claim that it is not a scientific textbook but makes assertive statements that are scientifically valid. The second statement of Barbour ignores a vast body of literature and academically qualified opinion which tries to harmonise Scripture and science. He may not agree with this, but it is unfair to pretend it is not there. In effect he writes off the Creation Research Society of the U.S.A., and the recently formed Newton Scientific Association in the U.K. - both of which have high academic standards; as well as individual scholars such as Morris (cf. 17.2.), Rushdoony, Heinze, Jones and many others. However to have listed these bodies and men immediately highlights an evangelical preoccupation with evolutionary controversy.

16.5.1. Evolution. The debate on evolution tends to produce more heat than light, and also, rather sadly, has tended to displace other important questions in the field of science and belief. Fundamentalism has failed to understand that Genesis is concerned to present a Creating God who is sovereign and transcendent. It has reduced Genesis to an evolutionary debate, reading 20th century problems into an ancient writing and assuming that it answers scientific questions because we are a scientific culture.

16.5.1.1. Anti-Evolution. Unfortunately the evangelical field is dominated in literature - though not in worldview (cf. 16.5.2.) - by a strong and vociferous anti-evolutionary campaign. This is readily discernible from evangelical booklists. This movement has produced a flood of booklets which serve as sources of ammunition for 'Gospel witness', as well as more reasoned and balanced statements.

Unfortunately the more reasoned works tend to get lost in the deluge of minor books, often written by non-scientists.

As an example take D.C.C. Watson's 'The Great Brain Robbery' (1975). This is essentially a bad precise, with additions, of Whitcomb and Morris' 'The Genesis Flood' (1975). Watson defends an age for the world of about 7,000 years as well as Ussher's chronology and dating of Adam. But deeper than this is the impossible philosophical tangle he seems to get into. In the early part of the book his thesis is that Christianity and science are incompatible; that science (conveniently reduced to evolution) is wrong and to be rejected by the believer because the Bible says things differently. But then, having undermined the authority of science he turns to it (in carbon dating) to prove the Bible correct! Over the piece one is left with the impression, because of the way in which everything is treated in absolutes, that unless one disbelieves in evolution (rather than a positive belief in creation) then one cannot be a true Christian - a rather unfortunate emphasis.

16.5.1.2. Pro-Evolution. However it would be wrong to think that this is all one-sided. R.J. Berry, Professor of Genetics at London University, recently produced a small book entitled 'Adam and the Ape' (1976) in which he attempted to expound Genesis 1 and 2 in context and at the same time describe current thought on biological evolution. Thus he presented a theistic evolutionism which contended that God placed His image in an already existing human-like animal. Another work in similar vein which defends theistic evolution is Victor Pearce's 'Who Was Adam?' (1976). He claims as his central theses that (a) the Adam of Genesis 2 was a New Stone Age man, the first to carry out the Neolithic cultural change to farming; while the man of Genesis 1 was Old Stone Age man but probably died out; (b) that the genetic code represents part of God's spoken word of creation, which allowed Him to recode cells when Adam was made; (c) that the Incarnation involved God's recoding of man to make 'the Word made flesh'. Other prominent evangelicals who would adopt a position of theistic evolution are Ramm and MacKay.

16.5.1.3. J.R. van de Fliert. Turning to more strictly defined Reformed Orthodox circles we find the same reflection of values and confusion vis a vis science. Many exhibit a flat rejection of evolution, but again there are those who, holding to the "belief in the Holy Scriptures as the reliable Word of God"(van de Fliert 1968, p.5.) maintain that the Bible does not give any outlines for historical geology. Van de Fliert, Professor of Geology at the Free University of Amsterdam, argues strongly against Whitcomb and Morris' 'The Genesis Flood' claiming that it is erroneous to think that belief in the Word of God can be based on, or controlled by, "so-called scientific reasoning". (ibid.)[5] When we treat the Bible as a scientific text "we lose the Bible as the reliable Word of God completely, because we then make its teaching dependent on the poor state of our scientific knowledge today....which will change tomorrow!" (ibid.) Belief in Scripture should not be tied to scientific thought and any attempt to unify our scientific geological thought of today with the account of the early chapters of Genesis "represents a colossal overestimation of science, an overestimation which is as great as that of those scientists who completely reject God as the Creator." (ibid.) God's creative act is not something that can ever be open to man's scientific control. Whitcomb and Morris, argues van de Fliert, imply that the Bible teaches the very principles, fundamentals and details of human science in general, and historical-geological science in particular.

> "This conception (sc. the equation of reliability to scientific reliability), however, implies inevitably that science and God's Revelation in the first chapters of the Bible are placed on the same (scientific) level..." (ibid, p.25.)

This, he feels, is tragic for it binds an eternal and unchanging Word to temporal and transient values. In effect the fundamentalist places a higher faith in science in that he requires scientific proof/harmony for his faith - something "far more dangerous for christian religion than the scientific development itself." (ibid, p.25.)

> "I ask myself what kind of a religion is christianity when scientific geological facts could prove or disprove the reliability of God's Revelation to man!" (ibid)

So instead of the human scientific enterprise being worked out within its proper sphere as indicated by Scripture, fundamentalism suggests 'a colossal overestimation of science.' He concludes that the Bible is outwith the reach of scientific control, it is no scientific book, and is therefore indifferent to the results of science.

While there is much of this that I agree with, it seems to me

5. Cf. W.White's response (1969) and van de Fliert's reply (1969) in this ongoing debate.

that van de Fliert falls into a grace-nature dualism, in this case in form of Scripture-science. If followed out in other areas - social and ethical for example - we would have an eternal revelation which was no earthly use to man for it would be silent concerning the existential affairs of man. Yet we do well to note that Christian faith is based on the special revelation of God in Christ and Scripture, and not in the general revelation of God as uncovered in part through science.

<u>16.5.2. Worldview Crisis</u> (cf. Sire 1977).

<u>16.5.2.1. The Russell Thesis.</u> The question of science and belief in the evangelical camp goes much deeper than the evolutionary debate. Indeed we must centre our attention on the current crisis of the evangelical worldview. Valuable work has been done in this area by Richard Russell in an unpublished postgraduate thesis entitled 'The Growing Crisis of the Evangelical Worldview and its Resolutions.' (1973) Russell himself is a philosopher-sociologist and characterises himself as a Dooyeweerdian charismatic! From his research he has established that evangelical males tend to read natural science subjects, while females read art subjects. In that men dominate 'The Universities and Colleges Christian Fellowship' (formerly I.V.F.), the arts are consequently played down as of restricted and secondary interest in life-involvement. But even in the evangelical, university trained scientist, the emphasis is not on true reflective knowledge but on a pervasive pragmatic utilitarianism. This is seen in the dualistic metaphysics which is embraced, accepting a clear division between life as an evangelical concerned to witness to the 'soul-saving-gospel' and life in the secular laboratory. Russell equates this separation with the grace-nature dichotomy by Ockham of quite discontinuous magnitudes, re-interpreted in terms of the personality-science motive of contemporary humanism. This results, for example in MacKay, in a division between Christianity (freedom) and mechanistic universe (determinism). (Cf. ibid p.73.)

Basically the policy pursued is how to reconcile Christian faith with secular science (inclusive of secular premisses). A typical example is Rhodes contribution to 'Christianity in a Mechanistic Universe' (note the title) where he argues that: "The realm of science is the realm of the whole universe, of all existence." (In MacKay 1965, p.35.) But in this scientific activity Christian faith plays no part for all scientists must seek to make the hypothesis 'God' superfluous in their discipline; when they think as scientist they must shut out their Christian faith. Note the repeated way MacKay will say, 'talking as a scientist I say....', but as a Christian I say further ..' (cf. 1974, p.38.) There is this other added dimension. Science is seen to give an objective view of reality, the view of the detached, uncommitted observer; faith gives a subjective view, the view of the participant. Thus faith and science are mutually exclusive but complementary approaches to reality. Each sphere is complete and self-sufficient and we must "beware of 'mixing our models', of using observer and participant language interchangeably." (Rhodes: In Mackay 1965, p.44.)

This shall be criticised under 16.5.2.2.

16.5.2.2. Complementarity. (This affects a much broader spectrum than the evangelical.) The idea of complementarity is derived from Bohr's view of the relation between particle and wave theories of light, although the discussion is often put in terms deriving from the later Wittgenstein who emphasises the irreducibility of languages.[6] With Bohr there seems no way to combine the two concepts - wave and particle - in one unified model. Early on the idea of the atom with its particle like electrons making up a mini-solar-system was picturable, but the atom of quantum mechanics is not picturable. The atom is not merely inaccessible to direct observation, not merely unrepresentable in the classical terms of space, time and causality as we know them, it is totally outwith sensory terms. Positivists see this as a pointer that all models should be discarded and theories treated as "calculational devices for correlating observations." (Barbour 1974, p.72.) Barbour sees it as a warning against literalism, yet not a call to reject models.

Bohr gave us the principle of complementarity: "A complete elucidation of one and the same object may require diverse points of view which defy a unique description." (1934, p.96.) He asserts in this connection that the more a particular experimental arrangement makes waves evident, then the less evident becomes particle behaviour.

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6. "In the Tractatus he had argued that all languages have a uniform logical structure, which does not necessarily show on the surface, but which can be disclosed by philosophical analysis... Early in his second period...he came round to the diametrically opposite view. The diversification of linguistic forms..actually reveals the deep structure of language...(which) has no common essence." (Pears 1975, pp.13,14.)

A second thesis concerns the interaction of subject and object - but spontaneous nuclear disintegrations have weakened this argument. Like Kant, Bohr shares a pessimistic view that the conceptual limitation of man prevents him from ever knowing the ding an sich. Crucially he also holds that the principle of complementarity can be extended to other phenomena such as mechanistic/organic models in biology, freewill/determinism in philosophy, love/holiness in theology.

MacKay (cf. 12.5.3.) picks up this theme and argues that two descriptions are complementary if they have a common referent; if the logical preconditions for their use are mutually exclusive; and if each model is in principle exhaustive within its framework. In this way he sees science and religion as complementary accounts of one complicated reality. Denis Alexander (1976, p.51f) puts it in terms of differing maps. A map serves to represent reality though it is not that reality, nor the cause of that reality. A map's 'goodness' depends on how closely it corresponds with the reality it seeks to represent. However maps are different and while one seeks to give geographical detail, another may seek to indicate ethnic divisions, population density etc.. These various maps are complementary descriptions of different facets of reality.

Now all this has a certain plausibility for all shades of theological opinion. But while I would defend the fact of disciplinary irreducibility, I would also maintain that there is a philosophical and religious stance which permeates all disciplines. That is: while theology may be complementary to physics, religion is not. There seems to me no philosophical or religious justification for an uncritical acceptance of a religion-science dichotomy.

It should be noted that in Bohr's construction, complementarity applies only when dealing with the same entity and the same logical type. It is for this reason that some reject Bohr's model of complementarity in favour of the Wittgensteinian concept of alternative languages with respect to science and religion. But whether the approach of Bohr or Wittgenstein is utilised it is generally done so within a dualistic motive of personality-science. In this way the structural and aspectual diversity of the unity of creation is lost sight of; the unified wholeness of creation split by dialectical ideals. All that is left is a realm of atomistically free individuals who are in opposition to a mechanistic universe.

16.5.3. Evangelical Motives in Science. The evangelical motive in writing about science and religion is generally apologetical -- to present either a platform on which to build the gospel (add grace to nature) or a defence of creationist views. Typically such writings attack the philosophy of naturalism (which is viewed as the material world of physics and biology coupled with the mental world of psychology as exhaustive reality) as the yardstick of reality. But a rigid dichotomy of science and faith is maintained.

16.5.3.1. R.E.D. Clark. The basic content of Clark's 'The Universe: Plan or Accident?' (1961 - cf. his 1967) seeks to investigate some 'odd points' as science advances our understanding of nature. The entropy law is seen as pointing to a "clock (that) must once have been wound up." (1961, p.225.) The solar system is seen as something different than would have been expected from a chance production; in chemistry "we found positive confirmation that the plan theory was correct" (ibid p.226); and the natural selection of biology is argued to be quite inadequate in that it would undercut teleology. From these and other diverse scientific areas, Clark amasses specific 'evidence' for which the only logical interpretation is seen to be design. Against the objection that science changes, he argues that the "best science of every age has led thinkers to the same or a very similar conclusion." (ibid p.228.) This particular work is therefore basically a book of natural theology - and while conceding that it does not reach the Christian God, nevertheless Clark at the end of the book moves, in a gigantic leap, from argumentation to evangelical proclamation.

16.5.3.2. D. Alexander. Of similar intent is a recent book by Alexander entitled 'Beyond Science' (1976) which was incidentally given a favourable review in 'New Scientist'. As the title indicates the purpose of the book is to use science to get 'beyond science' to the upper realm of grace, the arena of religious concern as a superaddition to the world of science. The book is, however, an excellent critique of many aspects of modern scientific activity dealing with the problems of genes, sex and society, chemistry on the brain, life and soul, determinism and freewill etc.. Alexander, who has worked on the biochemistry of nerve structures, clearly recognises that science is not neutral in that it is a human activity under the control of man. "No science is neutral, but some investigations are less neutral than others." (ibid p.43.) He attacks total theories which try to explain everything. Such theories arise from time to time which seem to explain so much that they receive wide popular appeal, but on examination they reveal that there are no facts which cannot be accommodated into their system. Such models can never be proved wrong, but while aesthetically pleasing should not be designated as scientific (cf. 14.2; 15.4.2.). Freud and Darwin stand outside true science for not providing crucial experiments in the realms of truth/falsity. In science there is no finality because our techniques of investigation are open-ended. Thus, like MacKay, he goes on to picture science and religion in a complementary manner. Utilising MacKay's illustration of the flashing light at sea (cf. 12.5.3.) he asserts that: "Meaning and mechanism are two aspects of one and the same reality." (ibid p. 53.) But this is a false division stemming from a failure to appreciate that the flashing light is qualified in meaning as to its communicative content, and not its optical properties. There is a mechanism involved at that level from the heart and mind of the sender and a resulting action (hopefully) in the receiver. It is logically improper to view the meaning on a human level and then reduce the mechanism to another sphere of meaning - for there is meaning at the physical level as well, but that is not the qualifying meaning in this case.

But the book is not concerned primarily with science and correct scientific procedures. Rather science is utilised to undermine materialistic and positivistic approaches to reality by pointing to the element of human involvement, the lack of any true autonomous reason. This is then used to point 'beyond' the lower realm of science to the 'important' and 'meaningful' questions concerning the God of creation and salvation. Thus, while much useful material is presented with respect to scientific concerns, this is primarily an evangelistic book.

<u>16.5.4. Evangelicals and Philosophy.</u> The Evangelical and Reformed intellectual climate may fairly be said to be dualistic. There is little attempt to unfold a particularly Christianly orientated philosophical stance, but rather a recognition of a higher realm of grace and a lower natural realm of the secular life of man. In practice reformed thought follows the two-realm theory of Luther. So Colin Brown (1969) in writing about 'philosophy and reformed theology' singles out as the philosophers of reformed thought - Barth,

van Til and Schaeffer. But they are theologians, not philosophers. Meanwhile professional philosophers such as Dooyeweerd, Vollenhoven, Hart and van Riessen are left out or confined to a footnote. (Cf ibid p.264f.) In fact Brown never even considers the possibility of a systematic Christian philosophical stance - religious involvement in philosophy being reduced to a philosophy of religion (after the form of linguistic analysis). In fact he claims there is no such thing as general philosophy today, but only philosophies of.... One reviewer suggests that he finishes up vacillating between pietism (grace) and intellectualism (nature) "without having uncovered the true relation between commitment to Jesus Christ and theoretical endeavour." (R. Russell 1973, p.81.)

But, as is obvious, the philosophy of religion today is largely dominated by views deriving from other philosophical areas - especially logic and epistemology. Thus Brown opens the door to the secularisation of all of life, including religion, for the lower realm of nature eats up the higher realm of grace. Theology becomes dependent on the efforts of liberal humanism rather than the revelation of God and the enlightening of His Spirit.

Similarly A. Holmes (a philosopher) in 'Christianity and Philosophy' (1964) fits the grace-nature model, following a pattern of grace and nature as in the new evangelicalism (cf. ibid pp. 6, 12, 26.). Here religion is one phase of human life, philosophy another and so on, each with different goals and methods. So religion, philosophy and science are merely complementary, and while biblical faith may exclude certain philosophic options (e.g. materialism) it gives no particular positive direction to theoretical thought. In a later work, Holmes (1969, p.29f.) moves over to favour a 'perspectival view' of philosophy which leans to some degree on Dooyeweerd. He pictures the possible options as the 'Ancilla Theologiae' which would subordinate philosophy to theology (Augustine and Aquinas); the 'Disengagement Theory' which preserves pure Christian belief and the autonomy of simplified philosophy (Occam and Luther); the 'Frustrated Reason Theory' which sees the best of philosophy as inadequate for faith (Pascal , Kierkegaard and Blondel); the 'Fulfilment Theory' which avoids the problems of disjunction and conjunction by picturing a dialectical process where Christianity is absorbed into the Absolute (Hegel and Tillich); and the 'Perspectival Theory' which emphasises the guiding influence of

Christian revelation and redemption over philosophical and scientific inquiry (Dooyeweerd and G. Clark).

16.6. SECULARISM

L. Gilkey writes that: "Secularism is.....the cultural Geist within which all forms of thought, including the theological, must operate if they are to be relevant and creative." (1968/a, p.192.) He argues that secularism is the pre-rational basis of all contemporary philosophy; that it exists on the level of presuppositions; that it is qualified by the concepts of naturalism, temporalism, relativism and autonomy; and that it has lost all sense of ultimacy. Now undoubtedly the all-pervasive influence of secularism is upon our culture, but that we should bow down to it as Gilkey suggests seems to me disastrous. Christianity must fight to assert that Theism should be the cultural Geist within which all must take place, and that as long as other forms of heart-directing faith exist, they must do so in antithesis with Theism. Theism cannot be subordinated under, or synthesised with, secularism. Christianity asserts in all ages that reality cannot be reduced to the material or temporal or relative, to which some spiritual dimension can be tagged on. It argues that there is a created cosmos with an eternal and temporal reference, with an absolute Origin and reference as well as a relative reference. Within this creation there is the law of God upon all men and absolute autonomy is therefore a negation of truth and reality.

Having said this it must be conceded that secularism has influenced all facets of modern society, including theology. At root secularism affects the heart of man, serving to motivate and direct his life and thought. Here we confront not certain specific unbiblical or anti-revelatory theses, but a Zeitgeist, the dogma of theoretical autonomy. But in reality no sphere of man's being can be divorced from service to God who is Lord of 'all' - including thought. In summing up the entire law Jesus pointed to the need to love God with all our mental activity as well as with all our heart, soul and strength. This must mean that whether it be the theoretical thoughts of a physicist or the theologians reflection on the Word, they should both properly be directed from and to God. If not, an idol is worshipped, for behind all man's thought and action lies the motivation of the heart. It is from thence the streams of life radiate. In the Fall man became ensnared in a lust for independence from his Creator, a desire to be something in himself. But the image cannot be independent of what it reflects; it cannot be anything itself, and this is why in a real way all true knowledge of reality and of self is vitally dependent upon a knowledge of God. The rebellious heart seeks the absolute within the relative, seeks to isolate an aspect of the creation and to raise it to the status of an independent being and consequently deify it. Yet an aspect of creation can have no meaning except in its universal connection with all other aspects and except in its basic and determinative relation to its divine source.

Secularism and Theism possess an antithetical confessional character of prior commitment. Christianity confesses a sovereign Creator, a fallen creation and a redemption accomplished through Jesus Christ. Secularism, though taking ideologically diverse forms, confesses the autonomy [7] of man's rationality and has a deep commitment to a principle of neutrality. A commitment that one Christian writer sees as "a colossal prejudice." (van Dyk undated, p.2.)

In a real sense man's life is religion, in the sense of his total service to God or to an idol. Undoubtedly Christianity became a personal, private religion confined to church walls, private home life, missionary endeavour, morals and devotions, and not to man's work qua work, whether mental or manual. But religion is not shut up to some special temporal realm such as the worshipping cultus. It is the basic motive of the heart of man that constitutes his religious foundation. As the basic motive came under the influence of secularisation, so also has science come under the same influence such that "....science, secularised and isolated, has become a satanic power, an idol which dominates all of culture." (Dooyeweerd 1954, p.1.)

A clear statement of the antithesis has been blurred down through the centuries by the dualistic concept of nature-grace. Despite the attempt of Aquinas to synthesise the two they quickly broke down into an opposing and mutually exclusive relationship under the impetus of Ockhamistic and Averroistic nominalism. Science was relegated to the sphere of natural reason with serious implications for the

7. I am using 'autonomy' in the following sense, accepting that there are certain 'limited' autonomies (e.g. in axiomatic systems): When a man believes himself to be autonomous he believes that he is law unto himself, that he is free from any law except that which he puts on himself; he believes himself to be self-determining and self-sufficient in his theoretical thought.

sovereignty of God, the doctrine of common grace and the nature of man. Despite a renewed vision of these facets in the Reformation under Calvin the insight of a unified motive of creation, fall and redemption was soon overcome by synthesis motives. Melancthon's educational reforms had a humanistic philological spirit which led to a new scholasticism; Beza restored Aristotle to favour and once again the church went to Jerusalem for faith and Athens for wisdom.

So the door was opened to secularisation which proceeded apace under the influence of modern humanism which claimed that it was merely the logical outworking of science itself. But:

> "There has never existed a science that was not founded on presuppositions of a religious nature, nor will one ever exist. That is to say in effect that every science presupposes a certain theoretical view of reality which involves an idea of the mutual relationships which exist between its various aspects, and that this idea, on its own part, is intrinsically dominated by a central religious motive of thought." (Dooyeweerd 1954, p.11.)

In the field of science and technology the spirit of secularism is at one and the same time victorious and confronted with a growing crisis. This is clearly seen in a work such as Toffler's 'Future Shock' (1973) where he oscillates between technological optimism and pessimism (cf. pp.292-3, 326, 403, 425, 439, 440. - cf S.B.Barnes 1972, p.278.) Again there are those who appeal to science as a neutral arena where the facts prevail, where objectivity is the watchword (all shades of positivism, technologism); while on the other hand we have the views of men like Polanyi, Kuhn and Popper who contend that there is more involved than merely the right application of some scientific method which leads to pre-determined results constrained by fact. These three thinkers have made a trenchant attack on empiricism and the idea of neutral observations which construe such an important part of secularism.

There is a dangerous scientific elitism, coupled to a self-gagging religious divorce of science and religion, which threatens to subsume all scientific thought under secular thought. I. Asimov and others contend for the future of mankind to be guided by the scientific community. Paul Ehrlich and B.F. Skinner also affirm this elitist concept of science - a science which is viewed as the high priest and saviour of mankind.

Secularism stands opposed to Theism. Theistic thought must seek to speak to the whole of life and thought, not to retreat or to adopt the ways of the spirit of secularism. It must seek to expose the totality of the system where all in the global village from war to education is under the dominating spirit of secularism, and present a radical Christian alternative. An alternative which is not just a personal, private retreat, or some added dimension, but as something which offers radical renewal and reconstruction for a fallen world. For what secularism omits is that the cosmos is <u>created</u> and <u>fallen</u> and <u>redeemed</u> now and not yet - the Kingdom is here and still to come. As well as a clear proclamation of this into our secular culture we are needing to point up the latent hypocrisy of the system. An hypocrisy enjoined from the discarding of any Christian debt with respect to the positive impetus to science, and from the increasing gap between principles and practices.

In the final analysis the tragedy of secularism is that it leads to the alienation and dehumanisation of man. This follows of necessity from its premisses of a closed universe and autonomous rationality which construes man as less than he is, making him to drift on the ocean of uncreatedness cut off from his source and goal. Ironically having set out on the path of secularism whereby God is dead or irrelevant, God does in effect become as such. Man reflects the idol which he chooses to follow, he appears to be autonomous, to be secular man - but this is an illusive delusion far removed from ultimate reality. But then ultimate concerns are of no interest in a closed universe. Thus he is caught in the absurdity of searching for answers where there are no answers.

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CHAPTER 17

TWO EXTREMES : LIBERAL AND FUNDAMENTAL

17.1. Ian G. BARBOUR (Cf. 15.2; 16.4.6.)

17.1.1. Issues In Science And Religion (cf. Barbour 1968/b.). In this work, one of two books by Barbour that I shall look at, he sets out to examine the methods of inquiry in science and religion; the relationship of man with nature; and God with nature. He suggests that today most writers see science and religion as deeply contrasting enterprises (under the influence of linguistic analysis and existentialism). While Barbour has reservations about the concept of complementary languages he is prepared to utilise it as a "first approximation" (ibid p.4.) of the relation between science and religion. Indeed his argument seems to rest fairly heavily on this idea. But he goes on to argue that we cannot rest content with a total dichotomy and suggests several parallels in methods and models -- the similarity of the interaction of experience and interpretation; the utilisation of analogies and models to express deeper concepts; and the importance of an authoritative community.

> "Personal involvement in science and in religion differ in degree, but there is no absolute dichotomy of 'objectivity' versus 'subjectivity', since the knower makes an important contribution to all knowledge." (ibid p.4.)

Hence we should seek an "integrated worldview" (ibid p.4.). This even follows from independent complementary views, for these must be views of the one reality. This takes us into broader metaphysical realms and a certain ambivalence in Barbour's thought emerges.

> "To be sure, religion must never be identified too closely with a metaphysical system or forced to fit into a neat and final synthesis that claims to encompass all reality. Scientists, for their part, legitimately resist any imposition of alien metaphysical systems imported from outside their own work. But both scientist and theologian inevitably use metaphysical categories whether they intend to or not; and each can contribute to tent ative attempts at a coherent view of reality, without any violation of his own integrity." (ibid p.5.)

In this statement we appear to find a clash of concept between the first two sentances and the third; between endeavouring to keep metaphysics at arms length and acknowledging that it is bound up with both religious and scientific activity. It would seem better to accept the full implications of metaphysics; to appreciate the presuppositional importance of them for both scientist and theologian.

Having studied methods and worldviews, Barbour defends the importance of a theology of nature. In much of modern theology 'providence' refers to God's acting in history and says little or nothing about His acting in and through nature. This is wrong. Barbour does not advocate a new natural theology, but a theology *of* nature. So he re-examines God's relation to the world where, in place of the Newtonian world, a dynamic, growing, evolving universe is pictured. Continuing creation is embraced as of the essence of the biblical picture - not creatio-ex-nihilo - and as consistent with an adapted form of Whiteheadian Process Philosophy. [1]

With respect to man's relation to nature, Barbour attacks any reductionistic view which assumes that behaviour can be exhaustively determined by the laws governing only a component part. Rather, complementary languages become useful for acknowledging the distinct characteristics of man and science without falling into a dualism. Thus mind and brain are not two entities; purpose and mechanism do not exclude each other; freewill and determinism are merely the differences of participant and spectator language. [2] "In general, 'either/or' dichotomies turn out to be not mutually exclusive competitors but alternative types of analysis useful in differing contexts." (ibid p.7.) On this basis he seeks a unitary view of man which will recognise levels of complexity. Man is not a body-soul dualism as this fails to appreciate the essential inner unity of the human being which both science and the Bible point to. Man is "an integral self, a psychosomatic being incorporating many interrelated levels of activity." (ibid p.7.) It is pertinent to note that this definition of man leaves little room for the image of God, for the spirit/soul, but seems to reduce man, not to a single aspect of meaning, but certainly to aspects of temporality.

In place of reductionistic or dualistic views, Barbour sees the basic approach through the medium of complementarity by which we may

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1. Logically and theologically it can be critiques that God's relation to nature must stand at the ground of a proper theology of nature. Thus a theology of nature does not, as in Barbour, precede the doctrine of God. That it does is evidence of his immanentistic motive.
2. It may validly be thought that this is itself a cognitive reduction of profound problems.

seek to analyse some of the basic structures of reality. A certain eclectic pattern emerges, for as he himself notes a dialectical method is being employed seeking to synthesise various schools. However his use of complementarity is more restricted and cautious in 'Myths, Models and Paradigms' (cf. 17.1.2.).

When Barbour discusses the parallels in science and religion he quickly turns to his own line of thought in 'process philosophy' as "An Inclusive Metaphysical System" (ibid p.128.). In this God is seen primarily as the ground of order and novelty in the world. Basic to this is the primacy of time where "the world is a process of becoming" (ibid p.129.); where transition and activity are seen as more basic than permanence and substance. Reality is composed of dynamically interrelated events and not some self-sufficient static substance. From this he derives that; "Nothing exists except by participation" (ibid p.130.) and that reality is in effect an organic process. Process is seen to imply both temporal change and interconnected activity. The basic model is no longer a Newtonian machine but a Whiteheadian organism. But while Whitehead emphasised the interdependence of each event, he also emphasises the individuality of each part, maintaining a real pluralism where each event is the formation of a new unity from the initial diversity.

Within process thought creation is seen in a continuing model which rejects all natural theology as scientifically and theologically inadequate. But while he seeks to avoid a god-of-the-gaps mentality, his reductionistic concept of 'religion' (cf. 17.1.3.) leaves 'religion' open to a psychological-aesthetical-ethical explanation. However I would agree that the doctrine of creation is essentially an affirmation of our relationship to God and not a fundamental hypothesis concerning the origin of the universe. Within the created order, then, Barbour seeks to develop a theology of nature which is neither dualistic or reductionistic but where two-language views can give an helpful start to understanding the profound metaphysics of different levels. Only here can we adequately incorporate the continuity and discontinuity between man and the lower forms.

It is significantly with reference to nature that Barbour draws out the conclusions of this book. He asserts, with traditional and process positions against existential views, that God acts in nature. This is a timely warning against the interiorization of Christianity.

"We can accept the existentialist thesis that religious problems should not be approached in the detached objectivity of theoretical speculation, but this does not mean that we must avoid reference to nature. God makes a difference in events, not just in our way of looking at them. If the ideas of 'complementarity' or 'space' are to be introduced, they should be taken to refer to different aspects of reality, rather than to different interpretive perspectives; and we should go on to explore the relationship between these aspects, rather than accept too readily a sharp dualism of isolated spheres." (ibid p.454.)

It might be thought that the concepts of Barbour here bear close resemblance to the concepts of sphere distinctiveness in Dooyeweerd (cf. 19.7.4.) However Barbour is tied to a linguistic analytical tradition whereas Dooyeweerd follows a more Neo-Kantian tradition. In any case it is clear that Barbour sees two-language views as advantageous and that levels of activity/analysis are not mutually exclusive.

It is when we turn to God's sovereignty that we find process thought inadequate. He contends that: "If existentialism ends by abandoning God's sovereignty over nature, neo-orthodoxy, neo-Thomism, and Pollard, at the opposite extreme, have overemphasized divine omnipotence." (ibid pp.456-457.) The power of God is to be seen as a limited power - limited to an influence for love and goodness. This certainly leaves scope for the reality of suffering and evil, but it tends to create an eternal metaphysical dualism of good and evil. God is effectively limited to a persuasive influence.

"The world makes a difference to God, and time is significant in his experience; he responds to new events and is a continuing influence contributing to both order and novelty... ...would make God a more effective influence but not an omnipotent ruler." (ibid pp.457-458.)

Even granting Barbour to be right here it seems to stretch Scripture to claim that this is the God revealed there! One wonders in what sense we are any longer talking of the Christian God, the God revealed by His Word in creation, Christ and Scripture.

To me it appears that process thought seriously undermines the reality of a sovereign God. Perhaps significantly the last paragraph, which I quote in full, is as follows:

"Does this restrict God's power over nature? As human beings our own action on stones is mechanical, whereas our action on other persons is personal; must we not hold that God, too, acts on stones mechanically or not at all? The parallel breaks down, however, because we are external to the stone, whereas God as source of all initial subjective aims is constitutive of its being. The stability of the stone is in accordance with God's purposes as source of order. Yet even in the inanimate there is an infinitesimal element of new potentiality, which only the long ages of cosmic history could disclose; 'continuing creation' has been a slow process, if we take the scientific record seriously. It is in human life, however, that the greatest opportunities for God's influence exist today. And it is in religious experience and historical revelation, rather than in nature apart from men, that divine initiative is most clearly manifest; our conclusions on metaphysics and on theological method here support each other. Both experience and history point to a God who acts not by coercing but by evoking the response of his creatures. But these same sources remind us of the inadequacy of all our models - for there is no adequate analogy for God. Only in worship and reverence can we acknowledge the mystery of God and the pretensions of any human system that claims to have mapped out his ways." (ibid p.463.)

This bears all the speculative marks of process thought - speculation that has neither scientific basis (such as continuing creation, for this process is so slow as to be undetectable but is assumed gratuitously) nor Scriptural foundation.

17.1.2. Myths, Models and Paradigms (cf. Barbour 1974). Here we find a development of his thought within the realm of the philosophy of science and its relation to theology. Up to the 1950's positivism dominated in science, but even after Popper et al empiricism still dominates. Empiricism claims that science starts from a set of publically observable data which is capable of description in a neutral/pure observation language quite separate from theoretical assumptions; that theories can be verified or falsified in relation to fixed experimental data; and that the choice between theories is a rational and objective procedure in line with certain objective criteria (cf. 16.4.1.).

Within this context, and bearing in mind the dominance of linguistic analysis, Barbour notes that existentialism and positivism both provide a sharp contrast between the object of science and the study of religion, and goes on to make the point that science is not as objective as positivism nor religion as subjective as existentialism (cf. ibid p.5.). He suggests that in science theoretical models are mental constructs devised to account for certain phenomena ; they do not give literal pictures of reality, nor are they useful fictions, but partial/provisional ways of imagining what is not observable. Religious models are also analogical with respect to our experience in human life. But while certain parallels exist between the fields of science and religion:

> "I do not believe, however, that the term (sc. complementarity) should be extended to call science and religion 'complementary', since they are not talking about the same phenomena and their models are of differing logical types serving differing functions." (ibid p.8. - cf. 16.5.2.2.)

Thus he builds up a basic approach of 'critical realism' which applies to both science and religion as follows (cf. 11.5.):

SCIENCE	RELIGION
1. The influence of theory on observation; the lack of a neutral language.	The influence of interpretation on experience.
2. No falsification of scientifically comprehensive theories: great resistance, thought anomalies cannot be ignored indefinitely	Hence Flew's demand for a crucial falsification condition is unreasonable.
3. In the choice between paradigms there are rules of assessment independent of the paradigm.	In the paradigm choice there are no rules, but there are criteria of assessment.

These three facets - diverse languages, the role of models, and the role of paradigms - are seen by Barbour as combining to support critical realism. (cf. ch.11.)

<u>17.1.2.1. Models.</u> In science he pictures <u>experimental models</u> which are constructed and used in the laboratory; <u>logical models</u> which are formal deductive systems; <u>mathematical models</u> which are somewhere between the first two, that is models which are symbolic representations of quantitative variables; and <u>theoretical models</u> which are imaginative mental constructs. (ibid p.31.)

According to Barbour, if in science a model gives a theory by which to correlate patterns in observational data, then in religion a model gives beliefs to correlate patterns in human experience (cf. ibid p.49.). This however suggests that religion and science are separate; that religion deals with the personal, interior world of feeling and experience as distinct from the external world; and that beliefs have no significant role in science. But does his 'religious' category equally apply to psychology or sociology which are also correlations of experiences on the basis of certain beliefs.

However this basic distinction, acting as a ground-motive- colours all that is subsequently said concerning models in religion. It indicates that despite the claim that religion is life-orientating, that it "is, first and last, a way of life" (ibid p.68.), he operates in a dualistic concept. Hence religion is seen in aspectual or subjectivistic terms. Religion is concerned with human experience such as (a) awe and reverence; (b) mystical union; (c) moral obligation; (d) reorientation and reconciliation; (e) interpersonal relationships; (f) key historical events; and (g) order and creativity in the world. Note that (a) to (e) are clearly personal subjectivistic terms, amplified in that (d) contains no primary reference to God for man is reconciled to himself, able to accept himself; (f) refers to the corporate response of the community to certain historical events; and (g) also is seen in a subjective way, the key being the influence of the teleological argument to awaken awe and reverence. (Cf. ibid pp.53ff.)[3]

With this background he critiques the religious instrumentalism of Miles (1959), and the view of Evans that religion is the expression of attitudes, before turning to Ian Ramsey and the concept of 'Disclosure Models'. Ramsey sees models in science and religion deriving from analogies between observations - there are resemblances between patterns in the world and patterns in the behaviour of fathers that leads to the model of God as Father. But Ramsey puts his main emphasis on the way models are disclosed (cf. Barbour 1974, p.57.).

> "The contemporary use of models in science or theology - models which are not picturing models - points us back, then, to that moment of insight where along with a model there is disclosed to the scientist or the theologian that about which each is to be, in his characteristically different way, articulate." (Ramsey 1964, p.20.)[4]

3. Cf. Ramsey (1971, pp.202-224.) and Sinnema (1975, pp.1-24.).
4. H.Cameron (1976) notes that the finiteness of man means that certain situations are more likely to be disclosure prone of God. "It does seem likely that specially favourable focal points of encounter with God are not dispensable....Some situations then must be regarded as having a higher suggestiveness rating (H.S.R.) in the way of ministering to our awareness of God at any time, and promoting fellowship with Him, than others do." (pp.34,35.)

Barbour, though not rejecting disclosure, does not like this idea, contending that flashes of inspiration are normally of no use.

For Barbour models seek to interpret religious experience, to express attitudes, to evoke disclosures, and lastly to construct metaphysical systems (cf. 1974, p.64f.). This order of treatment is curious in that one would have thought that the metaphysical system would come first as that which governs the other areas. After all, is not a metaphysical system determinative of, as well as determined by these areas?

<u>17.1.2.2. Paradigms.</u> Today sees a profound discussion on the paradigmatic aspect of science. In the wake of positivism came the insight that all data was theory-laden, that theories were not simply verifiable or falsifiable, and that there was no clear criteria of choice between rival theories. While Nagel, Braithwaite and Popper tried to hold to some basic objective data (cf. 15.3.3.2.); others like Kuhn, Hanson, Polanyi, Feyerabend and Toulmin posited that there was no bare data. Feyerabend (1976) contends that every theory possesses its own observation language making comprehensive theories incommensurable (cf. Barbour 1974, p.95f.). This is seen in the uncomparableness of Newtonian and Einsteinian systems where in the former mass is an unchanging property of a body, while in the latter it is a property of the relation between a body and a frame of reference. These are different paradigms.

When a conflict of theories arises we cannot withdraw to some arena of pure-observation-language. But can we perhaps withdraw to an observation language that is not immediately questioned? Yet, while a theory may be revised in the light of observations; observations are also revised in the light of theory. There is no sharp line between the two.

Against Kuhn, Barbour suggests that 'normal science' is more diverse and self-critical; that there is in effect a gradation between 'normal science' and 'revolutionary science' and not a sharp line. In a new paradigm the old is not totally discarded. Thus he concludes that the following are the criteria of assessment in science. (a) All data are theory-laden, but rival theories are not incommensurable (cf. Feyerabend) even if something like a gestalt switch is involved. (b) Comprehensive theories are highly resistant to falsification, but observation does exert a degree of control. A research programme is more resistant than a theory. (c) There are criteria of assessment but no clear-cut rules for their unambiguous use. (d) There are metaphysical assumptions and ontological commitments, but these too are open to change. (Cf. ibid pp.112-118.)

So much for science - what about paradigms in religion? Here too, Barbour argues, we 'see as', we do not simply 'see'. As there is no uninterpreted data so there is no uninterpreted experience, and therefore no immediate religious knowledge. Note here the confining of religion to a subjective sphere and science to an objective realm - the one deals with data, the other with experience (but can experience not be data and vice versa?) - even although he clearly recognises the role of assumptions of a metaphysical nature in science. But more important perhaps, there is no meaningful concept of the Word revelation of God entertained by Barbour. His discussion is in terms of man coming to the world and to his experiences. But is not the Christian position that of a God who comes to man, who has given to man His imageness, His revelation, and will give him His Spirit to lead him into all the truth. The truth which is the reality of what is there, not after our interpretation, but after God's.

Barbour conceives that historical revelation and religious experience are the basic sources of theology. But I would contend that the special revelation of God in Christ and Scripture (that is historical revelation?) is the primary field of theology - His revelation in the conscience, the manishness of man, and in the world are secondary sources. That is, I cannot accept Barbour's Liberal perspective on revelation. (Cf. ibid p.134.) Under his construction scientific events also become revelatory. In effect Scripture is reduced to the status of a 'religious' book; it loses any sense of divine inspiration, or exercising any normative role over men. Here we have a human God and a very human communication to deal with.

This is borne out in the criteria of assessment postulated with respect to religion (cf. ibid p.142f.). We are to assess religion by means of how well social and psychological needs are fulfilled, by ethical norms and actions, by simplicity, coherence and extensibility, and comprehensiveness. Thus the subjective features of science are simply more so in religion and the objective less so. The concept of true truth is threatened.

Barbour then presents four inadequate paradigms - the monarchical model of the King and the Kingdom; the deistic model of the clock-maker and the clock; the dialogic model of one person to another; and the agent model with respect to an agent and his actions. After briefly discussing each of these Barbour suggests that the Christian model is in fact a fifth alternative - namely the process model. Here is pictured "a society of which one member is pre-eminent but not absolute. The universe is pictured as a community of interacting beings, rather than as a monarchy, a machine, an interpersonal dialogue or a cosmic organism." (ibid p.161.) The following quotations give a flavour of his position.

> "The god of process thought is not immutable and independent, but changing and nver completed, even though his essential nature does not change. Temporality and becoming characterise all participants in the community of being.
>
> Between God and the world there is interdependence and reciprocity, in the process view....God is not self-sufficient or impassible, for he is involved in time and history, but he is not totally within the temporal order." (ibid p.162.)
>
> "Process thinkers reject both omnipotence and predestination. If there is genuine freedom and novelty in the world, then even God cannot know the future until decisions have been made by individual agents." (ibid p.163.)
>
> "To the Christian community, then, Christ is more than a historical exemplar; he is a model for God." (ibid p.167.)

Without further quotation it is clearly evident that process theology and traditional concepts of the sovereignty of God are divergent.

This position can be criticised as follows. (a) It uses as a starting point (which is also necessarily its end) the self-destructive synthesis of modern man's presuppositions; it assumes the autonomy and independence of nature and man, and man's freedom to subject the world to his own categories. (b) Barbour compromises seriously the sovereignty of God. Thus while on the one hand he affirms God's transcendence, he negates this by denying the super-naturalness and absolute transcendence of the biblical God. (Cf. ibid p.137.) This has led to the movements position of 'panentheism' - that all things occur 'within God'. (c) The idea of God as a personal being is dissipated, he is reduced to the principal aspect of the whole of things. (d) Any biblical base is denied even if a biblical overtone is invoked to dress up the position.

17.1.3. Science and Religion. Now to turn to the question at the heart of all this - the relation of science and religion. In fact

Barbour gives a good initial definition of religion. "Religion, broadly defined, is total life-orientation in response to what is deemed worthy of ultimate concern and devotion." (1968/b, p.10.) Science is seen to refer to the natural sciences, except for certain tangential comments. In subsequent practice, however, he negates this definition of religion by erecting categories of religious assertion which reduce its total impact. Religion in effect is confused with theological assertion and reduced to an aspectual character.

17.1.3.1. Methods. Barbour consequently makes the following conclusions concerning the methods of science and religion. He notes that both are selective; that both entail a two-way interaction of experience and interpretation; that both have a recognisable community which sets paradigms over the presuppositional arena; that inter-connected networks of concepts are evaluated together. But there are differences for religion is more subjective, has more personal involvement than science; revelation through historical events has, of course, no equivalent in science; the purpose of religious language is to awaken and manifest worship and self-commitment; and finally religion is not testable in the same way as science. So religion is basically involved in actor-language, while science involves spectator-language, although "the contrasts are not as absolute as most recent theologians and philosophers have maintained." (ibid p.268.)

17.1.3.2. Models. Concerning the use of models in science and religion there are also similarities and differences. Both are similar in that they share the characteristics of being analogical in origin, extensible and comprehensible; they have a similar status, being neither literal pictures nor merely useful fictions, but rather symbolic representations of aspects of reality; their use, in that scientific models order observations and religious models order experience. There are differences in that religious models serve non-cognitive purposes; they evoke a more total personal involvement; they appear to be more influential than the formal doctrines derived from them, whereas in science it often appears the other way round. (Cf. 1974, p.69. - cf.14.1; 14.3.)

17.1.3.3. Critique. There are several problems with this manner of comparing and contrasting the methods/models of science and religion. Barbour's concept of religion in practice is narrowed down from its original definition to a complementary sphere of being, and in the process confused with psycho-aesthetic-ethical aspects of meaning. Initially he defines religion as of ultimate life-orientating concern and therefore exercising a directing and forming motive over all of man's activity, yet reduces this to merely an aspect of man's activity. No longer does the concept of religion possess radical life-orientating power as of an ultimate concern over all spheres of meaning, over all of life, but is reduced to the realm of 'trust' and 'loyalty' (cf. 1968/b, p.266.). Religious life is reduced to worship, to an ultimate concern that is effective over only an aspect of life (cf. 20.1. - especially 20.1.1.1.).

In my view it is misleading to compare religion and science in this way. The function of religion is to direct and control the whole of life, including scientific activity. Religion (of some form - either directed to or away from God) provides the ground-motive of the heart and consequently of an individual's scientific activity. Religion cannot therefore be set off over against science and a neat list of similarities and differences drawn up, for it is integral to science. However we may be able to compare and contrast statements from different spheres of meaning (although I am not convinced of the value of this, for what purpose is gained in comparing ethics and history, aesthetics and logic?) Let us also remind ourselves that while it is convenient to refer to science as 'natural science' this is in effect a reduction of 'scientia'. Properly speaking theology is a science (scientia).

Barbour refers to the question of testability - science is testable, religion is not. Now this may hold if he is comparing some physical law which is open to experimental examination and some existential feeling of awe. But we cannot extrapolate from this to a generalised statement concerning 'science' and 'religion'. After all, all spheres of meaning above the analytical act normatively and not objectively as do the lower spheres. Therefore history, ethics and aesthetics cannot be tested in the same way as physics. So Barbour's claim that testing "is likely to seem crucial to the scientist as he defends the disinterestedness of science" is a distinction between 'science' and the 'humanities'. But the humanities are not religion.

The differences Barbour notes are essentially of degree - 'more than' - and not of logical type. Thus it seems to me the whole enterprise of comparison is a false pathway which confuses the fundamental religious nature of all scientia. (Cf. 18.5.)

Two more criticisms can be noted. Barbour evinces a false distinction of data (re. science) and experience (re. religion). Even on his own terms 'experience' becomes the data of religion, while in science the scientist has to experience his data. Likewise his distinction between observation and experience is unclear. (Cf. chs. 13-15.) Secondly, Barbour would appear to be open to van de Fliert's criticism (cf. 16.5.1.3.) of placing too high a status on science and allowing it to effectively govern his religious views. [5]

However I would note the helpful role that Barbour gives to philosophy. He notes the importance of it in clarifying the relationship between science and religion and while I reject his development of this I endorse the importance of a philosophical-religious understanding in any approach to the question of theology and the natural sciences.

17.2. HENRY M. MORRIS

Morris is included in this study as one of the foremost conservative evangelical scientists writing in this field today. He is a Fundamentalist and accepts this designation. Unfortunately for many it seems sufficient to say 'Ah Fundamentalist' and thus dismiss Morris (and others) without a hearing, prejudged by the banner under which he marches. But this is not good enough and is in reality a condemnation on those who would so dismiss him. It is unintellectual dogmatism that refuses a fair hearing (cf. 16.5.). It is a criticism of modern Liberalism that it ignores Morris while the 'secular' 'Open University' can note in one of its courses that his work 'The Genesis Flood' (co-authored with J. Whitcomb) is a respectable and serious attempt to argue the case for a universal flood. We should not dismiss this position without proper reflection. Indeed Morris presents a coherent, consistent, simple and empirical position which can be difficult to refute if the parameters within which he writes are accepted. Again it is wrong to ignore a position which has so many advocates, especially within

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5. This is an example of Schaeffer's thesis that in any dualism (science *and* religion) the lower storey (nature/science) will eat up the higher realm (religion/personality/grace) and destroy it. Cf. Appendix A.

the scientific community, for it is not just a matter of a few junior scientists, but hundreds of well-qualified authorities in their own disciplines who see no problem in accepting the Bible 'literally' in its grammatico-historical sense.[6] Concerning his qualifications to discuss the topic of science and the Bible Morris writes:

> "Having studied most of the basic sciences, having belonged to many scientific societies and associated with scientists and intellectuals daily for thirty years, having taught in five great universities for twenty-six years, having read thousands of books and articles on various scientific subjects - and at the same time having averaged over one hour every day for twenty-seven years in the study of the Bible - he is firmly convinced that every word of the Bible is inspired by God, absolutely free of error, with innumerable marks of divine inspiration throughout its pages." (1968, pp.3,4.)

<u>17.2.1. The Bible and Science.</u> What is the attitude of Morris to the sciences? In one essay he tells us that 'knowledge' is concerned with the awareness of the facts around us as they are; while 'wisdom' relates to the interpretation of these facts. Then he tells us that the former approximates to science, the latter to philosophy, though in the final analysis both true knowledge and wisdom come from God alone. (Cf. 1972, p.111.) He approaches the word 'science' in its formal meaning of knowledge (scientia); it involves facts which are observed and laws which are determined. Further: "The scientific method involves experimental reproducibility, with like causes producing like effects." (ibid p.151.) Science therefore "is <u>knowledge</u>, not inference or speculation or extrapolation." (ibid p.151.) At this point one tends to think he has read little philosophy of science after the 19th century.

True science for Morris is confined to the measurement and study of present phenomena and processes. Only data gathered in the present, or accurately recorded in the historic past, may be validly called upon in scientific activity. This strict Baconianism is

6. Morris is representative of 'The Creation Research Society' which was formed in 1963 in Michigan as a committee of ten scientists, and now includes several hundred full members - membership being limited to those having graduate degrees in science. Their statement of belief includes: (1) that the Bible is the Written Word of God, and all its assertions are historically and scientifically true; (2) all basic types of living things were made by direct acts of God during the Creation Week and whatever biological changes that have occured since then are within the original created kinds; and (3) that The Great Flood described in Genesis was an historic worldwide event. (Cf. D.C.C.Watson 1975, p.104.)

utilised to attack evolutionary theories which deal with what is outside the historic past, and which rely heavily upon inference and speculation. But one may feel justified in asking how he manages to exclude inference and extrapolation from his own speciality of hydraulic engineering! However, while holding to the containment of science to present data and processes he nevertheless maintains that only the creational framework allows full and complete understanding. This follows, he argues, because "meaning is inextricably inter-related with origin and destiny." (ibid p.153.) Apart from this he wishes to contain science in isolation from the past or future and from presuppositions. He concludes:

> "To a considerable degree, therefore, a Christian study of physics or chemistry or other science can proceed along the same lines as a treatment by non-Christians. The same textbooks can be used, the same experimental apparatus, the same methods, provided only that the study is limited to an elucidation of the actual present properties and processes of the data of that science. But as soon as intrinsic meanings or origins or destinies are brought into the treatment, there will inevitably be conflict between the uniformitarian and Christian world-views." (ibid p.153.)

While accepting that extrapolation from the present into the past and future will occur, this is seen as outwith science and belonging to the realm of faith or philosophy. Extrapolation "involves assumptions and presuppositions and is therefore basically a philosophy, or even a faith." (1975, p.xxvi.) This means that science is related to a datum of bare uninterpreted facts, while presuppositions are seen as an additional realm involving philosophy. So when discussing the Flood he sees neither the 'uniformitarian' or 'biblical' approaches as scientific! However in the area of scientific theories he allows that moral and emotional considerations have an important role to play. Indeed the final decision between competing theories "is ultimately a moral and emotional decision." (ibid p.329.)

Unlike the approach which would envisage a Book of Nature and a Book of God operating within their respective spheres of meaning, Morris sees the special revelation of God as exercising a crucial directing influence over the latter.

> "...when one subconsciously identifies with natural revelation his own interpretations of nature and then denounces theologians who are unwilling to mold Biblical revelation into conformity with his interpretation of nature, he is guilty of

serious error. After all, special revelation supersedes natural revelation, for it is only by means of special revelation that we can interpret aright the world about us. (ibid p.458.)

But our view of special revelation is surely also an interpretation, and what happens if we are in error there but correct with respect to an interpretation of general revelation?

The major work of Morris in this field is 'The Genesis Flood' - co-authored with J.Whitcomb. This book seeks to attack evolution in general and defend the Genesis account of a world-wide flood in particular. As part of their argument there is a trenchant attack on the 'principle of uniformity'. But while they have been said to undermine the principle of uniformity without which science cannot exist, this is not in fact what they are saying as they have been at great pains to point out. They realise very well that uniformity is a basic premiss of scientific inquiry (cf. Morris' appeal to reproducibility as of the essence of true science). But the false faith of uniformitarianism is defined as:

"...the belief that existing physical processes, acting essentially as at present, are sufficient to account for all past changes and for the present state of the astronomic, geologic and biologic universe. The principle of uniformity in <u>present</u> processes is both scientific and Scriptural (Gen. 8:22), but comes into conflict with Biblical revelation when utilized to deny the possibility of <u>past</u> or <u>future</u> miraculous suspension or alteration of those processes by their Creator." (ibid p.xx.)

Hence the false faith they attack with respect to uniformity is one which has the character of anti-theism, evolution and materialism, rather than the true faith which is directed by the God of creation and revelation. (Cf. 7.1.4.)

The Bible is given absolute pre-eminence, accepted in a literal way - although Morris seems at the same time capable of peculiar analogical interpretations. While the Bible is not regarded as primarily a book about science it nevertheless is held to contain "sources of modern scientific truths, and no scientific errors." (1972, p.21.)

<u>QUOTE A</u>:"The Bible, with this perfect claim to absolute divine authority, does very clearly establish a framework of interpretation within which men are expected to formulate their understanding of the data of science. It is most reasonable and most gracious of God to do so, since it is

quite impossible for man, with his study of present processes, to know anything for certain about the prehistoric past or the eschatologic future. Only God can know these things, and we are able to know the truth about these matters only through faith in God's statements concerning them. Therefore, the Bible-believing Christian goes to the Bible for his basic orientation in all departments of truth. The Bible is his textbook of science as well as his guide to spiritual truth." (ibid p.110.)

Thus he maintains that the Bible not only gives a sound basis for understanding religious truth but physical truth as well. The Bible serves as a textbook for scientific principles and the basic biblical framework is pictured as centred round key facets of history such as the special creation out of nothing in six days; the Fall; the Flood; the work of redemption in Christ; and the eschatologic return of Christ. [7]

17.2.2. The Bible 'Is' a Scientific Textbook. Despite a cautionary note that the Bible does not contain detailed technical descriptions or mathematical formulations of natural phenomena, he entitles a chapter in one book as "The Bible Is A Textbook Of Science." (ibid p. 108.) Indeed his whole apologetical method centres round an appeal to the "great number of scientific truths that have lain hidden within its pages..." (1968, p.5.) A facet he appeals to as clear evidence of the Bible's inspiration by God. This leads him to adopt a procedural rule that anything from the realm of scientific inquiry that seems to contradict the Bible is to be labelled as not true science! (Cf. 1972, p.107.)

Morris is naturally not content to leave his claims of specific scientific knowledge hidden in the Bible hanging in the air and he develops several areas where he sees modern science corroborating the Bible. This appeal is widespread and includes astronomy, geology, meteorology, hydrology, paleontology, physiology, archaeology, taxonomy, anthropology, medicine etc..(cf. 1968, p.5f; 1972, p.118f.)

17.2.2.1. Astronomy. In astronomy for many years men sought to number the stars, but the Bible all along maintained that they were without number (Jer. 33;22). The Bible sees the earth as a sphere sitting in space (Is. 40;22. Job 26;7). Appeal is even made to the detailed data Velikovsky adduced to support the long day of Joshua,

7. This does not do justice to the essential pre-theoretical nature of Scripture. Cf. Sinnema (1975).

although Morris rejects his interpretation of this as unscientific and unbiblical. But it gives support, in its detail, to the biblical text. (Cf. 1968, p.22.)

17.2.2.2. Hydrology. Morris makes frequent appeal to the 'hydrologic cycle' as being accurately recorded in the Bible. Water is precipitated as rain or snow, drained off by rivers into the oceans and thence raised by evaporation into the skies and carried by the wind back to land (cf. Eccles. 1;6,7; Job 36;27-29. 1972, p.25f.)

> "It is remarkable that not one of the great number of Biblical references to water is out of accord with the findings of modern science. On the contrary, there are many references which seem to reveal a modern perspective, so modern in fact that it would seem to be inexplicable apart from divine revelation." (1972, p.25.)

(Cf. Jer. 10;13. Prov. 8;26. Ps. 135;7. Job 26;8. 28;24-27. 37;11.)

17.2.2.3. Energy. Turning to the physical sciences he notes that the fundamental fact concerning them is that they are non-physical in ultimate essence. This was declared long ago in the Bible but only comparitively recently has it been acknowledged by modern science which today has abandoned mechanical concepts in favour of non-mechanical mathematical concepts. (Cf. ibid p.112.) So Morris develops several analogies between science and Scripture with respect to the concept of energy. He appeals to different forms of energy - light, sound, heat, electrical and chemical - to indicate how God's upholding hand maintains all things in existence. But his textual evidence often appears vague and strained. He cites Jeremiah 20;9 as an example of electrical and chemical energy: "Then I said, I will not make mention of Him, nor speak any more in His name. But His word was in mine heart as a burning fire shut up in my bones, and I was weary with forbearing, and I could not stay." Similarly his texts to show evidence that the physical form of energy known as stress and strain is in the Bible may fairly be described as tenuous.

> "There seems to be an implication, spiritually speaking, of this form of power released by the Word in Luke 16:16,17: 'The law and the prophets were until John: since that time the kingdom of God is preached, and every man presseth into it. And it is easier for heaven and earth to pass, than one tittle of the law to fail.' In this passage it is noted that as the Word is preached it exerts a pressure upon its hearers, causing them to 'press' into the kingdom..." (ibid p.55.)

He interestingly discusses the word 'power' in Scripture in the light of a possible understanding of it as referring to energy in a non-physical manner. Thus he writes of Hebrews 1:3.

> "And the Scripture quoted above apparently says that the Lord Jesus Christ is the ultimate Source of the infinite power (or energy) which, revealing itself through its outworking (the Word), is the agency by which all the physical is 'upheld'. Here is the modern discovery of the equivalence of matter and energy, expressed 1900 years ago, and further teaching that it is the living Word of God which supplies the power for keeping the matter of the universe from disintegrating, and for enabling it to manifest all the multitudinous physical phenomena that constitute God's creation." (ibid p.46.)

While agreeing with the general point here I would hesitate to make the claim that the text evidences the equivalence of matter and energy. This reads too much into it.

<u>17.2.2.4. Creation.</u> Not surprisingly Morris attacks the attempt to push the date of creation back into the dim and distant past. The Genesis genealogies give a date of about 6,000 years ago, and while this figure "is subject to reasonable increase" a date "of about 15,000 B.C. for man's creation would probably represent the outside limit " to which breaks in the genealogies could be stretched. (Cf. ibid p.30.) To back this up he attacks modern dating techniques - techniques which one must admit leave many questions unanswered; for example, assuming a uniformity that the evidence suggests does not prevail. Thus radiocarbon dating is attacked:

> "...the fact that this method rests upon doubtful presuppositions and needs to be used with great caution may be illustrated by a recent incident. Dr. Stuart Pigott, a British archaeologist, reports that two radiocarbon tests on a sample of charcoal indicated a date of 2620-2630 B.C. for an ancient structure at Durrington Walls in England. But compelling archaeological evidence called for a date approximately 1,000 years later!" (1975, p.43.)

Morris defends creation in six 24 hour periods and the fact that this creation would of necessity have a built-in time dimension. (Cf 1972, p.42.) While this leaves the philosophical problem that creation could have taken place five minutes ago with men being created with built-in memories, this is not to be accepted even though no one can prove it wrong. (Cf. ibid p.109.) It is not acceptable because the Bible indicates otherwise - not because it appears an absurd idea.

Morris boldly contends that attempts to harmonise the order of creation and modern historical geology evaporateon inspection of the details. For example, the Bible tells us that all plants, even fruit trees, were made on the third day, while fish and other marine organisms were created on the fifth. Historical geology reverses this order. The Bible sees birds and fish created on the same day; paleontology teaches that birds were evolved from reptiles long after the origin of marine life. (Cf. ibid p.33f.) Thus he concludes that modern historical geology is wrong, appealing to the Genesis record, and the New Testament for to attack Genesis is to attack the words of Paul, Luke and even Christ (cf. ibid p.38.). In effect he maintains that creation is not open to scientific examination of any kind for all present processes relate to the providence and maintenance of creation by God - not to creation per se.

17.2.2.5. Evolution and Thermodynamics (cf. 7.4.2.). With reference to evolution he writes:

> "Thus it seems evident that if evolution has taken place on any large scale at all (that is, of course, progressive evolution), it must have done so at complete variance with the indications of all modern genetic research and indeed with all basic physical law. Most of the proffered evidence for evolution can be better interpreted in the light of the law of deterioration, and with far better scientific basis." (1968, p.53.)

Here we see reference to the 'law of deterioration', or the second law of thermodynamics. Morris indeed appeals strongly to the first and second laws of thermodynamics. The first law (energy conservation) indicates that creation cannot now be taking place. The second law (entropy) indicates that all is now deteriorating, being degraded, waxing old like a garment. Morris appeals to the universal validity of these laws and quotes many authorities from other scientific disciplines to back this claim up. (Cf. 1972, p.122. 1975, p.222f.)

The first law states that no energy can be created or destroyed, although its temporal form may change. In creation God brought energy into being, and therefore this period is of an intrinsically different character from that which now prevails. It is therefore impossible for man to extend his present knowledge of basic processes to determine the events/sequences of creation. This Morris claims "is the fundamental fallacy in modern evolutionary philosophy." (1972, pp.95,48.)

The second law of energy deterioration states that in any real process where energy is transferred in form there is an irretrievable loss to a heat sink - energy is not destroyed but deteriorated to become less useful or available for further work. In a closed system, order will decrease unless energy is introduced into the system. Therefore he concludes that the universe is running down, growing old. This compares favourably with Scripture (cf. Ps. 102; 25f. Heb. 1;10-12. Rom. 8;20-22.) and is the expression that something has gone wrong in God's creation. If the first law refers to all processes since creation; the second law refers to all processes since the Fall. (Cf. ibid pp.51,95.)

Attendant on these two laws is one obvious glaring problem for evolutionary thought and Morris points it up with great relish.

> "A very interesting anomaly is evident here. Biologists for the most part decry vitalism, vigorously denying that there is any sort of 'vital energy' present in organic matter, energy of some radically different nature from the ordinary forms of physical energy. Such concepts as those of 'creative evolution', 'orthogenesis,' 'entelechy,' and the like are anathema to most life scientists.
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> It is contended that all organic processes must be explained in terms of chemistry and physics. This means that the basic laws of chemistry and physics (notably the first and second laws of thermodynamics) must be as determinative in organic processes as they are in inorganic processes. These laws postulate quantitative stability and qualitative deterioration, rather than evolutionary growth and development. And this quite clearly indicates that evolution is invalid as a guiding principle in the study of biologic processes." (ibid p.116.)

Morris, then, hangs a lot on the first and second laws of thermodynamics. This is not as dangerous as might appear at first glance for these two laws are probably the most fully demonstrated and experimentally verified laws that we know. (Although we might add a caveat that Newton's laws at one time also bore this character yet were eventually overthrown.) He writes:

> "These laws are basic in every scientific system or process. As far as science has been able to show, they are universal in scope, with no exceptions known.....If men had been willing to develop their scientific systems on the basis of Biblical presuppositions, however, it should have been quite obvious all along that the basic physical processes were those of conservation and decay, as now formalized in the statements of the first and second laws of thermodynamics. The Bible does not, of course, state these principles in the mathematical symbols or technical jargon of modern physics but the basic truths are quite clearly enunciated." (ibid p.114.)

But hindsight is easy. I would suggest that it is easier to read laws back into the biblical text than to deduce them from it. If the Bible is a scientific textbook as Morris claims we should be able to deduce these laws out of the text and not simply recognise them after the physicist has unfolded them without recourse to the Bible.

The problem is whether we see some interaction between biblical material and the sciences, or whether we maintain a rigid compartmentalisation. This is quite a different question from that of the relation between theology and the other sciences for that is the relation of one scientia to others. But with respect to the Bible it is whether it bears on only pre-abstractive affairs; on that plus theology; or on that plus the sciences.

17.2.3. Critique. The basic aim of Morris is unashamedly evangelistic (cf. 16.5.3.). He is concerned to prove, by illustration from science, the veracity of the Bible. But while he makes the claim that the Bible is a scientific textbook, he is really concerned to show that as it is scientifically reliable it is clearly divinely inspired and the reader should acknowledge it as such and accept its saving gospel (cf. 1968, p.3.). Unfortunately this means that he in effect belittles the very book he endeavours to exhalt, for if the Bible is all that he claims, then it hardly needs verification from the scientific activities of man.

Again we can strongly question his idea that there is a substratum of science which is free from influence by speculation and presuppositions. He seems at cross-purposes here, claiming that there is 'science' (knowledge) which is the present facts as they are; and yet on the other hand maintaining that only in a creational context of the believing mind can true meaning and purpose be understood. But is he then saying that there are facts without meaning or context? One certainly must distinguish between the sciences and philosophy, between data and interpretation, but it is false to divide them such that science deals with facts while faith/philosophy deals with presuppositions. After all, science in all its divisions rests on faith which is directed either to, or away from, God and has its presuppositions and 'presupposita'.(cf. glossary.)

Great play is made of the weakness of the Principle of Uniformity with reference to the Flood - but then he is forced to slide tantalisingly around the problem that: "all things continue as they were from the beginning of the creation." (2 Pet. 3;4.) Again, in Quote A (p.349) Morris confuses two quite distinct ideas - the Bible as providing a general framework within which the sciences may be pursued; and as providing specific scientific details. While agreeing to the validity of the former (cf. Part IV), I have strong objections to the latter in any deductive sense.

Priding himself on a strict literal interpretation of Scripture he makes basic 'eisegetical' misinterpretations. In dealing with the creation and fall, he claims that the Bible clearly teaches that sin and death entered as a result of Adam's disobedience. This, he then claims, contradicts the theory of fossils of millions of dead creatures, man and animal, from the period before the Fall. But the problem he sidesteps is that if we follow the text carefully we find that Adam was told that in the 'day' he disobeyed God he should die (Gen. 2:17.). But he did not die physically and the obvious meaning is that the Bible is more concerned to discuss the spiritual state of man. The problem is spiritual or theological, not primarily physical or biological, and it is wrong to make biological deductions from a spiritual commentary.

Yet the basic problem is not one of textual interpretation, but the relationship of science and the Bible. At one moment Morris is appealing to science to vindicate the Biblical text; the next moment he is assuring us that historical geology is wrong simply because it does not equate with the Bible as he sees it. Thus the vindication he seeks from science is at best ambivalent for it is manifestly inadequate to rule out of court specific instances in this way. Similarly in the Creation Research Society's creed we find that all statements in the Bible are historically and scientifically true. But this leaves no room for the fact that the Bible records the words of the Evil One (prince of liars), the speculations of men (infallible?), as well as clear cases of accommodation.

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CHAPTER 18

THOMAS F. TORRANCE

18.0. INTRODUCTION

T. F. Torrance argues that Karl Barth combines the quest of the Fathers concerning the 'being of God' with the questions of the Reformers concerning the 'acts of God'. As the latter lost 'being' in functionalism and subsequently their ontological base, so Torrance calls us to go beyond Barth and create a closer tie between natural and revealed theology; we are called to invent "new cognitive instruments." (1972, p.246.) Torrance thus stands in opposition to the modern theological streams flowing from Bultmann and linguistic analysis. He attacks Bultmann's flight from space and time which discards the "place of historical facticity" as an "obsolescent survival out of the uncertainties and anxieties of the late nineteenth century." (1969/a, pp.48-49.) Linguistic analysis, while so long dominant, is now clearly seen to be derived from an "outmoded particulate view of nature." (ibid p.49.)

18.1. HISTORICAL OVERVIEW

Torrance makes a perceptive critique of the history of ideas and penetrates to the deeper underlying cultural changes when dealing with 'science' and 'theology'. He notes three great periods of scientific change - the cosmological change of Ptolemy; the shift from Copernicus through Newton; and the modern change in relativity and quantum theories. The first of these occured at the same time as the spread of the Gospel from the Hebraic into the Hellenistic culture; the second witnessed the Reformation but saw no basic change in theology vis a vis science, there was adaption, but "the essential imagery and the basic conceptuality of Christian doctrine did not change." (1975, p.47.)

> "It must be noted, however, that it was not change in science or cosmology that constituted the real difficulty for theological statement: it was something much deeper in the culture and thought of the times, the axiomatic assumption of a radical dichotomy between the phenomenal world of the sensible and the real world of the intelligible." (ibid p47.)

Problems arose, not so much from science, as from the diverse world-views that came to be synthesised with Christian theology.

18.1.1. The Reformation. The Reformation was the historical event which gave impetus to the birth of modern science. Here was the crucial shift from the priority of thought to that of 'being' or truth. In rejecting the Roman notion of tradition and its intellectualised concept of truth, the principle of true objectivity began to emerge. There was a passion in the Reformers for truth. They:

> "...were ready to sacrifice pleasant illusions and traditional preconceptions for the sake of the truth. They were determined to let the truth declare itself to them, the whole truth and nothing but the truth, irrespective of what it called in question in themselves." (ibid p.268.)

The Medieval world may have had the conditions for modern science to emerge but it was the Reformation that made its birth a reality. (Cf. ibid p.62f. 1969/b, p.59f.)

18.1.1.1. Change in the Doctrine of God (cf. 3.5.1 3.5.2.). One of the great Reformation contributions to science and theology was in replacing the Stoic-Latin view of God as 'deus sive natura' by the biblical concept of God as Creator and Redeemer. The Patristic period, seeing God as impassible and changeless, conceived creation as existing only as objects of the eternal knowing and willing of God, thus losing the distinction between Creator and creature. It had become firmly entrenched in Medieval theology that creaturely existence was directly grounded in the eternity of God and this eternal framework left little room for any real contingency in nature - a facet which had to be recognised before modern science could begin.[1] So while the recognition of orderliness in the universe is very ancient, the recognition of the orderliness of the contingent seems to have arisen out of a Reformed theology.

> "For really free questions to arise, there had to take place a radical loosening up and questioning of the whole medieval synthesis, and because that synthesis was knotted tight in and through its doctrine of God and nature, it was at that point that the real shift in outlook had to take place, before the great transition from a mainly static to a largely dynamic mode of thinking could begin either in theology or in natural science." (1969/b, p.62.)

18.1.1.2. The Distinction Between Nature And Grace. I am not sure that I follow Torrance's argument here, or if am reading his terms in a different light. He seems to argue that nature and grace were

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1. It is useful to compare Torrance with Bavinck's anlysis of this - cf. Veenhof 1978

bound up pre-Reformation and that the Reformation, in distinguishing them, attacked the medieval synthesis without falling into a dichotomy. (Cf. ibid p.65f. 1975, p.64f.)

> "In the Augustinian tradition the universe was regarded as a sacramental macrocosm in which the physical and visible were held to be the counterpart in time to eternal and heavenly patterns. As such the world had significance only so far as it reflected or illustrated eternal patterns, but it was not worthy of attention in itself.
>
> With the Reformation, however, there emerged a new outlook involving the primacy of grace as the turning of God toward the world....
>
> This way of distinguishing and relating the realm of grace as the way of God and the realm of nature as the course of creation in its distinctness from God bore immense fruit, for it at once disenchanted the world of its alleged divinity and yet claimed the world for God as his creation....In the realm of grace, grace has dominion and precedence in everything, for man's salvation is due to God alone and even his knowledge of God derives its possibility from God's grace and condescension; but in the realm of nature, man is by grace given dominion and precedence, for all things are under his command." (1975, p.65.)

But it is precisely in the Augustinian attitude to the world as 'not worthy of attention in itself' that I would argue that we have a clear division of a realm of nature lying below the importantly conceived realm of grace. Torrance seems to push the Reformation view through too far and give autonomy to man in the realm of nature (cf. ibid p.66.). But it depends whether this distinction between grace and nature is with reference to two different entities (man's life before God and his life in the world) or with reference to two different kingdoms (light and darkness).

Torrance sees the Book of God as of grace and the Book of Nature as of nature (cf. Calvin and Bacon). Thus the Reformation gave a new significance to the world as the 'object' of divine attention in contrast to the Medieval negation of its importance. I would contend that the Medieval emphasis was a dichotomy of grace and nature and that the Reformation reconciled them in a unity under the motive of creation, fall and redemption. In effect I think Torrance and I say the same thing in different ways - though I would not wish to read the Barthian triumph of grace into creation in the same way. (Cf. Berkhouwer 1956.)

This acceptance of the world opened the door to secularism, the forgetfulness of God.

> "....the way was opened up for the development of empirical science which is inhibited so long as man looks only away from the world to God to find its meaning in its participation in divine patterns. But once this outlook is established and the primacy of Grace undermined, there arise tendencies toward Deism....or toward agnosticism.... Both these tendencies are fostered by what we may call 'the religious materialism' of Protestantism..." (1969/b, p.67.) [2]

Torrance expounds this with reference to Francis Bacon, suggesting that in the distinction of grace and nature Bacon saw his religious duty being to develop natural science in a process of active inquiry and real discovery - not by mere contemplation, but by experimental inquiry which was guided 'by a clue'.[3]

<u>18.1.1.3. Scientific Objectivity</u> (cf. 1975, p.67f. 1969/b, p.75f.). The Reformation gave to the world the modern emphasis on unbiased and disinterested truth, that is the scientific spirit.

> "This was a passion for the truth from the side of the object which indicated a repentant readiness to rethink all preconceptions and presuppositions, to put all traditional ideas to the test face to face with the object, in order to distinguish what is objectively real from our subjective states." (1975, p.67.)

We might object that to some extent this originated with the humanists of the Renaissance; but for Rome truth was corporate subjectivity, while Protestantism gave to active reason its individualistic form. Unfortunately under the influence of secularism this degenerated into autonomous self-legislating reason. The Reformation could stress the great objective fact that 'Christ died for me', focusing primarily on the object of our salvation; but all too soon this focus would be transferred from 'Christ' to the 'for me'. (Cf. 1969/b, pp.79,81.) [4] Thus the historical truth of the Christian faith became only that which man could envisage for himself, that which he could control. Yet this is not the only line in Protestantism for there is another which has always sought to submit "all tradition to the criticism of the Word of God as heard in the Bible, and therefore to reform its own judgements and think through its theology in obedience to the objective revelation in Jesus Christ." (1975, p.69.) Protestant theology is caught in a struggle between

2. Cf. Appendix A - Schaeffer's thesis that nature 'eats' up grace.
3. This 'clue' negates a simple Baconian bucket in Bacon.
4. Cf. Kant's 'Copernican Revolution' which installed the self-legislating ego.

self-centred and Word-centred thought.

<u>18.1.2. Secularisation</u> (cf. 16.6.). After discussing these insights of the Reformation, Torrance notes how they were lost in the humanising motives of the Enlightenment (cf. 5.3.). <u>Kant</u> (cf. 5.4.3.) made a clear distinction between 'mundus intelligibilis' and 'mundus sensibilis' as that between things-in-themselves and things-for-us. (Cf. 1969/a, p.43.) Here space-time became the <u>a priori</u> of man's knowing and the point of absolute rest taken to be in man. "Then the only God man can or will have is that which he postulates in his need and morally appropriates for himself." (ibid p.44.) For Kant, objects conform to our knowledge of them; we approach nature not as pupil but as judge, although the <u>ding an sich</u> is a reminder of the limits of reason. This is a combining of the Reformation emphasis on the majesty of God, the order of nature and the littleness of man, with the Renaissance emphasis on the rights and powers of man, his freedom and rational autonomy. Torrance rightly opposes this Kantian idea that we constrain nature to act in our limits. (Cf. Kuhn who claims we constrain nature in our paradigms.) He claims that specific problems arose from the phenomenalism started by Galileo and developed by Locke and Kant - a phenomenalism also due in part to the confluence of Newtonian and Cartesian thought. Protestant thought lapsed back into scholasticism under the influence of Newton's concept of absolute time and space linked to a divine sensorium. This was aided in the development of science by abstraction from observational experience and its quantitative organisation of its data for pragmatic ends; hence splitting the object and the subject, being and knowing, and leading to a destructive stress on abstract concepts and their logico-deductive control. Hume, of course, in his radical critique of causality led to Kant's transfer of absolute space-time from the divine sensorium to the human mind which imposes its laws on nature rather than draw them out of it. Thus instead of the humble question of the servant, man ends up putting his question to nature after the prescriptive manner of the judge. (Cf. 1972, p.240.)

<u>18.1.3. Kierkegaard and Einstein.</u> While attacking Kant, Torrance seeks to reinstate Soren Kierkegaard, seeing in his thought the recognition that authentic subjectivity alone gives true potential when it collides with the divine Subject. He sees him as in effect prefiguring the conceptual revolution of Einstein. "And so a hundred years ahead of his time Kierkegaard devised a way of thinking

by abandoning a point of absolute rest and moving kinetically along with the truth in order to understand it." (ibid p.246.) Einstein is in fact decisive for Torrance, being the pre-eminent character in breaking up the mechanistic universe under the pressure of electro-magnetic field theory and the failure to explain it mechanically; and in following the Newtonian method of freely inventing a new cognitive instrument to unfold the created order of the universe. 'Free' in that it was not arrived at under logical procedures from specific premisses; 'invented' "under the pressure of the nature of the universe upon his intuitive apprehension of it." (ibid p.241.) Hence Einstein was able to set before the astonished world of science a new way of thinking - that of mathematical invariance.[5] This broke down the problems of Kantian phenomenalism and Machian positivism and established "a genuine ontology in which the scientific mind was at grips with objective structures and the intrinsic intelligibility of the universe." (ibid p.242.)

18.2. TOWARD KNOWLEDGE

Part of man's dominion over creation is exercised through his logic whereby he is able, by using his God-given rationality, to exercise controlling power. (Cf. 1969/b, pp.225-226.)

18.2.1. Existence and Coherence Statements. Torrance follows the Humean distinction between 'existence statements' and 'coherence statements'. David Hume divided statements into (a) those refering to external, independent facts, and (b) coherent series of statements (cf. 1975, p.52f.). The former relate to extrinsic meaning and are denotative; their truth residing not in themselves but in the reality to which they point or correspond. They reach out beyond themselves and are therefore never complete. Acts of intuition lie behind them and they are therefore open and indefinite, depending upon the nature of the existant - though we must not limit existants to those of sense-experience. Existence statements, then, refer to matters of fact and are reached through experimental and moral reasoning (cf. 1969/b, p.164.) On the other hand there are coherence statements which are propositions with respect to ideas reached through abstract

5. Mathematical invariance refers to the cognitive instrument via which the mind reaches inherent structure in the universe; refers also to the invariant structure in nature which is irrespective of any or every observer.

or demonstrative reasoning. While in science the former dominates, nevertheless there can be no purely theoretic proof. Existence and coherence statements need each other, and the coherence statements of our existence statements are in effect our scientific constructions or theories (noetic models). (Cf. 1975, p.53f.) There is no dichotomy between the two types of statements; coherence statements never stand isolated from existence statements and that is why something like
7 mathematics cannot reduce to mere tautology (cf. ibid p.60.).

The logic of existence statements is simply the logic of question and answer; and the basic question refers to empirical knowledge - 'What do we have here?' In essence this is a logic of reference, of heuristic induction and discovery. We receive our structures and categories, not from behind us as from axioms, but from in front (cf. 1969/b, p.226f.). Naturally we must analyse existence statements to see if they are 'recognition statements' or 'psychological constructs'; and seek to refer them coherently to groups or sets of statements (cf. ibid pp.238-239.). Because of this refering function existence statements remain open concepts: the analogues into which they are built forced on us by their correspondence with respect to the disclosures of the real world, though they are never replicas or transcripts but perspicuous forms through which we discern the world.

There is also the logic of coherence statements. Individual existence statements cannot unfold their meaning in isolation but need to be bound together if they are to pertain to the real world - they must cohere. This Torrance sees as the province of formal logic and not involved in the active process of inquiry; here we investigate the general rules of derivation between individual sets of propositions where certain propositions necessarily follow from others.

We must also distinguish between closed and open concepts even if the line between them may often be blurred (cf. ibid p.15.) While closed concepts can ultimately be reduced to clipped propositional ideas, there are other concepts which are too big for us and which we cannot neatly delimit. Torrance illustrates this two ways. First: from Byzantine art where Christ is often represented standing on a dias which is depicted such that its lines do not converge as in normal perspective but diverge. "Here the concept of Christ while definite at one end is infinitely open at the other, but it is a concept." (ibid p.15.) Second: he draws on modern physics which has to deal with classical concepts and quantum effects. The former are closed but quantum is open (Heisenberg).

Thus Torrance is enabled to suggest that knowledge only comes in the interaction of the subject and the object, and scientific knowledge can therefore never escape from being an arbitration between thought and being. Overall he distinguishes three logical levels:

> "(i) the fundamental level of our actual knowledge of things in accordance with what they are, (ii) the level where we test and formalize this knowledge through some sort of calculus into a coherent system, and (iii) the level at which we interpret the formulations of this system and determine its mode of connection and consistency." (ibid p.259.)

<u>18.2.2. What Is Science?</u> With the foregoing in mind, how then does Torrance conceive science? He writes:

> "Scientific knowledge is that in which we bring the inherent rationality of things to light and expression, as we let the realities we investigate disclose themselves to us under our questioning and we on our part submit our minds to their intrinsic connections and order." (ibid p.xi.)

This quotation clearly indicates that Torrance tends to the Baconian empiricist tradition.

Torrance acutely perceives the problem of a vague abstract called 'science'. There is in fact no such thing as 'science' only the individual 'sciences', including everything from mathematics to theology. Nor can we, in studying these sciences, abstract 'science' from the actual process of inquiry and discovery for there is no one scientific method. In order therefore to come to grips with the sciences we must learn how they have come to be what they now are. If we are to build on the foundations of the past we must get to know the past. This is significantly part of Torrance's strong historical treatment of all that he deals with. The actual work of the sciences is carried through by the specialist working within the parameters of his sphere of meaning, and presupposing as he does so a 'scientia generalis', that is, like his specialised research, tied to what is known. (Cf. ibid p.115.) Each science is bound up in its own particular sphere. "Experimental science can never transcend its starting point, or its own limited instruments and therefore attain to God's knowledge." (ibid p.100.) Problems arise from the extension from a special science to the generalised speculations of philosophy. We must beware of confusing philosophy with 'scientia generalis'.

18.2.3. Questions: as Interrogation and Problem. If we are to learn, we must question openly with no ulterior motive or we will slip by the proper object. Questioning follows two pathways -- the 'interrogative' and the 'problematic'.[6] The correlates of interrogation are scientific discovery and theological revelation. Nevertheless it is not simply a matter of asking questions of the external world, for the questioner is questioned even before he begins to think. (Cf. ibid p.123.)

Torrance rejects an a priori approach to knowledge. He claims that "genuine critical questions as to the possibility of knowledge cannot be raised in abstracto but only in concreto, not a priori but only a posteriori." (ibid p.1.) Yet he is well aware that each specialised discipline starts from pre-abstractive knowledge and assumes the reality and investigatability of its own proper object, and that it may be known more deeply. Thus it would appear that even in rejecting any theoretical a priori for abstractive thought as it pertains to a particular discipline he tacitly acknowledges the involvement of pre-abstractive and crucial a prioris. But his basic claim remains that: "Real statements are statements that are forced upon us by the pressures of objective reality." (ibid p.174.) Thus his emphasis is away from idealism, or the approach of modern philosophers of science such as Popper, Lakatos or Kuhn, to a reformulation of a more traditional British empiricism and a correspondingly greater stress on the real world and true objectivity. This is indeed a valuable correction to the dangers of idealism.[7] As he applies this in theology we find:

> "...if we are to think scientifically in theology, that is, a posteriori and realistically, we have to think out the problem of our theological statements from within our actual knowledge of God in Jesus Christ on the ground of its own real and intrinsic coherence." (ibid p.186.)

Note the equation of 'scientific' and 'a posteriori'. But is he contending that we can draw out of Scripture an unbiased picture undistorted by eisegesis?

So he sees the attempt in modern science to clarify "the deep

6. This division seems to approximate to the Kuhnian division between revolutionary and normal science - though Torrance does not follow Kuhn's sharp distinction.
7. Torrance seems to me to push this too far - cf. 12.5.4.

objective rationality in the nature of things" as challenging any theological attempt "to transcend the subject-object relationship as an irrational flight from objectivity and rigorous, exact thinking." (ibid pp.8-9.) [8] In scientific theology we are to begin with the actual knowledge of God and not some independent theory which we seek to actualise and fill out with material content. We do not start from an epistemological investigation but from the reality of that which is given. This does not mean that we are left with bare objectivity for there are the traditions we have received against which new knowledge will be assessed. (Cf. 1975, p.44.)

Thus Torrance develops a powerful corrective against the epistemological starting point of much modern thought and drives through to the radicality of the given, the ontological base that must precede any true order of knowing.

> "...there can be no true <u>ordo cognoscendi</u> (order of knowing) which is not based upon an <u>ordo essendi</u> (order of being) conceived entirely as grace, and the <u>ordo essendi</u> reaches its true destiny in the <u>ordo cognoscendi</u>." (ibid p.116.)

Lurking behind any question we put lies the fact of our existence, and therefore in a real sense every form of thought entails the being of the thinker. It is from this attack that Torrance drives through to point out why Reformed theology is based on the interaction of faith and grace - through the Word. Hence he turns back to one of his central themes - the Calvinian emphasis that without the vertical relationship of man with God, man has no authentic place on earth, no purpose, and no meaning. This holds, not just for theological questions, but in the totality of life. (Cf. 1969/a, p.75.)

18.3. SCIENTIFIC THEOLOGY

<u>18.3.1. Scientific Method</u> (cf. ch.13 and ch. 14.). What are the scientific features in theology? There is an application of the general scientific method which Torrance sums up as including the following facets.[9] (a) The respect of objectivity: a proper devotion to the object which will not accept as genuine that which does not correspond to reality. (b) A scientific theology will be

8. At this point I am not clear of his interpretation of modern science which seems to also adduce pointers for the opposite argument - i.e. a retreat from objectivity (Heisenberg).
9. One might ask how this equates with the dictum of Torrance that there is no science but only the sciences in their diversity.

rigorous, disciplined, methodical and organised knowledge, governed not by hypothetical speculations but by the material content of its knowledge (cf. 21.4.4.). (c) There is a basic search for elemental simple forms in which to reduce the multiplicity of knowledge. This is the application of Occam's razor and has been well demonstrated in the work and writings of Einstein (cf. 1969/b, p.118.). (d) There is the role of inquiry. Torrance accepts that the Socratic method has a place but that it is not sufficient to reveal new knowledge. The Socratic method provides a sharp distinction between philosophical thinking and the natural sciences, aiming to clarify what we know (cf. Kuhn's 'normal science'). But this does not lead to discovery. Science must be ruthless and unrelenting in unfolding the true nature of the object and in allowing ourselves (in openness to the object) to be 'told' by the object what we cannot unfold ourselves (cf. ibid p. 121.) - "unless we learn to put our questions openly and without ulterior motives, they will be directed past the object; they will be blind questions." (ibid p.123.) Applying this procedure to scientific theology he rejects any logico-deductive argument from fixed premisses. (Cf. 1972, p.244.)

<u>18.3.2. Scientific Requirements of Theology.</u> What are the scientific requirements of theology? (a) The total Lordship of the object of our reflection. This is the one "all-determining" assumption for theology (cf. 1969/b, p.131.). The Kingdom of God involves an epistemological inversion for He whom we study is the Lord of our knowing - even though it is we who know. The field of investigations has control over its researchers, and this holds in a more rigorous way than the general principle of the constraints of given reality.

(b) Another requirement stems from our need to personify the object of our theological knowledge. Jesus Christ is not a bare object but a living person who communicates His Word to us. So we are led into a Dialogical theology (cf. 17.1.2.2.) which can proceed only by continual reference to its <u>source in the Word</u> and deriving its <u>content from this Word</u>. We need to accept the parameters of this dialogical relationship for to attempt to transcend them would be an attempt to step outside given reality. "Theological inquiry can be conducted only in direct encounter with the Word and in the mode of activity set up within that encounter." (ibid p.134.)

(c) A third requisite is the objectivity of the Object (cf. ibid p.135f.) Here the object of our reflection has a double objectivity as God and as man, as eternal Lord and human form. We accept that ultimate objectivity is beyond us for we are bound in creaturely subjectivity. (d) There is the centrality of Jesus Christ as the self-objectification of God on our behalf which entails that our systematic interest is that of servant (not master) before objective knowledge. Man is head over creation, but he not head over his Lord. God is never merely Object; He cannot be reduced to a neat logical system. (e) There ought to be a demonstration in line with the nature of the Object of our study.

Theological statements have a twofold character - paradeigmatic and economic. They are paradeigmatic in the sense that they take images from the visible world and point beyond to divine realities. They are not exemplars (cf. Kuhn) but basically ostensive; revelatory of the divine economy. They are economic in that they are not the product of our own thought but derive from the ordered action of God. Here we must guard against treating biblical images as simply names/ conventions which have no root in reality; and against trying to push through from them to God Himself in the strength of our own thinking (cf. 1975, pp.49-51.). We must guard against theology becoming a synthesis of faith and some fleeting philosophical concept; we are to avoid merely seeking to bring the Gospel into line with modern concepts. In theology, as in the natural sciences: "Real statements are statements that are forced upon us by the pressure of objective reality" - that is God's reality. (1969/b, p.174.)

18.4. KNOWLEDGE OF GOD

18.4.1. The Ultimate Source. Torrance strongly emphasises the Calvinian starting point that without knowledge of God there can be no true knowledge of anything. (Cf. 1975, p.101.) "Creation out of nothing means that the creaturely world is utterly distinct from God yet entirely contingent upon his will." (ibid p.273.) Man is totally dependent on the grace of God. Created out of nothing he has neither being or origin in himself but is created and upheld existentially by God. Man is in the image of God; his life is but reflective of God's action. Torrance goes on to refer to Calvin's opposition to secondary causation in theology and the tendency, becoming widespread in his day, of replacing God with 'Nature'. But

Calvin, rooted in the biblical view and Hebraic thought, maintained an essential relation of all things to the will and action of a gracious God. So not only does man depend on God as his Creator, but he depends on Him providentially from moment to moment. (Cf. ibid p.103.)

We begin with the knowledge of God and not an epistemological programme. This knowledge is a rational event - reason is our ability to recognise and assent to what is beyond us, as well as our capacity to behave in terms of the nature of the object. It is a knowledge that is precisely that - 'knowledge' in the proper formal sense of that word, conceptual both with reference to cognition and expression. (Cf. 1969/b, pp.9-11.) God lies behind all truth, even the most mundane of worldly truths (cf. ibid p.141.). The truth of God is a truth of being but may never be reduced to a set of ideas for this would imply the conversion of universals into abstract entities; nor can it be reduced to a set of statements for this would imply that we could state in statements how they are related to what was stated! (Cf. ibid p.143.) The truth of God deals with that which is final and ultimate not with that which is provisional and relative. Calvin saw - in the claim of Jesus to be the Truth - Christ being clothed, as it were, with His promises, with His Gospel (Institutes 2;9;3 -cf. 12. 5.2 my thesis.)

The logic of God in distinction from the logic of man entails that we always begin with the Grace of Christ in His giving and Incarnation of Himself for us.

> "This unconditional priority of the Truth and the irreversibility of His relationship to us may be called the <u>Logic of Grace</u>, that is the way in which we are bound to think the Truth in accordance with His nature and action as Grace." (ibid p.207.)

It is in the internal relationship of the divine and human in the Person of Christ (Torrance is an advocate of Chalcedonian Christology) that we find the normative relationship for all theological reflection on man and God. We must not forget that the divine and human are united in One Person who is One Word. "Since He is Person and Word the forms of knowledge that arise in us are correspondingly personal and verbal (or propositional)." (ibid p.207.) Therefore in that this knowledge is personal and historical it is not free and autonomous, but arises in certain delimited spheres and follows certain given paths. It may validly be gathered from this that the

Incarnation is of crucial importance for Torrance and indeed he claims that apart from the Incarnation of Christ there is "no actual interconnection by word or deed between God and man." (1969/a, p.78.)[10]

18.4.2. The Word. As well as the objectivity of theological knowledge there is prior to it the actuality of the knowledge of God. Any pretence to autonomous reason can only be viewed as "a diseased form of rationality" where reason has become introverted. (1969/b, p.26.) Theological knowledge turns on what is given; it is theo-logical, it is theo-nomous thinking which pivots only in the revelation of God. In revelation the given fact is not mute - the Logos is met as Word and is to be heard; met as a truth to be acknowledged, and not just as something to be rationally interpreted. Therefore we are called to distinguish between the self-interpretaion of the Word and our interpretation of it. (Cf. ibid p.30.)

> "Unless we have a Word from God, some articulated communication from Himself to us, we are thrown back upon ourselves to authenticate His existence and to make Him talk by putting our own words into His mouth and by clothing Him with our own ideas. That kind of God is only a dumb idol which we have fashioned in our own image..." (ibid p.31.)

It is a failure to sit before that which is received and submit to it, combined with a failure to grasp the relevance and interaction of true subjectivity and true objectivity, that has led much modern theology to degenerate into autobiographical statements by theologians who "get sucked down into the whirl-pool of their own 'self-understanding', from which they begin and with which they end, for within the darkness of that vortex they lose sight of all daylight above them." (ibid p.312.) We are not to be centred in ourselves but in the given Word of God.

In the light of man's dependence, as opposed to some pretended autonomy, Torrance indicates how we must always be thrown back on Scripture. Holy Scripture is "the source and norm of all our theological statements." (ibid p.192 - cf.p.195.) We are called to live from the centre of truth, not self (cf. 1975, p.87.). But Torrance clearly distinguishes the Word behind the words. Theological statements are bound up with the Word to which they refer and from which they derive, such that they "do not have their truth in

10. This overstates his case for while true with reference to the Mediatorial work of Christ in redemption, it is not so with respect to His Mediatorial work in Creation. Here Torrance follows Barth.

themselves but in their referents." (1969/b, p.268.) The Bible is to be heard as the Word of God even while we acknowledge it in its human expression as limited and imperfect. Nevertheless:

> "....it is inseparably conjoined with the divine Word as to be the written Word of God to man, and is brought into such a faithful correspondence with the divine revelation that it mediates to us in and through itself the exemplary obedience of Christ as the authoritative pattern and norm for the obedience of the Church in all its thinking and speaking." (1975, p.140.)

Faith is the reorientation of the reason to the self-revelation of God; it is the rational response of man to the Word of God - there being no faith-reason antithesis. Torrance again uses this theme to push through to claim that genuine theology is suspicious of all _a priori_ thought for it is based on what is given and is therefore truly _a posteriori_ and empirical. (Cf. 1969/b p.33.)

> "We all have our presuppositions, our antecedent ideas and even theories, but when we engage in theological thinking we are summoned to renounce all other presuppositions in concentration upon the object. This is thinking that freely refuses to be fettered by _a priori_ dogmatisms drawn from anywhere outside of what is given to it, whether those presuppositions or dogmatisms come from some logical system, or metaphysics or natural science, from our own personal satisfactions and desires, or even the Church. True theology is free from all these and genuinely open to the self-disclosure of its object." (ibid pp.34-35.)

We are to be open to the 'self-disclosure' of the object; we do not detach ourselves from it but submit to its revelation. "It is sheer attachment to the object that detaches us from our preconceptions..." (ibid p.36.)

18.4.3. Autonomy of Thought? There can never be autonomy for man. There is a tension between our desire for freedom and our factual dependence for all things upon God - and paradoxically Torrance becomes ensnared here. He tells us that when we are confronted with 2 x 2 = 4, no decision is demanded from us for here we are faced "with what is timeless and necessary." (ibid p.214.) Is this, then, a Platonic form? an _a priori_? Elsewhere, after appealing to Frege who noted that arithmetic became meaningless when torn away from its link with language, and Godel's incompleteness theorem, Torrance points out that even the apparently autonomous proposition needs to be related to have meaning. Thus the bald proposition that 2 x 2 = 4 is meaningless if it has no reference to concrete reality. (Cf. ibid p.274.)

So while the doctrine of God and creation allows full place to the other spheres of knowledge, the independence of the other sciences with respect to contingent realities; they also delimit them and indicate their derivation from the Creator. These doctrines suggest that any science will face insuperable problems if it seeks to absolutise itself. Autonomous reason is a deseased form of rationality (cf. ibid p.25f. and p.283.). Significantly at the very beginning of his 'Theological Science' he states that: "If knowledge is to be more than personal opinion....there must be control of our personal intellectual constructions by something which is not controlled but received." (ibid p.viii.)

There is also the individual dependence of each sphere of science. Theology and the natural sciences each have their own proper objective - though they overlap in that both operate in the same rational structure. Each is called to develop its own mode of inquiry in line with the distinct characteristics of its field of investigation - but always in relation to the will and grace of God. (Cf. 1972, p.233.)

Torrance sees real problems in modern thought and particularly in theology's loss of an ontological base. He sees the revulsion from objectivity as a false reaction and much of existential and anthropocentric theology as a retrograde step. (Cf.1975, p.267.) Theologically the "root problem.....is the sin of the human mind." (ibid p.278.) The original sin of man to be as God is still widespread; man wants to impose his will on the universe, still wishes to dictate the type of Christ he wants.

We are called to a critical reassessment of our attitude to nature (Torrance rightly counsels against the substitution of 'nature' for God); and the place of subjectivity in knowledge. The impact of Planck, Einstein and Heisenberg has been to show that scientific propositions are statements about what we can do as well as about nature itself. Modern science has shown the need to take subjectivity more seriously than traditional empiricism or positivism has allowed. Thus while in science we create statements in interplay between subject and mute object; in theology statements are pronounced by God and only thereafter by man.

In the light of modern scientific advances, some have called for a fundamental abandonment of the traditional Christian frame of reference, seeing it as bound up with an outdated cosmology. But here Torrance, while the champion of Einstein, perceptively notes that the problem is not the changing outlook on cosmology, but rather the profound and disastrous dichotomy erected between the sensible and intelligible worlds, between the world of the creature and God. (Cf. ibid pp.261-263.) [11]

18.5. THEOLOGY AND SCIENCE

Torrance makes the crucial distinction that the question to deal with is not 'science and religion' but 'science and theology'. (Cf. 1969/b, p.xvii.) In both theology and the natural sciences there is a confrontation of the same problems: namely (a) how are we to genuinely refer our thoughts and statements beyond ourselves; (b) how can we acquire true knowledge of reality without a self-distortion of it; and (c) at the same time retain the full significance of our personal involvement.

He envisages modern theology deriving from John Calvin from whom "there emerged three primary features of modern scientific thinking." (ibid p.xiii.) (a) Calvin reversed the Medieval questions of 'quid sit', 'an sit' and 'quale sit' to 'qualis est?' Thus, argues Torrance, he entered a genuine interrogation not governed by a priori abstractions; he started questioning the actuality as opposed to the essence and possibility. (b) He notes how Calvin emphasised that theology starts from a situation where the knowledge of God and the knowledge of self are already bound up together. We cannot discuss God in abstract. (c) Within this relation our knowledge of God must be tested, traced back to its true ground, referred to Him and not ourselves. This pattern Torrance sees duplicated in modern science which also starts with the interrogation of reality by empirical approaches - involving (a) and (c) above. In connection with (b) he suggests that quantum theory, the interaction of the observer and the object observed, has this emphasis. [12] So he sees a clear parallelism between the methods of modern theology and quantum theory where both physics and theology now deal with the old

11. A degree of tension is created by Torrance between the recognition of the influence of the subject and the claim that in Theology (a science?) we simply sit before what is given, the child before the 'facts'.
12. We ought to note that this particular line of argument is now placed in a secondary role - cf. Nagel. (Cf. 1969/b, p.xvi.)

antimonies between subject/object, being/act, and determinism/ freedom.[13]

Torrance (refering to Kant) clearly recognises the sphere sovereignty of the individual sciences; each discipline being subject to its own true sphere of meaning. Nevertheless each is an aspect only of the whole and he invokes the idea of complementarity in quantum mechanics (cf. ibid p.102.). (Cf. 16.5.2.2.)

Like others, Torrance is prepared after a good starting delimitation of the problems to be drawn into a discussion of the similarities and differences between theology and the natural sciences. Though his sub-heading indicates a more careful approach - 'Similarities and Differences Between Theology and the Other Sciences.' (ibid p.286.) But throughout the word 'science' tends to be more referable to 'natural sciences' and he does not seem to work out in practice the full implication of theology being a 'science'.

18.5.1. Similarities Between Theology and Other Sciences.

(a) Theology and all other sciences are essentially human activity/ inquiry - there is the assumption of an intelligible object, the possibility of a rational investigation. Both follow the basic scientific method(?) of active exploration and experimentation, moving forward from premisses and data to new understandings which may be deductively assessed. In this way we are safe-guarded from confusing the ontic structures of reality with our own noetic models.
(b) There is respect for the objectivity of facts. We proceed only through reference to external reality. (Cf. ibid p.288.)

(c) Neither theology or any other science works with a preconceived metaphysics. Here Torrance concedes that the very language we use, whether in mathematics or theology, is already metaphysics-laden; but argues that the scientific method of respecting objectivity calls this metaphysics into question. While I agree with the desire to let objectivity speak I do not believe that metaphysical presuppositions are easily minimized like this (cf. Part II.). Again I would want to suggest that, while certain assumptions may be called into question at a given time, not all are called into question at the same time and so challenge the basic heart-directing world and life view.

13. We might note that this is too neat a comparison; nor does quantum theory constitute physics!

(d) Torrance sees a parallel in that both theology and the other sciences eventually come up against a line beyond which they cannot go. While knowing that there is this line and therefore that there is that which is beyond, nevertheless all that we can do is "scientifically maintain a respectful silence." (ibid p.291.)
(e) Finally there is the problem for both of relating the language of their discipline to the language of ordinary life.[14]

18.5.2. Differences Between Theology and Other Sciences. In empirical science we are concerned with statements subsequent to the forced interplay between subject and mute object; but in theology we deal with statements that God has pronounced and only afterwards reflected upon by man. (Cf. ibid p.98.) (Note the confusion here - empirical science is contrasted with theology; yet Torrance tells us elsewhere that theology is an empirical science!) Basically he argues that there are differences with respect to objectivity and subjectivity.

While in classical physics the object was seen with respect to determinism, this has now vanished in modern physics where natural science does:[15]

> "...not come up against anything that is in terms of itself, and so must always refer facts to other facts behind them in an endless regress and operate with an essentially relative conception of truth, but in theological science we do come up against ultimate objectivity and our thought is given a final term of reference." (ibid p.297.)

Theological science deals with the ultimate object, a final term of reference. In natural science the knower and known are both creatures; but in theological science we know, not the creature, but the Creator. There are also differences in subjectivity, although here it seems to be a matter of degree (cf. ibid p.303.)

18.5.3. Einstein's Epigrams. Torrance has a wide and profound interest in Einstein and uses several of Einstein's epigrammatic sayings to highlight crucial issues. Three can be noted.
(a) God does not play dice (cf. 1976, p.10.). While many have taken this to refer to Einstein's stand against the uncertainty principle as an explanation of actuality, Torrance sees it as intending to

14. He also sees a basic similarity in theology and the other sciences in that they give disclosure models rather than picturing models.
15. Torrance here follows Heisenberg's interpretation and not Einstein's. Cf. 27.4.1.

express a basic belief in the objectivity of the universe quite separate from mental hypotheses.

(b) God does not wear his heart on his sleeve (cf. ibid p.14.). If the first saying refers to belief that there is an immanent order in the universe; this saying: "stands for the no less profound conviction that the real secrets of nature, the reasons for that order, cannot be read off the patterns of its phenomenal surface." (ibid p.14.) Theology, like science, is called to penetrate to deep objectivity or it will fall back into abstractive dualisms between the natural and revealed knowledge of God where God's revelation becomes detached from its ontological roots in the Incarnation of the Word.

(c) God is deep but not devious. This expresses the simplicity and steadfastness of the universe which shines through its complexity and subtlety; "the universe is not arbitrary or evil." (ibid p.18.)

If these facets were fundamental for Einstein's scientific outlook, they are every bit as basic for the theologian as he seeks to unfold the mystery of God's revelation to man in Christ. (Of course Einstein's God was in no way the Christian God!)

18.6. SOME CRITICAL CAVEATS

Now while I agree with much of the central thrust of Torrance I must enter several caveats in addition to those already noted. It seems to me that he overdoes the parallels he draws out of modern science into the field of theology. He seems guilty of attributing to Einstein's theory of relativity the status of being an 'absolute' and 'final' theory, a characteristic that Einstein himself refused to give it. Yet Torrance confidently asserts that: "Relativity theory defines the whole universe, and it is nonsensical to ask what is beyond everything." (1969/a p.50.) But what happens if/when physics moves on and relativity is superseded and left behind just as Newtonian mechanism has been relegated to the realm of a useful tool? The critical pivot of my criticism is that theology should be concerned to develop its own sphere, recognising its irreducible elements in the context of sphere universality (see glossary). Why pick on the particular sphere of physics with which to compare theology; why not pick on the analytical, historical, juridical or aesthetic spheres of meaning?

Similarly in his interesting discussion on the problem of space and time in connection with the Incarnation, he finishes up confidently asserting that: "This relationship between divine freedom and contingent necessity in the world....is exactly analogous to that found in the variational principles of physics..." (ibid p.66.) Exactly analogous! This again evidences the too rigid a connection that Torrance endeavours to make between theology and quantum theory. Further he tries to define 'space' thus: "...space must be defined in terms of bodies or agents conceived as active principles, making room or creating space for themselves in the universe..." (ibid p.69.) But this quite fails to define space. A definition should not contain the elements of that which is being defined. Yet in the above definition the concept of space is either implicit or explicit in the terms 'bodies' and 'room' as well as in the repetition of 'space'. So 'space' is defined as space! Now accepting the Dooyeweerdian analysis, each sphere has an irreducible kernel and is therefore qua sphere undefinable. It is this property that helps to distinguish it as a distinct mode of meaning that cannot be reduced to another.

Yet despite such criticisms, Torrance gives a valuable and timely corrective to many dangerous tendencies in modern theology and makes a real contribution to the study of the interface between theology and the other sciences - even although it must be said that he tends to reduce the other sciences to the physical, and physics to relativity and quantum theories. But there is a real penetration to the ontological problems which exposes the weakness of the modern preoccupation with epistemological questions. Not that he negates epistemological questions, but seeks to ground them in the reality of the given creation (cf. 1975, p.116.) God alone is the source of all true knowing and I wholeheartedly share his emphasis on the necessity to enthrone God as the Lord of our knowing (cf. 1969/b, p.131.) recognising that we always stand in danger of the great sin of the mind, of usurping the rightful place of God by placing ourselves at the centre instead of Him who alone is the true Arche (cf. 1975, p.107.) So Torrance seeks to avoid any destructive synthesis with the latest intellectual fashion (cf. ibid p.174.)

But I must depart from him in his attempt to play down the role of presuppositions (cf. 1969/b, p.33.). He himself notes the problem of a true objectivity when we are faced with the legacy of the traditions in which we stand (cf. 1975, p.44.); and in the light of the fact that our present knowledge prescribes for us certain goals and patterns. (Cf. ibid p.57.) Yet despite this he appeals for a sitting before the facts, claiming that relentless interrogation will allow us to undercut even our presuppositions. In this he rejects any a priori, but it seems to me that he himself accepts an unexamined Baconian presupposition. Now undoubtedly that he stands in the empiricist tradition is of great value in exposing the weakness of idealist tendencies, but it does not negate the fact that he does stand in that tradition and does make assumptions that have devolved from the standpoint of empiricism. Perhaps at this point I might suggest that his presentation seems to me weak in its consideration of

conceptual as opposed to experimental side in even the physical sciences. This is seen in his Baconian treatment of Einstein as opposed to the viewpoint of Popper or Kuhn. Again I would imagine he is in difficulties concerning the philosophy of perception and physiology and education. My criticism will be worked out in Part IV.

In the end I am unhappy at his comparison and contrast of theology with the other sciences. He starts by telling us theology is a science, an empirical science; that there is no such thing as 'science' only sciences - but then procedes to contrast 'theology' and 'empirical science'. It is a better analysis than Barbour or Morris, but I remain unconvinced, not in the details, but of the whole enterprise as it is presently construed.

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CHAPTER 19

THE REFORMATIONAL RESPONSE

19.1. INTRODUCTORY BACKGROUND

C. A. Coulson contends that "a Christian philosophy of the natural sciences is much needed." (1968, p.58.) He notes that Scientific Humanism claims that science has no presuppositions, while religion is full of assumptions; that science is based on facts, while religion is based on fancy; and that scientific laws are impersonal and therefore irrevocable. But, as he goes on to point out, science does have presuppositions involving honesty, integrity, hope, enthusiasm, passion, humility, co-operation, judgement; science is not a collection of facts, but what men make of the facts they select; and scientific laws are not simply found lying about in the universe but are conceived/imagined by men. Unfortunately these philosophical overtones are neglected in school today and so children are indoctrinated into the tenets of scientific humanism. Therefore it is crucial that a voice be raised setting forth the Christian heritage of science and proclaiming a Christian philosophical stance on which theoretical thought may be built. Something of this is seen in the final response I wish to examine. Known as the 'Reformational Movement', I find myself in broad sympathy with it.

The movement is largely dependent on the foundational work of Groen van Prinsterer and Abraham Kuyper in the last century, and developed in the 20th century in the philosophical researches of Herman Dooyeweerd and Dirk Vollenhoven. Though originating in one of the traditions of Dutch Calvinism this line of thought has had considerably wider practical impact. It involves a radical disjunction from humanistic philosophies and attempts to develop a Christian stance vis a vis specific disciplines, particularly the foundational discipline of philosophy. Here stand philosophers like J.P.A.Mekkes, S.U.Zuidema, K.J.Popma and H.van Riessen; with a new generation which includes professors Jan Dengerink, Egbert Schuurman, H.Hart and Al. Wolters. In other fields there are Professor C.Seerveld in aesthetics; the late Professor H.R.Rookmaaker in art history; Drs. B.Goudzwaard and A.Cramp in economics. Despite the abstract and philosophical interest of the movement it has had considerable impact in a more popular vein through the work of Dr. F.

A. Schaeffer at L'Abri in Switzerland, and in the more popular side of Rookmaaker's work. However it is in its radical philosophical approach that several insights devolve on the present study of the religious and theological foundations of the natural sciences. This is particularly pertinent in that at the root of the problem - the discussion of 'science' vis a vis 'religion' - there is often a lack of a clear philosophical basis. 'Religion', 'theology' and 'faith' are confused with one another; while 'science' is shut up in an objective field (spectator language) instead of unfolded by faith.

Men in the Reformational Movement who are dealing specifically with the question of the natural sciences include two philosopher-engineers, H.van Riessen (1953; 1955; 1973/a,b and c.) and E. Schuurman (1976; 1977.); Strauss (undated) and Kuyk (1970) in mathematics; and Stafleau a physicist. Stafleau's main interest in the philosophy of the Cosmonomic Idea centres in (a) the distinction and correlation of law and subject; (b) the notion of typicality, both on the law side and the subject side of reality (structures of individuality, individual things and events); and (c) the notion of modal analogies.[1]

19.2. TWO PRECURSORS OF COMMON GRACE

19.2.1. John Calvin. The movement is rooted in the tradition of the Reformation. The Reformers saw the totalitarian character of sin and while this 'corruptio totalis' was never reduced to the popular myth of calvinistic sin-pessimism, it did emphatically take account of the Fall affecting the whole of man's being, including reason. Thus for Calvin the 'lumen naturale' was blind in itself. Yet he did not posit an exclusive antithesis between Christian and non-christian thought (cf. Inst. 1;5;14.). We are not to depreciate the gifts God has given to men, for under the power of common grace God bridles the power of sin and allows the apostate mind true insights into creation (cf. Inst. 2;2;14-17.). From this embryonic doctrine of common grace, and other facets of his theological system (cf. 3.5; and 18.1.1. my thesis), Calvin, recognising the worth of physical creation, gave back to science its lawful domain under Christ who was not only individual but cosmic redeemer. Calvin also restored to science its indispensable liberty. Science was to be pursued in its appropriate sphere of interest with no interference

1. Cf. 'Perspective' Vol. 8, No. 5, Sept/Oct 1975.

from other realms; the church and state had no jurisdiction over physics or astronomy.

In Calvin 'common grace' had not acquired the status of a technical term as it would under Kuyper. Indeed controversy has raged over Kuyper's remark that the doctrine of common grace is an indispensable Calvinist dogma (cf. Klapwijk 1973, p.47.). But Calvin nowhere presents it as an independent tenet of faith and in the various Reformation Catechisms the doctrine is at most, here and there, presupposed. Nevertheless it may fairly be said that under common grace Calvin saw God upholding creation (cf. Inst. 2;2;16 and 2;3;4.); caring for humanity (3;14;3.); displaying His goodness (3;24; 2 and 3;20;15.); preserving the church (1;17;7,11.); and removing any vestige of excuse that man might present before his Maker (1;3;1: 3;3;25: 1;5;14 and 3;25;9.). For Calvin this last aspect was one of the most crucial reasons why God upheld nature, culture and science. Blessed with so many gifts and possibilities man will never be able to prove before God, or his own conscience, that God has not revealed Himself.

Calvin's position with respect to our study may be summed up as follows. (a) Sin pervades the totality of human existence; (b) God has His reasons for restraining sin in man and society; (c) God continues to bless the unconverted with diverse gifts within the order of creation, including knowledge and understanding; (d) non-christian thought does not refer either to a remnant goodness or to the self-sufficiency of human nature; but (e) witnesses rather to the God who upholds His goodness, grace, sovereignty and righteousness in a fallen world.

<u>19.2.2. Guillaume Groen van Prinsterer.</u> The truly modern emphasis of common grace begins much later in the nineteenth century in the figure of Groen van Prinsterer (1801-76). Opposed to any scholastic dualism he contended that philosophy was a derivative of religion - though he did not reject the possibility that non-christian philosophy may surpass non-christian religion in value. Claiming that Christianity was the source of religious enlightenment, he did not simply mean that God made Himself known in a general revelation, but interpreted general revelation in an historical fashion and maintained that it was the light of the primordial revelation in Paradise. Thus he could even acknowledge good in Enlightenment

philosophy -- a philosophy he bitterly opposed as a system. With wonder he notes the treasures that the non-christian mind has unfolded. A wonder that leads him to thankfulness and critical distance. (Cf. Klapwijk 1973, pp.49-51.)[2]

19.3. ABRAHAM KUYPER (1837 - 1920)[3]

Kuyper refers to his worldview as Neo-Calvinism and articulated its principles and practices both as a theologian and prime-minister and at a grassroots level through his long editorship of the daily 'Standard' and weekly 'Heraut' newspapers. Like Calvin he sought to put the self-glorification of God at the centre of his theology. But while the former contended against Roman Catholicism, Anabaptists and Humanists; Kuyper's concern was to set forth the claims of Christ for the entire culture, free from any Anabaptist isolationism. Like Groen, however, he was influenced to some degree by 19th century romantic, historical idealism.

19.3.1. Universal Faith. (Cf. Ramm 1976, p.181f.) Following Augustine he asserted that faith was a structural part of being human. All men exhibit faith; it is not a question of the religious having faith and unbelievers none. He further argued that faith was the root of science, an argument sustained on three grounds. (a) Observation is based on faith as to its possibility, reliability and instrumentation; (b) axioms, which are necessary for science, are grounded in faith; and (c) only in faith is there a motive to and for science. (Cf. 19.7.1.)

19.3.2. Universal Sin. (Cf. ibid p.183f.) Kuyper saw fatal effects in three areas of man's life. (a) He saw the destructive work of sin in the mind of man: it corrodes the mind such that we are subject to unintentional mistakes; it leaves us exposed to self-delusion; it distorts the powers of imagination; it makes us suspect to the evil from other minds; it exposes the soul to spiritual ills as a result of physical ills; it destroys our relationships with others; and it

2. Appreciation is coupled with the warning "that all the good and excellent becomes corrupted through the direction given to it." (Groen: In Klapwijk 1973, p.51.) With that thought in mind we may take cognizance of his statement that: "On a Christian basis one can be an eclectic thinker in a good sense." (Groen: In ibid p.51.)
3. (a) In a fuller treatment of this movement Herman Bavinck would have to be discussed as a central figure. (b) What follows concerning common grace is largely drawn from Klapwijk (1973) and Zuidema (1972) as well as Kuyper. (c) Because of the clarity of several quotations I have resorted to secondary sources in a few instances.

alienates us from ourselves. (b) He saw a destruction of our moral motives. The greatest treason, as T.S.Eliot put it, is to do the right deed for the wrong reason. (c) He saw a darkening of man's understanding accruing from sin.

<u>19.3.3. Common Grace.</u> It is in the work of Kuyper that we find the doctrine of common grace formalised as the very foundation of society which alone makes history and culture possible. He points out that Calvin's embryonic doctrine did not arise from philosophical invention but from the mortal character of sin.

> "Yet apparently this confession of the mortal character of sin did not square with reality. There was in the sinful world outside the Church so much that was beautiful, so much to be respected, so much that provoked envy. This placed the formulators of the Reformed Confession before the dilemma: either to deny all this good against their better knowledge, and thus to err with the anabaptists; or to view man as not so deeply fallen, and thus to stray into the Pelagian and Arminian heresy....the solution of this apparent contradiction, that also outside the Church, among the heathen, in the midst of the world, God's grace was at work, grace not eternal, nor unto salvation, but temporal and for the stemming of the destruction that lurked in sin." (Kuyper: In E.L.H.Taylor 1970, p.59f.)

Common grace makes science and culture possible because even when men deny God and His goodness they are nevertheless (while outside the covenantal blessing of particular grace) still enabled to love, honour laws, be rational, compose music and literature, promote science. Common grace, then, has a purpose of its own. It does not pave the way for some neutral appreciation of cultural activity but rather provides a mandate for Christians to blaze the way in the cultural arena - in science, art etc..

But the issue is complex and apparent contradictions appear in Kuyper's work. While stressing common grace he clearly presents the pre-eminence of particular grace and the Kingship of Christ as the Mediator of redemption. Hence we cannot use this doctrine to justify a view of culture, or involvement in it, as something alongside faith in saving grace. "The only thing Kuyper's doctrine of common grace <u>can</u> justify is the acceptance of a dialectic, polar relationship between the domain of common grace and the domain of particular grace." (Zuidema 1972, p.57.)

<u>19.3.3.1. Stage One.</u> It is generally accepted that Kuyper's thought on this matter passed through several stages. Initially (about 1874)

he wished to explain the obvious apparent success of the world (in the face of his reformed doctrine of sin and grace) on the basis of a natural knowledge of God as the result of general revelation. This position tended to a scholastic viewpoint, especially in the idea of a natural knowledge of God as some kind of bridge between church and world. This tended to a nature-grace dualism.

19.3.3.2. Stage Two. The question is placed on a wider canvas in his study 'De Gemeene Gratie' (1895). In this work he revived the archaic form of grace in the Dutch language, that is gratie, to represent common grace and to distinguish it from genade which referred to saving grace. Kuyper now saw common grace as of independent character and content, quite distinct from particular grace, for there was a common grace of God to those who remained under sin. Particular grace meant God made a new beginning through the Incarnate Christ; common grace meant God perpetuated the old through Christ as Second Person of the Trinity. Furthermore, common grace has a negative and a positive function. Negatively it serves to restrain sin, to conserve the things of creation in being despite the Fall. Positively it is seen as referring to the yet to be developed possibilities that man has in his creational calling to unfold and rule creation. This again treads close to a dualistic construction between common and particular grace as a distinction between earth and heaven, creation and re-creation, cultural activity and salvation. Klapwijk notes: "There is in all of this the threat of a spiritualising dualism which expresses itself in a separate directedness to the hereafter and to the present." (1973, p.54.) Yet, as Klapwijk also notes, there are places where the solution to this problem breaks through even from the pen of Kuyper. Christ, through His cross, bears not only the future but also the present; Christ has all power in heaven and in earth. Thus Christ is also King of common grace and Kuyper can give his famous aphorism that: "There is not a square inch of our whole human existence of which Christ, who is sovereign over all, does not say: Mine!" (In Klapwijk ibid p.54.)[4]

Yet Kuyper was open to criticism in his philosophical distinction between the essential basis of particular grace as supernatural and

4. This quotation appears regularly in discussion in English and takes several slightly different forms.

belonging to the arena of glory; while restricting common grace to the realm of creaturehood. This has justly been criticised as a dualistic/spiritualistic/eschatological conception where the unity of the Christian life is fragmented such that salvation does not truly involve the created order.

This may seem far removed from the concerns of natural science. Yet it is crucial for common grace is a pivotal doctrine with respect to the creational order - and science is very much concerned with the structures of creation. Thus Kuyper can claim that science is God's own creation (cf. Klapwijk ibid p.54.) Science is the fruit of common grace. But sin has darkened the reason of man and therefore without common grace all science ends in total deceit and illusion.

> "What does it mean that our thinking is darkened by sin? Not that we can no longer think logically or observe with our senses. It means that we no longer see things in their mutual connections and divine origin. Context and origin is not simply read off from things. Our spirit could still sense these relationships as long as it stood in a living relation with God, but just this property is lost because of sin. We can still see various parts of creation but we no longer understand its unity, origin and purpose. Here we can cite one of Kuyper's famous images: Man has become like an insane architect who, shut up in a cell, peers out of the window and stares at the walls and spires of his building without being able to understand the motive of the structure." (Klapwijk ibid pp.54-55.)

But in common grace God has provided for the valid scientific activity of men such as Plato, Aristotle, Kant and Darwin.[5] Thus, with appreciation to God and not to men, Kuyper can see the worth of pagan and profane thought. Yet he gives a radical critique of, and opposition to, non-christian science. He divided science into the physical sciences and humanities, with no sharp antithesis in the former but a clearcut antithesis in the latter. This meant an ambiguous approach to non-christian thought.

<u>19.3.3.3. Stage Three.</u> This final stage is reflected in his famous Stone Foundation Lectures - in 1898 (Cf. Kuyper 1931). Here he again takes cognizance of the value of the non-christian thought world. Far from being written off it is to be seen of worth and interest for the Christian.

5. Kuyper sees these men as those who have shone as "stars of the first magnitude." (1895, Vol.III, p.498.)

"Precious treasures have come down to us from the old heathen civilization. In Plato you find pages which you devour. Cicero fascinates you and bears you along by his noble tone and stirs up in you holy sentiments...". (Kuyper 1931, p.121.)

However he now saw the basic systems of Christian and non-christian thought in both natural science and the humanities as of essentially antithetical character. He developed this through the two irreconcilable mentalities involved. On the one hand the non-christian views the world as normal (the Normalist view); he refuses to see anything other than the natural world around; he lives in a closed universe. On the other hand the Christian (the Abnormalist) realises he lives in a fallen world, that things are not now what they were meant to be. This is not a clash over the data of science, nor is it a clash between faith and science.

"Not faith and science therefore, but <u>two scientific systems</u> or if you choose, two scientific elaborations, are opposed to each other, <u>each having its own faith</u>. Nor may it be said that it is here <u>science</u> which opposes <u>theology</u>, for we have to do with two absolute forms of science, <u>both</u> of which claim the whole domain of human knowledge, and both of which have a suggestion about the supreme Being of their own as the point of departure for their world-view." (ibid p.133.)

So Kuyper posits an antithesis between regenerate and unregenerate scientia (cf. Kuyper 1898, pp.28-32, 49-51.). Accepting the biblical doctrine of the Fall of man it follows that all of life, including scientia and scholarship, has been radically affected. Sin affects not only moral qualities but theoretical thought. God's work of rebirth and renewal in the lives of men is not therefore to be shut up to some 'religious' sphere, the church or our private, devotional life. Rather, in line with the biblical conception of the radical unity of man in his religious root (heart), regeneration is of crucial importance for the true exercise of theoretical thought.

This does not mean that Christian and atheistic physicists are implacably opposed in the technical details of their discipline. Special grace does not give the Christian a better understanding of technical matters and we must remember that all physicists <u>qua</u> physics work in the realm of common grace - common to regenerate and unregenerate. In science the difference between the Christian and the non-christian is not apparent in the normal activities of weighing, measuring or counting (cf. Kuhn's normal science?). Kuyper held that observation was non-abstract in character and that looking through a microscope or telescope was merely a form of observation. But the difference between the two mentalities became crucial when facts were interpreted. Indeed true science only emerged for Kuyper in the interpretation. In weighing etc. particular grace has no effect, but in interpretation particular grace has a decisive effect for the Christian is grounded in the assumption of God as the final and self-contained reference point. So for Kuyper the battle was to be fought at the level of human consciousness and not in the arena of scientific data. (Cf. C.van Til 1957, p.27.)

19.3.3.4. Evaluation. Some have simply read off from Kuyper's anti-dualistic statements the claim that he is opposed to all forms of dualistic thought. This must be questioned. Zuidema contends that Kuyper's 'nature' (re. common grace) and 'grace' (re. particular grace) function as polar opposites. Thus while he wishes to avoid a dualism of two total antithesis which will exclude one another such as light and darkness, truth and error, nevertheless his thought "rides on a dualism of two contrasting poles which at once attract and repel each other." (Zuidema 1972, p.68.) Hence he can talk of common grace in contrast with particular grace such that the two realms take the form of a dualism and appear to exclude one another (cf. ibid p.77.). This is amplified by the restriction of common grace to the domain of the visible and temporal, to the original creational structures and ordinances.

But it would be manifestly unfair to accuse Kuyper of the dualism of sacred-secular. Common grace is after all still grace; it is still under God; it is not neutral. Indeed for Kuyper there is no 'neutral sphere' in the life of man which may be seen apart from God, but only God's creation as it unfolds itself in history. In our criticism of any common-particular grace dichotomy we should remember that Kuyper would have nothing to do with a two-level theory of truth which sought to divide the religious-ethical from the scientific life of man. "What is true religiously must also be so scientifically. The seamless robe of truth may not be torn assunder." (H. van Til 1974, p.126.)

Hence Kuyper struggled to transcend his polar patterns of thought and drive through to a deeper unity (cf. the quest of Einstein). What he wished to show was that:

> "...<u>grace</u> and <u>nature</u> belong together and that you cannot see the richness of <u>grace</u> if you do not see how its root fibers everywhere penetrate into the joints and rifts in the life of <u>nature</u>. Now this connection you <u>cannot</u> see if 'grace' makes you think first of the salvation of your soul and not first and foremost of the <u>Christ of God</u>. It is for this very reason that Scripture constantly reminds us that the <u>Savior</u> of the world is at the same time the <u>Creator</u> of the world; in fact, that He could only become its Savior <u>because</u> He was its Creator." (Kuyper: In Zuidema 1972, p.99.)

In the final analysis we must learn that science is not vitiated by subjectivity - the modern 'heresy' of the philosophy of science - but by sin. It is here that the question of antithesis develops between truth and falsehood. Those living in a closed universe do not, and will not, recognise the deleterious impact of sin on man's capacity to advance his knowledge. Nor is this a conflict between science and faith since faith is the presupposition of every science, the formal function of the life of the soul which is basic to every fact of human consciousness. The conflict is not between faith and science, but between two scientific systems each with its own faith. Nor can we oppose science and theology for each absolutely claims the totality of knowledge. The confrontation is not in the field of data <u>per se</u> but at the level of human consciousness.

One of the best modern critiques of Kuyper's doctrine of common grace is from the pen of S.U. Zuidema who writes that:

> "Kuyper's doctrine of common grace is there for the sake of his doctrine of particular grace; and first and foremost for the sake of his doctrine that particular grace gives birth to Christian action which is as broad as life and which is not only impossible and not forbidden, but possible and even mandatory. With this doctrine he summoned God's people, "the church organism" to distinctive Christian activity, to activity <u>pro Rege</u>, to "antithetical" activity especially, not in the last place in the form of separate organisations." (1972, p.59.)

Later he adds:

> "A full picture of Kuyper is not given unless it is also shown that he did not halt before his self-imposed problem, but broke through to the confession that truly Christian action is possible also in the domain of common grace." (ibid p.96.)

Thus we come full circle to the fact that despite his polar opposition of common and particular grace, Kuyper in the end sees the only centre of common grace in the particular, or saving, grace <u>pro Rege</u>. Ultimately the fruits of common grace are to be brought eschatologically into the coming Kingdom.

19.4. KLAAS SCHILDER (1890 - 1952)

Schilder has been called "the greatest cultural theologian in Reformed circles since the days of Kuyper." (H. van Til 1974, p.137.) But he differed radically from Kuyper in rejecting the doctrine of common grace and substituting for it the common mandate doctrine. In the common mandate of Genesis to man he perceived that there was to be an evolution and development of creation abetted by the cultural activity of man. For Schilder the instinct of culture was implanted in Paradise as a God-given and God-glorifying activity. After the Fall this instinct became egotistical and self-glorifying. Through sin, man fell in love with himself and with the tools of his culture.

So Schilder rejects common grace and the idea of a common terrain shared mutually by believers and unbelievers.[6] This, he claimed, was to avoid constructing a neutral area between the contending forces of the world and the church. The Fall did not result in a division of the world into two sectors. The cultural mandate and the urge to dominate creation are still common in the experience of man. So there is still one nature but a twofold use of it; one territory but a twofold development of it; one cultural urge but a twofold cultural striving. On the one hand Godless cultural striving never truly ripens or is fulfilled; instead of a science being unfolded truly it is marred and paralysed. He further criticises the idea in common grace that we are permitted to develop and subdue the earth while God holds back the full effect of sin. Much more positively, he argues, we are 'commanded', not merely 'permitted', to cultivate and subdue the earth. Thus Schilder seeks to break out of the antithesis between God and the world. Like Calvin, Groen and Kuyper, he shares the vision that the whole of the life of man is lived before the face of the Lord. Writing of Schilder, Henry van Til says:

> "For we have a Christ, who as king, observes not only how we pray, but also how we handle the spade, the hammer, the book and needle, the brush and whatever instrument we may work with, to draw out of the world what God has put into it." (1974, p.147.)

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6. Cf. H. Hoeksema (1973) who rejects the whole idea of common grace and common mandate from within a Reformed perspective.

19.5. HERMAN DOOYEWEERD (1894 - 1977) [7]

In 'Reformational' thought the most significant figure in the 20th century is Herman Dooyeweerd. He contends that non-christian scientia and philosophy ought to be appreciated inasmuch and insofar as it is confronted with 'states of affairs' which conform to the law-structure of creation and which therefore force themselves on every man. The atheist still lives in God's creation and is confronted by God's incontrovertible states of affairs. Men may give new meaning and significance to certain states of affairs, but such possibility is always limited and never arbitrary. The meaning men give to states of affairs is always contained within the framework of the 'divine-meaning-stipulation'. [8] God alone is Creator and thus the final law and meaning-giver of creation. In his philosophy of the Cosmonomic Idea, Dooyeweerd thus solves Kuyper's problem as to how to arrive at a Christocentric yet non-ecclesiastically orientated view of culture. He does so by making a sharp distinction between religion and faith such that while his view of culture and science is religiously rooted in Christ, it does not imply any direct connection with ecclesiastical bodies or creeds.

19.6. THE RUSSELL - HELM DEBATE

Paul Helm, a professional philosopher, has attacked the 'Amsterdam philosophy' contending that it "derives its almost magical appeal from certain dominant metaphors," and has had "the effect, not of allowing Scripture to influence various areas of life, but of limiting its influence."[9] Helm seems concerned philosophically to defend the linguistic analytical tradition, and theologically to defend the centrality of an individualistic soteriology. Thus he concomitantly defends a neutralist position in the realm of nature. Praising Kuyper's "magnificent and truly liberating" vision of the cultural mandate he claims that this stress is misleading in some of its modern proponents such as Dooyeweerd (cf. Helm 1973, p.5.).

Richard Russell argues that Helm reflects a clear dualism with no internal relation between faith and knowledge (1973, p.86.). He contends that much of the problem stems from Helm's commitment to

7. I say little here concerning Dooyeweerd as I will draw heavily from him in Part IV - cf. 19.7.
8. While a radically apostate worldview motivates non-christian thought this in no way negates God's presence in such thought.
9. Cf. 'The Banner of Truth' Issue 118-119, July/Aug 1973, p.39.

linguistic analysis as a neutral criticism and clarification of meaning. For Helm there is Christian commitment in the realm of grace but not in the realm of nature where only the moral and spiritual aspects of natural activity are to be seen as involving Christian commitment.

This debate has broken out afresh in 'Third Way'. In an article entitled 'Developing a Christian Mind', Helm argues that truth is independent of mind and that traditionally three inadequate Christian attitudes have been common: (a) the two worlds mentality which divides the spiritual and secular; (b) the idea that everyone shares a 'set of truths about the world' which can be known for certain (such as mathematics, laws of nature etc.) and that the Christian adds 'another layer of truths' to this; (c) the narrow viewpoint that nothing can be known except from a Scriptural basis. Then Helm calls for an <u>interactionism</u> between Scripture and the theories/findings of the secular disciplines. (This immediately suggests that he is not entirely free from (a)/(b) above.) He welcomes a policy of interactionism because it obviously allows for the comprehensiveness of Scripture while at the same time allowing for its unevenness. While Scripture says a lot about guilt and forgiveness; a little about the geography of the Middle East; on many matters it is silent. "Paradoxical though it may be, it seems that the teaching of Scripture about many matters is that it has nothing to teach about these matters." (1977, p.8.) Interactionism also recognises the theologically undeterminate character of Scripture which therefore avoids equating it with a particular theory in the secular realm; it recognises the centrality of hermeneutics in the light of the non-self-interpretation of the Bible; and it recognises that there are sources of knowledge outside Scripture.

A few weeks later a sharp rebuttal of this argument appeared from Russell. He sees, despite Helm's initial reference to the inadequacy of a nature-grace dualism, the whole policy of interactionism as a form of "dualistic nature-grace mentality." (Russell 1977, p.7.) The very metaphor of 'two-way traffic' between the Christian mind and the secular realm which Helm posits smacks of dualistic thought. Thus Russell critically exposes the antimonies in Helm's argument. He accuses him of seeking to deny any division of sacred-secular but then tacitly operating within a dichotomous mentality. While Helm seeks to construct a neutral hermeneutic out of the secular realm (i.e.

linguistic analysis) and apply it to Scripture, Russell suggests we must "understand that the Christian religion is a whole way of life for the people of God within the covenant, rather than a way of individual devotional life and worship." (ibid p.9.)

19.7. PARAMETERS FROM THE COSMONOMIC IDEA

In this section I wish to outline some of the basic concepts which devolve from the Cosmonomic Idea on this study, and which frame my thought. This is not an argument for their validity, but merely a brief statement of some of the central facets.

19.7.1. The Religious-Faith Nature of Scientia. (Cf. 20.1 and 20.2.)

> "The way of knowledge certainly leads through the senses, but it extends farther. It is also continued from the sense through the nerves and the brain, and back of these out of our sensorial avenues to that mysterious something which we call our consciousness, and, in the centrum of that consciousness, to what we call our ego."(Kuyper 1898, p.41.)

It is not enough to stop at the senses for the question as to how the ego arrives at some degree of certainty concerning perceptions will remain. What must be concluded is that the ego believes. So faith becomes the starting point for any observation or demonstration, as well as bringing a motive to the construction of science itself. General conclusions would never be reached if faith had not postulated their idea and desirability. Despite the logical necessity of faith it is all too often overlooked.

> ".....in scientific investigation faith is virtually taken as a quantity that can be neglected, because it is the same in all, and therefore makes no difference in the conclusion. This, of course, ought not to be so, and an ever stronger protest should be raised against this superficiality which is so unworthy of the name of science; but the false antithesis between faith and science is so generally current, that they who value science most, as a rule, prefer the removal of the last vestige of the leaven of faith." (ibid p.44.)

Interestingly the arguments of Kuyper here can be amply backed up from the writings of Einstein who talks time and again of the religious feeling apart from which science is impossible - a feeling for the harmony of natural law, a feeling for the intelligent ordering of the universe, and an aspiration for objective knowledge that can only be ultimately explained on religious grounds. (Einstein 1973, p.40f.) And despite his pantheism, Einstein points to the Judaistic-Christian tradition as containing the highest principles consistent with these religious feelings. Coulson sums it up when he says: "Science itself must be a religious activity." (1971, p.44.)[10] If religion is the total response of a man to his total environment, then science as a facet of that environment is a facet of that religious stance.

Dooyeweerd and Vollenhoven posit the religious core of man's existence as the determining factor in all of life and thought. The human 'I' stands in three relations - to the modal aspects in which it functions; to its fellow man (I-Thou relation); and to God. Only this final relationship, manifest in the deepest essence of the selfhood, is essentially determinative. If God is not acknowledged, it is inherent in the nature of man to replace the Deity with some idol, some (pretended) origin (arche) whether internal or external to his own being. This bond between the 'I' and God/idols is religion; the connection of a meaning of creation to the Being of the Arche. The heart of every man is religious, and for this reason the selfhood is called the religious root of our existence. So Dooyeweerd makes a sharp distinction between 'religion' and 'faith'. "The religious I necessarily shows itself in the faith aspect as it does in all the other aspects. This is true for all people without exception." (Kalsbeek 1975, p.157.) Seerveld writes of this as follows:

> "By religious motive then....Dooyeweerd means the actual transcendent dynamis....which takes hold of a person's heart, fills and dominates, consciously or unconsciously, his every action. Religious motive is the moving power, the dynamic working of God's Spirit or an idolatrous Spirit at the very roots of man, who so captured works it out with fear and trembling and curiosity." (1965/a, p.194.)

Hence any unqualified objectivity in science is an illusion for all human activity is characterised by subjective elements at the centre of which lies a religiously directed faith of some sort. Faith in the existence of the object to be investigated in the condition sine qua non of all science. Thus science can be seen to possess presuppositions and moral commitments that point to an ordered universe and unifying hypotheses for which no proof can be presented. Distinction needs to be made between 'presupposita' and 'presuppositions'; the former are universal and necessary while the latter are the subjective view of the presupposita (cf. glossary).

In the breakthrough to the world of nuclear physics the

10. Or conversely, as the physicist Richard Schegel stated it: "Indeed, in an effective way, science is for many the religion of our age." (1967, p.254.)

following was written of Fermi:

> "When one member or another hesitated and seemed doubtful, then the Truth fell from Fermi's lips; what he said was 'an article of faith', he put the heretic back on the right road - he was infallible. In short, he was soon called 'the Pope'. (de Latil 1965, p.41.)

Of faith there can be no doubt; of infallibility certain error.

19.7.2. The Arche. A starting point is necessary for any statement or theory. The question is whether the starting point will bear the weight of the structure built on it. Is the arche rock or sand? Einstein noted that: "In order to construct a theory, it is not enough to have a clear conception of the goal. One must also have a formal point of view..." (1973, p.328.) Or as Dooyeweerd put it:

> "This fixed point from which alone...we are able to form the idea of the totality of meaning, we call the Archimedian point of philosophy. However, if we have found this Archimedian point, our selfhood makes the discovery that the view of totality is not possible apart from a view of the origin or the arche of both totality and speciality of meaning. The totality in which our selfhood is supposed to participate, may indeed transcend all speciality of meaning in the coherence of its diversity. Yet it, too, in the last analysis remains meaning, which cannot exist by itself, but supposes an arche, an origin which creates meaning. All meaning is from, through, and to an origin..." (1969, Vol.I, p.8f.)

We cannot begin in science until we have chosen this starting point, and this factor is recognised even by those who have little time for formal religion (cf. Theobald 1969, p.18.) The problem of knowledge and truth is that for any degree of certainty to be entertained a starting point in the non-cosmos is required, and this is impossible as long as sin confines man within the consciousness of the cosmos. Thus ultimately the only starting point big enough is that given to man in revelation from God (cf. Popper 1972/a, p.29f.); and in an awareness of the self-consciousness and self's relation to its Creator. On this question man will either presuppose God as in all and through all and above all; or he will presuppose himself as the basic reality of being.

It is not enough to write as Planck does that:

> "Religion and natural science are fighting a joint battle in an incessant, never relaxing crusade against scepticism and against dogmatism, against disbelief and against superstition, and the rallying cry in this crusade has always been, and always will be: 'On to God'." (1950, p.187.)

These are well known words and quoted approvingly by many Christian writers (e.g. Coulson 1971, p.83.), but they fail to detect the inadequate philosophical nature of this statement. We must start from God and see all as within His power and under His hand in creation; it is not a question of reaching out from the sinful finite to the infinite being of God.

19.7.3. Pre-Theoretical Thought (cf. 21.1.4.). Distinction has to be made between theoretical and pretheoretical thought (common, everyday thought). In the former the theoretician abstracts from the totality of being; he is discriminative and analytical, and endeavours to maintain a certain distance between himself and the object of his investigations. This is as true for the theologian as the mathematician. In pretheoretical thought a person experiences closely life-in-its-totality or fulness. This does not mean that a sharp delineation need be drawn between the two modes of thought - Dooyeweerd does, van Riessen does not. The psychologist possesses a certain theoretical knowledge about a child; the mother also knows certain things about the child in an intuitive wholeness. To posit the question of whether the psychologist or the mother 'knows' the child best is to present a false dilemma - both truly 'know' the child, but in different ways.

Scientifically, of course, pretheoretical thought is inadequate; yet at another level it has been said that "science is merely common sense writ large." (Popper; In Magee 1973/a, p.102.) But common sense is neither unchanging or infallible, and what is common sense for one generation (man cannot fly) is not necessarily so for another. As Popper writes: "It is part of common sense to be critical. It is part of common sense to submit our common-sense views to criticism; and science is, simply, the result of this criticism." (ibid p.102 - cf. Einstein 1973, p.293.) Pretheoretical thought is critiqued by theoretical thought.

Whatever the science it abstracts from the totality of being, and it only has meaning when it replaces the abstraction back into the canvas of the whole. There is real danger of a loss of meaning in the process of abstraction and the absolutizing of the relative.

19.7.4. Law Spheres (cf. 23.4.). This is an integral part of the philosophy of the Cosmonomic Idea as developed by Dooyeweerd, though the concept is by no means original to him. There are certain spheres of reality, which though not existing autonomously, have a certain particular character and structure.[11] One of the errors men have made is to try and explain all of created reality from one of these aspects (cf. Appendix E). Each of these spheres is characterised by some specificity, a modal moment or nucleus which cannot be further reduced in meaning. This does not mean that each kernel exists in and by itself, but rather that there is an aspect of empirical reality whose modal meaning can only reveal itself within the inter-modal meaning-coherence of all other aspects. The spheres have a specific hierarchy of order and are connected by 'anticipatory' and 'retrocipatory' moments - the former regulative and the latter constitutive (cf. glossary). Thus the _faith_ modality is characterised by the modal moment of transcendent certainty regarding the Origin of all being and meaning; the _ethical_ by love of one's neighbour; the _juridical_ by retribution; the _aesthetic_ by harmony; the _economic_ by thrift; the _social_ by social intercourse; the _linguistic_ by symbolical signification; the _historical_ by cultural processes of development; the _analytical_ by theoretical distinction; the _sensitive_ by feeling and sensation; the _biological_ by organic life; the _physical_ by energy; the _kinematic_ by movement; the _spatial_ by extension; and the _numerical_ by discrete quantity.

19.7.4.1. Sphere Sovereignty - cf. glossary.

19.7.4.2. Sphere Universality - cf. glossary.

19.7.4.3. Enkapsis - cf. glossary and 21.4.4. All structures in creation are mutually intertwined and interwoven in an universal, unique and unbreakable fashion. The importance of this concept is indicated in the index to Dooyeweerd's magnum opus where there is over 12 pages of references to it! (1969, Vol.IV, pp.51-64.)

19.7.5. Common Grace - cf. glossary and sections 19.3.3. and 24.2.1.

19.8. THREE FURTHER POINTS

19.8.1. Linguistic Analysis. The above features are integral to this study, but here I wish to reject a particular philosophical tradition which exercises a strong influence on the thought of many in the Anglo-

11. It must be emphasised that this system is not a finalised arrangement, rather it is a working model open to development, and Dooyeweerd himself has raised the number of spheres from fourteen to fifteen and changed the 'psychic' to the 'sensitive' sphere.

American culture.[12] Undoubtedly language is necessary and man alone within physical creation is a verbaliser . It therefore behoves any serious argument that it entertain a certain degree of precision and rigour in the use of language. Language, written and spoken, is necessary to hold concepts together, to give them body, and to communicate them; but to descend to a debate about words themselves, and the meaning structure of words alone, seems a retreat from reality. Popper at the start of his 'Logic of Scientific Discovery' gives a telling quotation from Kant:

> "I for my part hold the very opposite opinion, and I assert that whenever a dispute has raged for any length of time, especially in philosophy, there was, at the bottom of it, never a problem about mere words, but always a genuine problem about things." (In Popper 1972/b, p.13.)

Or as Popper himself put it in a radio discussion:

> "To this I can only say: I have spectacles, and I am cleaning my spectacles now. But spectacles have a <u>function</u>, and they function only when you put them on, to look through them <u>at the world</u>. It is the same with language. That is to say, one shouldn't waste one's life spectacle-cleaning or in talking about language, or in trying to get a clear view of our language, or of 'our conceptual scheme'. The fundamental thing about human languages is that they can and should be used...." (In Magee 1973/a, p.173.)

<u>19.8.2. Truth.</u>(cf. 12.5 and 15.3.5.) While science can never attain exhaustive truth, while it is not, and never will be, truth itself, it nevertheless moves towards the disclosing of truths of our existence. It might seem naive to suggest that propositions are either true or false, but in our day this issue has become clouded by the intrusions of the linguistic analysts, and others, who by the manipulation and dissection of language posit all sorts of conumdrums.

I make two points: the first in the realm of the sciences and covered in the following quotation from Davies:

> "General scientific theories can never be established as absolutely true, in the way that mathematical propositions are true; but certain theories, particularly those of lower generality, have been so repeatedly confirmed in spite of extensive sharply defined tests, that we regard them as true...." (1975, p.22.)

The second point relates to the apparent separation of verification from the content of religious belief, especially as found in some

12. There is, of course, much that is positive in the philosophy of language, especially in a creative thinker like Noam Chomsky.

modern formulations. But as J.S. Bezzant complains:

> "...when I am told that it is precisely its immunity from proof which secures the Christian proclamation from the charge of being mythological, I reply that immunity from proof can 'secure' nothing whatever except immunity from proof, and call nonsense by its name." (1963, p.78.)

Undoubtedly there are problems between science and Christian faith - but the approach to be pursued is critical examination, not evasion.

19.8.3. Traditions. In philosophy, science and theology most theoreticians seem able to discern the distorting influences of the various intellectual traditions on their fellow commentators. Generally they seem to regard themselves exempt. But no one can think in isolation from his environment or be absolutely original, no one can posit an entirely new system of thought, or some basic new starting point. This does not, of course, mean that we must bow to the received traditions - criticism is called for. Christian thought is required of the Christian scholar no matter what field he is in; but he must also be aware of the influences of the intellectual traditions in whose line he stands, and on the effect of the current environment on him. Then in the light of this strive to bend those traditions into paths conformable to the Word of God.

> "Christians of whatever tradition....have to recognise in principle the de facto influence of the Western philosophical tradition in their own thinking. This means that we are all to some extent synthesis thinkers - meaning by that term the intermingling in a single perspective of both biblical and unbiblical patterns of thought....the task of philosophical reformation, as opposed to attempted evasion or domestication, is the only alternative for any Christian who wants to fight synthesis." (Wolters 1975/a, p.14.)

Reformation is called for and not revolution or acquiescence; and this will mean "working along the grain of history, respecting what is good in the tradition and bending it around to move in another direction." (ibid p.15.) Thus the Christian scholar is ever working for that which is 'semper reformanda' and not simply 'reformata'.

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POSTSCRIPT TO PART III

I hope I have indicated something of the problem of labelling views as Liberal, Evangelical or Reformed. I would note an apparent confusion of terms between 'science' (as traditionally understood in our culture) and 'scientia'; and between 'faith', 'religion' and 'theology'. I find it impossible to follow Morris' view that the Bible is a scientific textbook; yet I also find difficulty with the concept of an analogy between science 'and' religion/theology in the work of Barbour and Torrance. It seems to me that the attempt to compare disciplines in this way is futile for each sphere of abstractive reflection is unique in itself. Eddington once remarked: "Those who look over his (sc. scientist) shoulder and use the present partially developed picture for purposes outside science, do so at their own risk." (1930, p.353.) Each discipline has an inner kernel of meaning that is irreducible and therefore uncomparable with any other sphere in a theoretical manner - although I would emphasise the modal anticipations and modal reciprocations that do exist (cf. glossary). While there may be points in common in that all theoretical activity is human and therefore reflects man's humanity; owning allegiance to some overall worldview; and that spheres qua spheres cannot be reduced to one another - this is merely general comment. I believe that we should talk about the relationship of the religious heart of man and scientia, but not about theology and science which are diverse branches of scientia. Nevertheless a caveat is necessary in case it be thought this advocates that disciplines do not interact. A sphere (or mode) is not a discipline <u>per se</u> and undoubtedly disciplines interact, enrich and enlighten one another. Yet I remain unconvinced of the attempt to examine science and draw theological analogies from it. Natural science and theology should both be carried out in the light of the Word of God. This is why my interest is not in developing a theology of science (or theological science) but in a theology which makes science a creative possibility and gives impetus to scientific activity - recognising that it and science are both scientia.

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PART IV

TOWARDS A CHRISTIAN PERSPECTIVE

PREFACE

Having noted various Christian responses to science I now wish to set down my own views of a Christian perspective concerning the religious and theological foundations of science. I must stress that what I present is open to development. Many of my conclusions are tentative. One typical area where my mind has changed at least twice in the last three years concerns the distinction between abstractive and pre-abstractive thought (cf. 21.1.4.). In turning to the final part of my thesis I would draw attention to the preceeding sections: 3.5; 4.3; 4.4; 6.2; 9.4; 11.6; 12.5; 16.5.2.2; 18.1.1; and ch. 19.

Chapter 20 seeks to clear up some of the confusion concerning the nature of religion, science and philosophy. In chapter 21 I turn to the epistemological base necessary for all scientia, namely the knowledge of God, and how this bears on our knowledge of self and reality. These two chapters constitute a development of the religious foundations of science (cf. Part II). What follows can be understood under theological foundations -- excepting chapters 23 and 27 which bear equally on the religious and theological aspects. The fundamental basis which subsumes all the diverse theological facets is the doctrine of creation by the ontological Trinity -- chapter 22. Chapter 23 discusses the theological and philosophical connotations of 'laws of nature'; while chapter 24 continues this theme and also introduces the motivating doctrines of cultural activity -- common grace, cultural mandate, and man as God's office-bearer. The principles gleaned from chapters 22 to 24 are then applied in a more practical way to the environment (chapter 25) and technics (chapter 26). Here we see two aspects of man's use, domination and submission of the creation. The latter topic of technics introduces the problem of the dialectic of freedom and power which leads into a more theoretical discussion of this in chapter 27. Thus chapters 25 and 26 stand together as two areas of practical concern; while chapters 26 and 27 stand together as concerned with the problem of the dialectic of freedom and determinism.

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CHAPTER 20

THE RELIGIOUS AND PHILOSOPHICAL BASIS OF SCIENCE

It is imperative to briefly discuss certain fundamental questions. Hence in this chapter I focus on the questions: what is religion?; what is science?; and what is philosophy?

20.1. WHAT IS RELIGION? [1]

20.1.1. The Nature and Scope of Religious Life. One thing is clear from Scripture: the Kingdom of God is as broad as creation and must not be limited to, or confused with, one area of that creation. There is no confusion of the institutional church (which is not a creational ordinance but relates to the redemptive work of God within creation) and the Kingdom (territory and rule) of God. Equating church and kingdom confuses the implications of the kingdom for the totality of life.

Confusion will also be inevitable when one begins with the presupposition that the order of creation is split into two realms of a higher and lower character. Anyone holding such a dualism, no matter what he does or thinks, will operate within and from out of this two-realm view; not only will he start with an *a priori* split of reality, he will start *from* such a split. It follows that all such thought will rearrange the various states of affairs within creation to suit this worldview.

> "The result: in one fell swoop (executed at the very beginning, or accepted as 'done') the total life of man before God - Religion - is reduced to man's cultic life in the institutional church. In this way all the non-ecclesiastical areas of life are denied the character of religion, of direct service to God. The creation-order is 'split' into two realms or regiments, a 'spiritual' realm of the church, of grace, of faith, and a 'worldly' realm of the *rest*, of the state, of commerce etc." (Olthius, J.H. 1970, p.118.)

If religion is not to be reduced to church plus devotional life, what is it? Dooyeweerd contends that religion is:

> "...the innate impulse of human selfhood to direct itself toward the *true* or toward a *pretended* absolute Origin of all temporal diversity of meaning, which it finds focused concentrically in itself." (1969, Vol.I p.57.)

1. The thesis here presented utilises the concept of religion in a different manner from normal - namely that 'life is religion'.

Religion, as the ultimate concern of man, the absolutely central core of human existence, transcends all the diverse aspects of temporal reality (cf. Tillich). It is not in essence a temporal phenomenon and can only be approximated in the concentric direction of our consciousness and not in the divergent direction. This means that any attempt to arrive at the content of religion from a phenomenological sense is not possible. True religion can never be explained by a mode of being, such as the psychological or historical, for true religion is an absolute self-surrender. All men make such surrender for it is the created nature of them to do so; either they will surrender to the God who is there or they will think they are something in themselves and surrender to an idol, an absolutized relative. Science unfolds reality in terms of theoretical abstractions and therefore teaches us neither a knowledge of a deeper unity, nor the origins of our abstractions. It is only religion that motivates the search for unity and origin for it is it alone that compels us to concentrate the relative upon the absolute ground of all. Thus true religion drives men to the knowledge of God and self; while idolatrous ground-motives compel an absolutization of that which is relative, a deification of that which is created. When someone absolutizes a relative aspect of created reality they can no longer comprehend any of the aspects of reality in their intrinsic character. (Cf. Taylor, E.L.H. 1970, p.358.)

Religion is not something aspectual in life but undergirds all of life. Commenting on 1 Peter 2;7f, F.W. Beare writes:

> "There is considerable boldness in the language which describes the Christian Church as 'a race', 'a nation', 'a people' - when in literal fact it embraced members of many different races and nations....Yet it must be remembered that there was a distinct tendency in the ancient world to think of religion as the essential basis of community, and of common religious observances as the determining feature of nationhood and the one really significant factor of homogeneity." (1947, p.92.)

20.1.1.1. Religion and Worship. Nothing may be excluded from religion. This distinguishes religion from worship, for while religion involves the whole of life, worship involves only a part. Men are called to worship God, and to their daily task where they are to carry out their work through faith and seek His glory. "The entire life of the believer is religious. Prayer is therefore no more pious than work. To worship is not more pleasing to God than to be engaged in science." (Spier 1966, p.5.)

20.1.1.2. Religion and Faith. Religion is distinct from worship and from faith. Faith functions in cosmic time and is bound to the temporal coherence of meaning with the other aspects of our existence. While Dooyeweerd makes this crucial distinction he nevertheless notes that the direction and content of faith are bound up with the religious ground-motive by which it is directed. Such faith is possessed by everyone; the unbeliever exercises faith just as much as does the believer, only his faith is misdirected. As the highest of the law spheres the modality of faith possesses a maximum of retrocipations but no anticipations (cf. glossary). This holds whether faith is understood christianly or misinterpreted in a humanistic sense. (Cf. ibid p.100f; Dooyeweerd 1969, Vol.I p.58.)

What is faith? The problem is the idea tacitly posited that since knowledge is specific and certain, and faith is not the equivalent of knowledge, then syllogistically faith is not certain. As O. Guinness puts it: "The way people talk about faith, you would think that rationality, inquiry, investigation, understanding and proof all joined hands to form a circle of knowledge, leaving faith outside in the cold." (1976, p.29.) But in order to know anything at all we must first of all assume certain things in faith. If we do not first step out in faith we can know nothing. Thus paradoxically in the final analysis reason can never justify itself. "Rationality is part of our greatness, but it also serves to keep us humble because rationality itself must be assumed by faith." (ibid p.31.) Nor must we think of doubt as the antithesis of faith. The opposite of faith is unfaith, or misdirected faith. Doubt is the state of suspended judgement, a half-way house between one faith and another. We see something of this in the original meaning of the Greek word skeptikos - inquirer. So faith and reason must not be posited in a grace-nature dichotomy for the two only exist in interaction.[2]

As Dooyeweerd writes, concerning the importance of a clear insight into the modal function of faith:

2. If we consider Lao-Tse's famous question we see something of the limitations of reason: "If when I was asleep I was a man dreaming I was a butterfly, how do I know when I am awake that I am not a butterfly dreaming I am a man?" (In ibid p.41.) Reason alone can never stop the dizzying implications of this.

"According to the order of creation this terminal aspect was destined to function as the opened window of time through which the light of God's eternity should shine into the whole temporal coherence of the world. That this window has been closed by sin, and cannot be opened by man through his own activity, does not mean that it cannot be disclosed by the Divine power of the Holy Ghost. It does not mean that sin has the power to render this essential terminal function of temporal human existence unavailable as an instrument of God's grace in Jesus Christ, so that God would be obliged to create a new organ of believing outside of the 'natural' order of creation. Sin cannot destroy anything that is implied in the order of creation. Otherwise it would be a real counter-power over against the Creator, whereas in fact it derives its power only from creation itself." (1969, Vol. II p.302.)

Nevertheless faith is a modal function within creation and not the religious <u>dunamis</u> which transcends functional character and determines the content and direction of faith. The habit of looking on faith as equated with religion is what leads to the reduction of religion to an aspect of life. Thus we find that the kernal meaning of the temporal sphere of faith flowing from the heart of man can only be theoretically approximated as "an original transcendental certainty, within the limits of time, related to a revelation of the Arche which has captured the heart of human existence." (ibid p.304.)

<u>20.1.1.3. Religion and Theology.</u> The scientia of faith is theology. We must not confuse religion and theology. Theology is a specific abstractive discipline which reflects on God and the things which pertain (particularly) to God. In Christian theology the specific field of study is the Scriptures and the history/doctrines of the Christian traditions. Yet, like all other disciplines, <u>theology needs a philosophical foundation.</u> Either it will adopt a biblically founded philosophy or one of the diverse autonomous philosophies. This philosophical base is requisite for it alone gives a <u>theoretical</u> insight into the inner structure and the interlacing coherence of the various aspects of our existence - of which theology is but one abstracted aspect. Philosophy seeks to give a stance <u>vis a vis</u> the whole of reality as opposed to the specific disciplines which are abstracted aspects.

We legitimately reduce reality in theoretical investigations so that it may be examined, but we lose the true meaning of any aspect or mode of being if we fail to realise its place within the coherence of reality and overall meaning. This is why data <u>qua</u> data as some sort of neutral zone is wrong. Data is only meaningful data within the coherence of an overall worldview. Too often there is simply an uncritical acceptance of received worldviews with no radical attempt to examine and formulate our own philosophical awareness.

However the theoretical object of scientific inquiry can never be the full integral reality for the object of theoretical thought as such can only be the result of a theoretical abstraction. Theology is a special scientia, as are physics, mathematics, biology, ethics, etc., and therefore guard must be taken against making dogmatic theology into the arbiter as to the developing of our life and world stance.

> "...dogmatic theology is a very dangerous science. Its elevation to a necessary mediator between God's Word and the believer amounts to idolatry and testifies to a fundamental misconception concerning its real character and position. If our salvation be dependent on theological dogmatics and exegesis, we are lost. For both of them are a human work, liable to all kinds of error, disagreement in opinion, and heresy." (Dooyeweerd 1972, p.135.)

God does not speak, after all, to theologians or philosophers or scientists, but to sinners and calls them to repent and to live out their lives as unto Him. But conversely the sinner is called as redeemed person to live as theologian, as philosopher, and as scientist before God, and in his academic life or daily toil to reflect the creational structures and ordinances of God.

<u>20.1.2. Created Reality Is Not Self-Sufficient.</u> Christian Theism holds that creation is not to be seen as autonomous, as some self-sufficient entity. The Christian scholar is called to avoid the idea that reason exists as some known and defined entity in distinction from God, such that it can form an <u>ultimate</u> starting point. (Cf. van Til, C. 1971/a, p.21.) God has made all things, including man and his reason, to be in relation to Himself and to each other. It is thus He imparts meaning to creation. God alone gives this meaning, but He is not that meaning. God is above all meaning in that He is self-sufficient; He exists from and for Himself. So Spier contends that: "The <u>meaning character</u> of reality signifies that reality is relative and only God <u>Absolute</u>." (1966, p.21.) Each aspect of reality, then, is an aspect of meaning but it is not complete in itself nor capable of integrating other aspects in itself. The attempt of man at theoretical autonomy is an impossible venture for even when a man strives to implement it he can never place himself

outside of his creational relationship to God. Man, even when rejecting God, is still dependent on God for existence and meaning; he still lives in God's world. Man can reject in his thought the law-order of God's creation but that in no way obviates the reality of that law-structure or that man is bound by it.

20.1.3. Religious Starting Points.

20.1.3.1. The Arche (cf. 19.7.2.). The question of starting points is crucial yet many simply skip over them in an uncritical way, often ignoring a discussion here by stating that if someone does not agree with their starting point they are 'unscientific' - ruled (a priori) out of order. All possible starting points of scientific thought must be subjected to a radical criticism, for true critical thought does not allow the arbitrary choice of a starting point within a mode of being. Not even mathematics is exempt:

> "In pure mathematics, the problem immediately arises: How is one to view the mutual relationships between the aspects of number, space, movement, sensory perception, logical thought and symbolical signification? Different schools in pure mathematics such as logicism, symbolistic formalism, empiricism and intuitionism arise in accordance with their respective theoretical visions on this basic problem.... The first three schools, logicism, symbolistic formalism and empiricism, try to reduce the aspects of number and space to the logical, the linguistic and the sensory-perceptual aspects respectively." (Dooyeweerd 1969, Vol.I pp.47-48.)

There is a need to distinguish between ultimate and temporal starting points; and between the Arche and the Archimedian points. Augustine and Calvin, for example, had no hesitation in starting from the self as a temporal starting point but this must not be regarded as an assumption of an autonomous selfhood for they were well aware of the fact that while they could start from the self and reason outwards, this point (or origin) was in no way ultimate or integrational. The modern antithesis to their thought is seen in Descartes who began to reason from the self as the ultimate starting point with God only introduced to prevent a solipsism. (Cf. van Til, C. 1969, p.120.)

The true Arche can only be God. He is not however the Archimedian point. The Arche is referred to by the cosmos, and therefore lies outwith the cosmos; it is that on which the cosmos is dependent - the Creator. The whole question of the Arche is well summed up by Augustine when he contended that there was no rest except in God. God alone is the Arche even when men construct fallacious origins within the boundary of the temporal cosmic horizon.

<u>20.1.3.2. The Archimedian Point.</u> The Archimedian point is different from the Arche and has essentially two poles — one within man, the other external to man. The paradox is that man can only start from himself by integrating about God or an idol; he can only step outside himself by starting from himself. It might seem that the idea of an Archimedian point within man is strange, but 'I' cannot transcend myself. Therefore in this sense the Archimedian point for all of man's thought is seen to reside in the heart/soul of man. The Archimedian point is not rational thought itself, but is posited by a religious act of the self which transcends the intellect. It has been suggested that our Archimedian point is to be found, not rationally but existentially and that this transcends philosophical thought. (Cf. Kalsbeek 1975, p.58.) For the Christian the external Archimedian point is Christ in whom we find the reborn root of mankind, where we find the rebirth of self. Thus our emphasis falls on Christ as the <u>creaturely centre</u> of a restored cosmos in whom we participate in the restored centre of our individual existence and transcend creation. So the Arche and Archimedian point are sharply distinguished. There are, of course, also the false integration points of humanistic thought which tend to be bound to an absolutized mode of being. The non-christian position is tied closely to some immanentistic view, while the Christian position allows for a true integration and transcendence of reality. (Cf. Dooyeweerd 1969, Vol.I pp.8-21.)

Hence the real starting point is not the rational self but the religious motive operative and directive in the heart of man. Dooyeweerd outlines four basic motives in Western thought: the Greek form-matter dualism; the early grace-nature dualism; the modern freedom-nature formulation of this; and the Christian motive of creation, fall into sin and redemption in Christ. As one or other of these grips the heart of a man, so his life and philosophy will be directed by it. (Cf. Appendix A.) Man is either bound to the true Archimedian point of Christ or to a false idol, and Dooyeweerd argues that:

> "By seeking his God and himself in the temporal world, and by elevating a relative and dependent aspect of this world to the rank of the absolute, man fell prey to idolatry. He lost the true knowledge of God and true self-knowledge. The idea that true self-knowledge may be regained by an existentialistic philosophy, apart from the divine Word-revelation, is nothing

but the old vain illusion that the human I is something in itself, independent of God who has revealed Himself as the Creator." (1972, p.190f.)

20.1.3.3. The Heart. Recognition of the faith-direction of the heart and the importance of the Archimedian point is found in various writers. Wittgenstein writes: "The sense of the world must lie outside the world....If there is any value that does have a value, it must lie outside the whole sphere of what happens and is the case." (1961, 6.41.) C.G. Jung comments: "We always require an outside point to stand on, in order to apply the lever of criticism." (1971, p.274.) A. Camus writes: "As rivals of the Creator, they have inescapably been led to the point of reconstructing creation according to their own concepts." (1971, p.72.) We are therefore directed to examine the heart of man in its basic orientation. Scripture gives ample indication that the heart is the controlling centre of man's existence.[3] This heart is something other than our functioning or feelings, and is to be distinguished from the issues of life, such as the psychical. Since the Fall and the coming of Christ there are two basic motives operative in the heart of man. Firstly there is the motive of apostasy from the true God where we find that the religious power of rebellion leads the heart of man to deify either himself or some external facet of creation. Here is the absolutizing of the relative even in theoretical reflection. In our modern culture this has taken a predominant form in the stress on the free autonomous reason of the human personality and on the science evoked by this and directed to the domination and exploitation of nature. Secondly there is the dunamis of the Holy Spirit which through the work of Christ seeks to redirect the heart of man and the whole of creation back to its true Origin (the Father). (Cf. Dooyeweerd 1972, p.139.) Thus in the basic twofold direction of the human heart we find ourselves driven back to the doctrine of antithesis. There is no reconciliation between the kingdom of

3. The 'heart' obviously does not refer here to the physical organ and the following biblical usages can be noted: (a) it signifies the innermost being of man in contrast with external features (Jer. 29;13: Joel 2;13.); (b) it signifies the source of life (Jer. 4;18.); (c) it is the background of all wisdom and reason (Ps. 90;12.); (d) it is the background of all words and deeds (Mat. 12;34: 15;19.); (e) it is the background of our emotional life (Prov. 15;13.); (f) it is the source of sin (Gen. 8;21.); (g) it is represented as the deepest centre of our entire temporal existence where the renewing work of the Spirit of God takes place (Ps. 51;10.).

darkness and that of light, between evil and good. Therefore in principle the antithesis is absolute, permeating the entirety of existence. (Cf. Taylor, E.L.H. 1970, p.367.)

In the sense that no one can occupy a position outside of himself, our starting point cannot be separate from ourselves. Yet any such point must transcend the diversity of modal being which constitutes the cosmos. Such a point is found in the heart/soul of man. The heart, as the datum of man's life, can never be neutral before its Maker, and the choice which the heart makes in life can never be theoretical, but only religious. The heart is the concentration point, the religious root of human existence. It is directed either to God or away from God, and here we are reminded of the Augustinian distinction between the 'civitas terrena' and the 'civitas dei'. This is not the relative antithesis of logical and non-logical thought but a spiritual antithesis between the Spirit of God and the spirit of darkness. This is absolute. Thus Kohnstamm, who is not a member of the Dooyeweerdian school, can agree that scientific judgements can never ultimately rest on theoretical evaluations but must flow from decisions in which the whole personality is involved. (Cf. Kalsbeek 1975, p.47f.)

No matter what activity man is engaged in the whole personality is involved. This is, of course, quite simply to reiterate the injunction of Christ that we are to love God with all our heart, all our mind, all our strength and all our soul. This would leave no province of man's being in space and time that was not directed towards his Arche. Nothing is withdrawn from the life of religion before the face of the Creator. It would seem fair in the light of this to suggest that it is out of the heart, not out of the head, that the issues of life flow. "The heart remains the unseen player on the keyboard of philosophical thinking." (ibid p.51.)

To quote J.J. Louet Feisser, who is not a Dooyeweerdian:

> "The Philosophy of the Cosmonomic Idea has dismissed the illusion of the existence of an unprejudiced and autonomous philosophy of Reason which fails to acknowledge its own presuppositions, but which nevertheless rejects out of hand every other point of departure as being unscientific. In this dismissal, in our opinion, it has made a very significant contribution not only to the renewal of philosophical reflection in general, but also to the rediscovery of philosophia christiana, which is not the hobby of a group of religiously biased Roman Catholics or Calvinists but deserves recognition as an authentic possibility of scientific

philosophy itself." (In ibid p.51.)

20.2. WHAT IS SCIENCE?

20.2.1. The Appeal To 'Facts'. The greatest problem in facing this question is that in our British empirical culture and tradition, science is so often seen to deal with 'facts' quite independent of any significant philosophical or religious influences. This "prejudice concerning the independence of special science in respect to philosophy seems to be nearly unconquerable." (Dooyeweerd 1969, Vol.I p.545.) Rearguard actions attempt to keep philosophy and science separate, to maintain 'objectivity' in science. This line of thought is advocated specifically with reference to the natural sciences which indicates how the concept of scientia has been limited to a certain area. This tendency reveals the attempt to construct an objective neutral science in isolation from philosophical, religious and ideological influences. It is often contended: what could be more objective/neutral than mathematics or physics (cf. 13.1.)? But as we have seen from the history of science and the current state of these disciplines, philosophy is of crucial determination. It is my contention that it is not possible to draw a line of demarcation between science and philosophy in order to free science from philosophy (cf. 15.3.3.2.).

> "It would make sense to speak of the autonomy of the special sciences, if, and only if, a special science could actually investigate a specific aspect of temporal reality without theoretically considering its coherence with the other aspects." (ibid Vol.I p.548.)

Modern physics rests upon epistemological presuppositions (cf. Heisenberg's acknowledged epistemological programme) which have had to fight the formerly ruling mechanical and Aristotelian concepts of nature. Yet most physicists seem to carry on their investigations with little awareness of their philosophical implications or ground. They simply accept a received philosophical system as axiomatic (cf. Kuhn's 'normal science'). This sort of naiveté must remain a dangerous luxury which no Christian scholar can afford.

The theoretical scientist is often inclined to maintain that in his routine constructive work -- which may be dissociated from more speculative realms - he operates with technical methods and concepts which are independent of philosophical and religious choices. This is the appeal to 'reality', to the 'facts'. In spite of such claims the truth of the matter is that behind all technical methods and concepts are hidden specific philosophical postulates. It is thus wrong to reduce a real problem to a merely 'technical' one, for this is to reduce reality to an aspect. A specific problem in reality may well have a strong technical component but in the final analysis this too has a philosophical basis -- the science of metrology could be mentioned here. In ecology we are concerned with a physical problem (how to create the right environment) and an ethical-spiritual problem (what kind of environment is desired). But we must never think that religious implications affect the latter but are inconsequential to the former.

<u>20.2.2. The Coherence of the Sciences.</u> The appeal to 'reality' in scientific activity is never truly free from philosophical-religious prejudice. This follows in that it is impossible for any particular science (which is aspectual) to grasp an event in its full integral reality. Psychology, for example, gives this away when Aldous Huxley could remark: "Significantly enough the patients of Freudian therapists regularly dream in Freudian symbols, whereas the patients of Jungian therapists always come up with archetypes." (1963, p.80.) The nature of the case is that as soon as a special science is born it is confronted with philosophical problems relating to the modal structure of its special aspect which delimits its field of research, how it relates to other modal aspects and to the cohering wholeness of the reality from which the aspect is abstracted.

Under the disguise of philosophical neutrality the technical pragmatic conception of scientific activity is misleading, for it fails to confess that it itself is a particular philosophical <u>weltanschauungslehre.</u> Indeed in every modal aspect of reality we can distinguish a general functioning coherence which bonds together the individual functions of things, events or relationships <u>vis a vis</u> some specific modal law-spheres. This coherence has an independent existence to that of the differences between these things, events or relationships which function in the same sphere. We may also distinguish the typical structural differences which are revealed within a modal aspect and which are to be seen in terms of the structures of individuality of temporal reality in its enkaptical sense. Thus the functional coherence between phenomena in the physical aspect of reality is to be abstractively viewed as indifferent to the internal differences displayed by reality within its structures of individuality. Dooyeweerd contends that "there is no single science, except pure mathematics, which is not confronted with reality in its typical structures of individuality." (1969, Vol.I p.554.) Chemistry and physics, while quite different, investigate the same aspect of reality and can no longer work merely with a general concept of function.

The physical aspect of reality does not allow itself to be understood by our scientific abstractions apart from a subjective insight into the mutual relation and coherence of the diverse aspects within the overall temporal order. Interestingly a thinker from a quite different viewpoint from cosmonomism notes:

> "The prima facie view is the judgement of our personality as a whole, in contact with nature as a whole; that is, a judgement in which our entire being takes part. But the analytical or scientific view is a partial view..." (Illingworth 1968, p.32.)

<u>20.2.3. The Abstract Nature of Science.</u> Abstraction from reality is necessary for the development of thought, and as a division of labour necessary for the development of life. But this never obviates the character of science as abstractive, yet only possessing true meaning when placed back into the wholeness of reality - the wholeness of God's creation. All science "pre-supposes a theoretical view of reality, because it must continually appeal to it." (Dooyeweerd 1969, Vol.I p.559.) At this juncture we can note the distinction of Torrance between intuitive and abstractive knowledge.

> "<u>Intuitive knowledge</u> is the direct knowledge of an actually present object caused naturally by that object and not by another. It is knowledge that is immediately evident, that is, knowledge by virtue of which it can be known whether the object exists or not, knowledge in which the mind cannot fail to attain the truth unless it is obstructed. Intuitive knowledge arises, then, out of direct experience." (1975, p.79.)

(Cf. my theoretical thought). Torrance goes on to compare this with abstractive knowledge. He writes:

> "<u>Abstractive knowledge</u> is knowledge in which we apprehend something not as it is in itself, but through abstraction from its existence or through the species abstracted from some other thing. In abstractive knowledge we do not have to do with immediate experience but with ideas detached from experience and related to one another logically through the discursive reason." (ibid p.79.)

In abstractive knowledge we struggle against the basic premiss of rationalism and empiricism which would endeavour to begin with man alone in order to find a unified meaning to life. But as Torrance so succinctly puts it: "The 'autonomous reason' is, of course, a diseased form of rationality." (1969/b, p.26 – cf. Richardson 1963, p.242.) The trouble of rationalistic specialisation is that it has lost sight of the inner coherence of all things in God. In the final analysis true science relates man to nature and to God in that: "Man is seen as totally dependent upon God at every moment of his existence...ultimate ground is the Creator...The scientific quest itself takes on its full significance only within this context of creation." (McMullin 1968, pp.40-41.)

20.2.4. The Faith of Science. Faith is the foundation of every science. Scientific work is itself a religious activity (cf. Kuyper, Coulson etc.) and there can be no conflict between faith and science – though there can be a clash between a particular faith and a particular view of science, between one faith and another. The religious nature of all of life, including science, derives from the nature of human life as religion. Man is so created that he is forced to find meaning for life either in the God who created him, or in some idol, some false surrogate of his construction. Both Kuyper and Dooyeweerd claim that 'life is religion' – not that life is religious – to highlight that it is not an aspect that is religious, but all of life that is involved.

20.3. WHAT IS PHILOSOPHY?

20.3.1. The Nature and Scope of Philosophy. The Philosophy of the Cosmonomic Idea contends that no philosopher can exercise thought in an autonomous realm cut off from the revelation of God. Yet philosophy *per se* is confined to the temporal and does not concern itself with supratemporal concerns. Thus it has been suggested that when we philosophise we seek to discern the structures of creation and describe than systematically. (Cf. Kalsbeek 1975, p.35.) Philosophy is concerned with discerning overall questions concerning the integration of particular scientific disciplines – including theology – and no discipline can in fact exist in separation from philosophical, religious and pre-theoretical thought. To exist separately a scientist would have to be able to confine himself to some body of 'facts'. But the moment you ask a man who contends that he only deals with 'facts' to explain his 'facts' out will come his philosophy. It is impossible to study a part of reality without some overall view of the whole of that reality. Thus this must be seen as an essential facet of all theoretical thought - whether it be ethics or mathematics - that some general worldview is involved, which directs thought and action. Theoretical, or abstractive, thought is never simply photographic but always interpretative. Science does not merely record reality but imposes an interpretation on it that can be either faithful or unfaithful to that reality. Any given theory either corresponds validly to, or misconstrues, reality. At the centre of scientific activity lies a process of analysis, conceptualization and explanation as well as description. This can be illustrated with reference to mathematics - the most 'objective' of the disciplines. Is arithmetic to be permitted to reduce the subject-side of number in a rationalist way to a function of the principle of progression? Can it justify the conception of space as a continuum of points? Can it autonomously designate real numbers as spatial points, and so on? To simply ask such questions exposes the philosophical heart of mathematical thought. "No mathematician can remain neutral to them. With or without philosophical reflection on his presuppositions he must make a choice." (Dooyeweerd 1969, Vol.I p.549.) This is corroborated by Korner:

> "Since the philosophy of mathematics is mainly concerned with the exhibition of the structure and function of mathematical theories, it would seem to be independent of any speculative or metaphysical assumptions. Yet it may be doubted whether such autonomy is even in principle possible - whether it is not...restricted by the mere choice of conceptual apparatus or terminology for dealing with the problems of the subject.... In fact all the philosophies of mathematics so far put forward ...have been either explicitly developed within the framework of some wider philosophical system or have been pervaded by the spirit of some unformulated Weltanschauung." (1971, pp.11-12.)

It may further be argued that total objectivity is impossible for the selfhood always intrudes in any human activity. Thus as philosophy directs the general trend of thought, so also there are presuppositions behind that philosophy. Presuppositions that may, or may not, be consistent with the overall philosophical viewpoint. Science, for instance, is dependent on the concept of law and all scientists acknowledge this even though some would like to reject the idea (cf. Harre 1967, p.107.). There are presupposita that are coercive on man if he is to think and act; and at a secondary level there are presuppositions where choice is exercised (and these are essentially nothing but translated convictions.)

20.3.2. The Dooyeweerdian Critique. Dooyeweerd presents a radical critique at the frontiers of philosophy which can be summarised here by his three basic questions which he directs at philosophical reflection, and by his postulation of three transcendental ideas associated with them. The first question concerns that which is abstracted from the integral structure of reality in the gegenstand (cf. glossary) relationship and which is therefore characteristic for the structure of theoretical thought. Thus he asks what the continuous bond of coherence between logical and non-logical aspects of experience may be (1972, p.12.). The second question concerns the pre-philosophical starting point from which philosophy can receive its total view necessary to bring together the aspects which are separated in theoretical thought. That is: "What is the central reference-point in our consciousness from which this theoretical synthesis can start?" (ibid p.19.) The third question concerns the possibility of the critical self-reflection with respect to the selfhood. "How is the concentric direction of theoretical thought towards the ego possible, and what is its source?" (ibid p.22.) This question cannot be solved without knowing the inner nature of the selfhood, without self-knowledge (cf. ch.21.).

Three transcendental Ideas are correlated with these questions as essential for philosophy to begin. (a) An Idea concerning the mutual coherence and relation of the various aspects which have been set apart in the abstractive procedure. (b) An Idea concerning the root(s) or radis (radices) of the various abstracted elements - or a totality concept. (c) An Idea concerning the selfhood and of the origin(s) of reality. These Ideas are spoken of as the three moments (for they are unbreakably interwoven and correlated) of the transcendental Idea of philosophy.

20.3.3. The Pretended Autonomy of Theoretical Thought. There is a widespread pretended autonomy of theoretical thought. If all theoretical thought in any given field, that claimed to choose a starting point in theoretical reason alone, had in fact no deeper presuppositions it should be possible to settle every difference in a theoretical manner. This does not occur in either philosophy or science. Proponents of different views - working out of different paradigms - inevitably argue at cross-purposes and a debate cannot be resolved by reason alone. As long as starting points at a pre-theoretical level vary, so also will there be little room for a resolution of views at a theoretical level.

In modern Western thought the tendency is to assume the ultimacy of the self. This is clearly seen in the majority of philosophical schools and has led to a general relativism in epistemology and metaphysics. Here lies the root of the lack of confidence in knowledge and truth, because man is the ultimate starting point - and it is correctly realised that man does not provide in himself an integration point for the cosmos. This move is found even in theological circles where it might be expected there would have been a greater resistance to the idea of the primacy of man. But theology, following secular thought, has tended to move from studying as its academic field what God has said to man about man, the cosmos and Himself, to a consideration of what man has thought about man, the cosmos and God. To give another example: subjective idealism cuts the subject loose from the object of knowledge, or denies the existence of any construct beyond itself. This we have already seen in previous chapters (cf. Part II), and here the logical conclusion of this position is noted: in separating the subject and the object of knowledge, idealism must also cut itself loose from God. It too is an assertion of an independence of man from God.

Man's desire for autonomy from God, the erection of self-contained and self-sufficient systems of thought, or theory, leads to an irreducible paradox for:

> "To maintain this autonomy, they are obliged to seek their starting-point in theoretical thought itself. But by virtue of its antithetic structure, this thought is bound to the inter-modal theoretical synthesis between the logical and the non-logical aspects. Even a so-called formal logic cannot do without a synthesis between the logical aspect and that of symbolical signification..." (ibid p.19.)

Attempting to avoid this paradox invariably leads to the absolutizing of one (or several) of the modes of being, which is a reductionism resulting from the attempt to integrate all modal aspects of temporal experience as simple modalities of the absolutized aspect. But this approach has never been resolved and dualism has always crept in to the overall view. Nature and grace gave way to nature and freedom, and this is typified in the confrontation of the science-ideal and the personality-ideal. Thus Darwin absolutized the biotic aspect; Wittgenstein the linguistic; Ayer the analytical and psychical; and Kant the ethical and analytical (cf. Appendix E). But any such absolutization is itself an act of faith. As Stoker comments:

> "The materialist, for instance, may rightly contend that matter exists and that all 'things' are somehow related to matter, but how precisely does he know that matter is absolute, that of and through and to matter all things are? The absoluteness of matter he cannot observe or infer from his observations; only his religious faith, his sense of deity (with which he is creationally endowed) and God's revelation in matter makes this absolutization possible." (1971, p.51.)

Further, no absolutization of a modal aspect can be justified from a purely theoretical standpoint. Hence an absolutization cannot originate in theoretical thought itself, but testifies instead to the influence of supra-theoretical motives which "are masked by the pretended autonomy of philosophical thought." (Dooyeweerd 1972, p.21.)

The problem of this pretended autonomy of theoretical thought is that it is not critical enough of the 'I'. Dooyeweerd comments:

> "...each attempt to grasp this central ego in a logical concept and to define it with the aid of synthetically conceived modal aspects of our temporal experiential horizon appeared to be doomed to failure....The central unity of the selfhood is not to be found in the modal diversity of the temporal order. A physico-psychical I does not exist, neither a logical, a historical, nor a moral self." (ibid p.27.)

<u>20.3.4. The Secular Philosophical Options.</u> In terms of the more general secular philosophical scene in Britain today the viewpoint I would adopt would be a <u>qualified</u> critical transcendental realism - qualified by the reality of the Creator and creational structures and ordinances. It is evident that the scientific activity of man which produces/unfolds knowledge is a social activity and therefore subject to the changes of society. But this must not be seen as a tendency to subjective idealism in science - science is not existential in that way for it involves the knowledge of things, of states of affairs, which continue to exist apart from man.[4] These intransitive objects of knowledge are invariant to our knowledge of them. This view rejects classical empiricism which views knowledge and the world as surfaces whose points are in isomorphic correspondence with science giving an automatic response to the stimulus of facts. It also rejects transcendental idealism which views the objects of scientific knowledge as models, ideals, of the natural order. Here knowledge is a structure rather than a surface within which reality is viewed

4. Cf. Popper 1975, pp.42ff. - especially his reference to Winston Churchill.

and the natural world tends to become a construct of the human mind. A third option is transcendental realism where the object of knowledge is equated with the structures and mechanisms that generate phenomena. Such objects are neither reduced to phenomena (empiricism) or to human constructs (idealism) but are real structures in a real world existing independent of man. This approach leaves ample room for fallibility in human knowledge. "To be a fallibist about knowledge, it is necessary to be a realist about things. Conversely, to be a sceptic about things is to be a dogmatist about knowledge." (Bhaskar 1975, p.43.)

It follows that it is a mistake to argue from the current state of science to philosophy. If philosophy is that which undergirds science then it is non-sense to so proceed for clearly we should be moving primarily in the opposite direction. Although feedback and interaction will inevitably take place. But essentially the realist is interested in truth (cf. ibid p.166.). Yet care must be taken to avoid atomising truth. "A detail is only a detail because it is a detail of a greater whole. For this reason 'a fact' is more than a 'bare fact', and an occurrence is more than a 'naked occurrence.'" (Zuidema 1972, p.126.) The scientist is ever concerned, even in his special science, with the lawful coherence of facts, with their order and organisation. This does not negate the experimental method at the heart of modern science, but experiments are always motivated by some prior problem and therefore always directed to a solution of theoretical questions which the scientist himself has formulated.

<u>20.3.5. Two Caveats.</u> However a caveat is necessary at this juncture in case my view becomes associated with the secular humanist philosophy known as 'transcendental realism'. This philosophy, in opposition to Kant, acknowledges that the categories of thought sustain a relation to the <u>ding an sich</u>, repudiating the Kantian view that the thing-in-itself is unknowable. This viewpoint, because of its initial point of departure, misconstrues and rejects the pre-abstractive experience of reality.

Secondly, while I wish to stress the underlying role of philosophy in science it is beyond question that man is not in the first instance a philosophical being.

> "It is out of the question that any creature behaves at root philosophically in his totality or in his concentrating selfhood. This is certainly beyond dispute with respect to the

plant and animal kingdoms. However, man also is not a 'philosophical being,' and also the man of philosophy, qua man, is more than philosopher, and qua philosopher, does not find his point of departure in his philosophical activity, let alone in its results." (ibid p.124.)

Yet philosophy is a force to be reckoned with even for those who are blind to its influence. A philosophy always involves a built-in-orientation to a total worldview and it is because of this totality-tendency that its directive influence on life must not be overlooked.

20.3.6. Towards A Christian Perspective. From the Christian viewpoint the self-knowledge without which no theoretical thought can proceed is, in the last analysis, dependent upon the knowledge of God. Of course both self-knowledge and knowledge of God as the Origin and integrator of all meaning (or the construction of some pseudo-origin) goes beyond the limits of abstractive theoretical reflection. It is rooted in the heart of man; it is centred in the religious fulcrum of our existence. This does not mean that this knowledge is shut up in the heart of man for by its very nature it penetrates the temporal sphere of our consciousness. A real account of this is only given in the biblical revelation concerning the creation and character of man in the image of God. God reveals Himself as the absolute Creator and Ruler and thus excludes every independent power which would rival Him. He has given to man His image; "concentrating its entire temporal existence in the radical religious unity of an ego in which the totality of meaning of the temporal cosmos was to be focused upon its Origin." (Dooyeweerd 1969, Vol.I p.55.) Thus there is a fundamental dependence in the self-knowledge of man on the knowledge of his Maker.

The human 'I' or 'Ego' (or self, heart, soul) of man functions in all the aspects of temporal createdness. But it is not exhausted by any single aspect, nor does it coincide with the collective summation of the modalities. This human self stands at the centre of three relations. There is its relation to the modal aspects in which it functions (including the psychological); and its relationship to others. In both these relations - to the diverse aspects of creation, and our neighbour - the deepest essence of the selfhood is involved, but it is not determined by them. The essence of the 'I' is determined only in relation to God - or in whatever the 'I' considers to be God. This bond between the selfhood and God (or idol) is religion. "Religion is 'religio', i.e., connection between the *meaning* of creation and the Being of the Arche." (ibid p.104.)

20.4. PROPOSITIONS CONCERNING RELIGION: SCIENCE: PHILOSOPHY

20.4.1. Religion. There will, over all life and thought, be the recognition that there is no autonomous province, no area of neutrality. There is a need to recognise that there is an organic relationship between faith and science which makes the Christian faith fruitful in every avenue of life, subjecting all to the kingship of Christ. The Christian is called to deepen his understanding of the sciences in the confidence that the universe is the Lord's and the fulness thereof. He is called to wield the trowel and the sword. (Cf. Spier 1966, p.11.) The trowel to achieve more clarity through scientific examination of God's wisdom in His works; the sword to stand against the intrusions of the kingdom of darkness.

The fundamental proposition under this head is that: Life is religion. Religion is the root of human selfhood and as such is to be distinguished from worship, faith and theology.

20.4.2. Science. This does not mean that we construct science or philosophy from the Bible alone for in these areas we are confronted by the revelation of creation, *qua* creation, to man. It would be folly to bind science, now recognised as temporal and faulty, to the Word of God. The Word is not proved by appeal to scientific data or theories; nor is science proved by appeal to texts, though these two will be consistent in that science is a true reflection of the laws of God when it is faithful to reality. But science is not a ground for spiritual analogies.

> "That there is some analogy between nature and the Christian life may be supposed from Christ's use of parables from nature. However, it is a mistake to assume that the 'Christian' in Christian scientific endeavour is the discovery of some such analogies, perhaps *vestigia trinitis* in the structure of the universe." (Knudsen undated, p.7.)

The task of the scientist is not to create or invent 'natural laws' out of a diversity of data; nor is it to devise models of the universe. That would imply the autonomy of science which overlooks the creatureliness of the scientist. Within biblical perspective the scientist is called to a discovery process which uncovers and explores the diverse levels which God has woven in one seamless web in His creation. Science must be a disciplined response to revelation; an attempt to rethink the thoughts of God after Him.

I therefore make the following propositions concerning science.

(a) Scientia is the abstracting activity of man's theoretical reflection on God's creation.

(b) Science is that means whereby we fulfil in a positive manner God's cultural mandate to subdue and control the earth. By it we understand the processes of creation and so are allowed (in belief in the constancy of God) to make predictions concerning the future activity of things, events and relationships within creation.

(c) Scientia analyses conditions; it deals with the 'if such and such, then this and that will follow' type of situation. Some conditions seem to be of absolute character (the objective sciences); while others are normative (ethics, jurisprudence etc.).

(d) Scientia cannot be dissociated from philosophy or religion. Dooyeweerd notes: "Science pre-supposes a theoretical view of reality, because it must continually appeal to it." (1969 Vol.I p.559.)

<u>20.4.3. Philosophy.</u> Some significant features can be summarised.

(a)The unity and diversity of the cosmos must be founded in the sovereign will of God as Creator, who reveals Himself supremely in Christ, but also in creation and scripture.

(b) Philosophy lies behind science and is the analyser of scientific activity - how scientists go about their work and what value the conclusions they draw have for life.

(c) In a world where scientists love detail, the task of philosophy is to integrate science, to unfold the meaning of the minutiae of detail in their relation one to another. The underlying unity of all cosmic events is found in the religious community of those who fell in Adam and are renewed in Christ.

(d) Philosophy must be based on, and seek to unfold, meaning as reflective of God's dynamic grip on creation. The unity of the law which transcends all temporal diversity of the aspects of being must be found in the demand to serve God with our whole being.

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CHAPTER 21

THE EPISTEMOLOGICAL BASIS OF SCIENCE

21.1. SOME PROBLEMS OF KNOWLEDGE [1]

21.1.1. The Interaction of Knower, Knowing, Knowable, and Knowledge.

It is necessary to distinguish between man as knower, acts of knowing, the knowable, and knowledge if confusion is to be avoided. Man as knower stands in the scheme of creation, fall and redemption in Jesus Christ even though he embraces some other motive. He only knows because God is there and has made him a knowing being. Each act of knowing is a unit and always unique, and therefore irreducible and undefinable as such. This points to the futility of attempted autonomy or self-integration. In knowing: perceiving and thinking exist in enkaptical relation. Nevertheless the knowable is not confined to perception, nor to things immanent. Man knows the things of God as it pleases God to reveal them to him; he cannot know the plan of God's salvation by mere cognition or perception, but only within the revealed Word of God. But man can know the external world without any special revelation of God for it is knowable through general revelation. The cosmos is not made knowable by man, nor does man give it meaning. Man is meaning; the cosmos is meaning - in dependence on God. The knowledge that man has as a result of the above is possibly true but never exhaustive for God alone has absolute knowledge. Man's knowledge is creaturely and derivative of God.

Having noted these distinctions it is necessary to note the correlation of these aspects. By perceiving, man comes into contact with the knowable (taking perception to include an examination of the Word-revelation). Man, however, only meets the knowable by trusting it; in order to know, faith in the knowable is an indispensible necessity. Faith itself is a facet of knowing without which man as knower would not meet the knowable (cf. 20.1.1.2.); it is a surrender to the knowable by man without which he cannot fulfil his task of knowing. Out of this man forms his theoretic realm by thinking.

> "Thinking has a remarkable control over its theoretical constructions. Left by itself, it can arbitrarily break up, take apart, separate, tear assunder, as well as combine, join together, connect, and unite its theoretical constructions, can analyse and synthesize, deduct and induct (generalise and

1. I am indebted in this section to an essay by H.G. Stoker (1971).

extrapolate), and so forth. This striking control has contributed much to the illusion that human reason is autonomous. But we should never forget that thinking is essentially bound by the perceived knowable and the task of knowing." (Stoker 1971, p.28.)

21.1.2. Transcendent and Transcendental Approaches. The above quotation from Stoker comes from a summary critique of two divergent epistemological programmes which he seeks to hold together in a creative tension. These are the transcendent critique and the transcendental critique. The transcendent critique proceeds from its own presuppositions and demonstrates the implications of these for the understanding of knowledge; or uses them to criticise other theories of knowledge, or science. The transcendental critique of knowledge starts from the acts, or functions, of knowledge and proceeds to the basic presuppositions; or investigates and exposes presuppositions in other areas. They thus follow opposite directions; the first proceeding from, the second proceeding toward, basic presuppositions. Nevertheless the latter method will implicitly assume the former position. Stoker writes:

> "Through the use of the (ii) transcendental criticism of human thought Dooyeweerd (a) starts from the distinction between the analytical and non-analytical aspects of cosmic reality, proceeds to man's selfhood (or heart) that brings about a synthesis between the analytical and non-analytical aspects, and he thence demonstrates that the human heart is directed either towards out triune God or loses itself apostatically in the diversity of created reality, and he (b) critically investigates philosophic theories (or systems), exposes the presuppositions on which they are based, proceeding to the religious ground-motives that function as the ultimate motives of the systems concerned..." (ibid pp.36-37.)

The two methods are complementary rather than contradictory (after Bohr, but not Wittgenstein).

21.1.3. The Importance of Revelation. The traditional Reformed concept of revelation has been that it is the root of all knowledge, and, as Pannenberg notes (1968, p.127.), the confinement of it to God's self-disclosure is a modern idea stemming primarily from Hegel. The logic of revelation necessitates someone who reveals; something that is revealed; and someone to whom it is revealed. The logic and unity of revelation at the foundation of our knowledge exposes the central coherence of knowing and the knowable, and leaves their radical difference intact. Revelation is the key to man's knowledge and four fields can be distinguished: (a) the revelation of God Himself to

Himself within His Trinity; (b) the revelation of God Himself to Himself through His works; (c) the revelation of God Himself and His relation to all things to man in His Word and in His works; and (d) the revelation of the created universe, including man, to man in an ultimate sense by God. Stoker claims (d) as his own 'special problem'; that is the problem for the philosopher and scientist as opposed to the theologian (who deals with (c)). The basic difference between the scientia of theology and all other scientia is that in theology alone the field of investigation (the Word) has authority over the discipline and the researcher in an ultimate sense. While Scripture gives parameters for the pursuit of scientia, it is not to be seen as a textbook on physics, biology, geology etc.. As Calvin commented: "He who would learn astronomy, and other recondite arts, let him go elsewhere." (1554, p.79.) Thus, following this view, any form of biblistic rationalism or mysticism is to be rejected.

Nevertheless (d) is grounded in (c) and impossible apart from it. Here man is confronted by the plan of God which can be known truly or falsely depending on the heart-motive of man. The following qualification is made. In scientific research so much is abstracted from the fullness of reality and so much left out of consideration that profound spiritual differences which might lie at the heart of researchers no longer exert decisive influence on results within a <u>limited horizon</u>. Differences only become clear as scientists begin to philosophise about their results. Fundamentally, however, no clear distinction can be made between their work and their results. (Cf. Kalsbeek 1975, p.169.)

<u>21.1.4. Theoretical and Pre-Theoretical Thought.</u> In distinguishing these two modes of thought several terms are used for 'pre-theoretical' thought such as 'naive', 'pre-scientific', 'normal', 'primal', etc.. I believe, however, that pre-theoretical is a confusing term in English as it tends to suggest some <u>non</u>-theoretical or <u>a</u>-theoretical stance <u>vis a vis</u> God and reality. But this is not the case as this realm is cognitive as well as the theoretical. I wish, therefore, to ascribe the designation of <u>abstractive</u> and <u>pre-abstractive</u> to this distinction. In abstractive thought abstractions are made to enable work in the various modalities to begin. The only theoretical pursuit where this would seem not to work is philosophy which is concerned with the integration of the meaning of being. But even here (a) philosophy is concerned with abstracted questions concerning

the whole; and (b) with specific abstractions such as the philosophy of science, ethics, history etc..

<u>21.1.4.1. The Validity of This Distinction.</u> This distinction has been criticised from some quarters as not philosophically rigorous in that it relies too much on the usage of "loose metaphors". (Frame undated p.6f.) But criticism does not obviate the principle. Indeed it should be noted that there is no consensus in detail in the cosmonomic school - van Riessen, for instance, rejects the principle of <u>gegenstand</u> as stated by Dooyeweerd (cf. glossary).

But there is a difference between scientific mentality and general living - not just a quantitative but a qualitative difference. Raymond Aron recently wrote:

> "But what scientist behaves as a scientist when he emerges from his laboratory or intervenes in the arguments in the market-place? And how could he? Neither the results nor the inspiration of scientific inquiry require us to feel compassion for the wretched, respect for the weak, recognition of the dignity of those who will never rise above the shadows." (1972, p.44.)

Again, Barbour notes that scientific language is symbolic, abstractive and selective in all theoretical communities; that for the abstraction known as physics a Bach Chorale is merely a set of molecular vibrations. (Cf. 1968/b, p.157.) In other words: in a scientific, or theoretical, discipline an abstraction from reality is made; attention is focused on an aspect of reality and not on the whole. Thus Einstein comments that: "Scientific thought is a development of pre-scientific thought"; that: "The whole of science is nothing more than a refinement of everyday thinking"; and that we cannot proceed without considering critically.....the problem of analyzing the nature of everyday thinking." (1973, pp.276,290.) Jacques Barzun records a confession of Huxley that a double view - scientific and pre-scientific - always intrudes. Huxley had tried hard, at sunset, to see the phenomenon as that of the earth moving and not the sun sinking, but he could not - the sun set. "Science in this case enables us to add a vision, not to replace it." (Barzun 1964, p.116.)

<u>21.1.4.2. The Distinction, and the Character of Abstractive Thought.</u> Abstractive thought - this sorting of details in the flux of experience - is not the only form of human cognition, for it is but a type of cognitive activity with special characteristics. It is a cognition which is analytical, antithetical and systematic.

Abstractive thought approaches the object of its study in a critical and analytical manner that logically endeavours to set the object apart from the whole of reality, and systematically goes about dissecting, discovering and understanding that object.

For example: a physicist engages in theoretical analysis. To analyse means 'to distinguish' (from the Greek analyein - to unloosen, to set free, to do away, to get rid of, to dissolve). The physicist abstracts, sets free, or unloosens the physical aspect of reality; and in his thinking provisionally eliminates all other aspects. He places the physical aspect of reality over against his thinking and uses the results obtained to make statements about the object, hoping that this will broaden human knowledge.

A table, for instance, can be approached pre-abstractively simply as it is encountered. We may note its style, age and value in a non-abstractive manner - but essentially appreciating the table in its wholeness and jumping unsystematically from one aspect to another. Abstractively, however, an economist would be interested in its value and subverse all other features to that end; the historian to its age and period; the joiner to its construction, and so on. It follows that there is no essential contradiction between abstractive and pre-abstractive thought, though there may be. The two are complementary, they are different kinds of knowing. Concrete reality is many-sided, yet it is a whole and undivided as we live in relation to it in its wholeness.

It is interesting that in talking about this Theobald (1969, p.24.) falls into the trap of attributing non-theoretical qualities to the pre-scientific approach, but then doubles back to suggest that there can be no sharp distinction between the two perspectives. Similarly Frame (undated p.6f.) attacks Dooyeweerd for maintaining that there is a sharp distinction between the two views. He argues, as an example: there is a scientist and a child walking through a field looking at flowers. The scientist, as such, is involved abstractively while the child experiences the rich diversity of colour and form. But as Frame points out, the child could have been told to study the flowers and would thus operate abstractively as well - and clearly the abstractive approach of the child and the trained scientist are quite different. So he suggests that instead of a sharp distinction we should view these two activities as different ends of a continuum; that all thought is relatively theoretical as well as relatively naive. The scientist in his abstraction can still see the rich diversity of reality. [2]

At the root of this question is the matter of the gegenstand relation which is seen to set the object of abstractive thought logically over against the rest of being. The problem is that man, qua man, cannot cut himself off from that reality even in the laboratory. I wish to suggest, for the moment, that the two approaches are neither the ends of a continuum (Frame), nor to be sharply distinguished (Dooyeweerd) - but exist as distinct facets in mixture. Thus all thought is relatively abstractive and relatively non-abstractive; the two qualitative approaches existing in a mix. Depending on other factors, one or other quality of this mixture will dominate. [3]

Having stated this modification to Dooyeweerd it remains that what he says is extremely valuable for my present study. He opens his 'New Critique' with these words:

> "If I consider reality as it is given in the naive pre-theoretical experience, and then confront it with a theoretical analysis, through which reality appears to split up into various modal aspects then the first thing that strikes me, is the original indissoluble interrelation among these aspects which are for the first time explicitly distinguished in the theoretical attitude of mind." (1969, Vol.I p.3.)

In other words abstractive thought is characterised by an antithetical relation whereby the logical aspect of thought is opposed to the non-logical aspects of reality. While science directs this attention to some aspect, philosophy is directed to the totality of meaning of our cosmos. As science is affected by philosophical views so in turn the philosophical view is affected by its religious root.

21.1.4.3. The Character of Pre-Abstractive Thought. Philosophy is based on pre-abstractive thought; ordinary experience is the base to which we must always return. (Cf. Spier 1966, p.14.) Indeed Kant begins his 'Critique of Pure Reason' with these words:

2. For about two years I considered this a reasonable formulation by Frame, even if his argument was not convincing - but I now believe that he does not allow for the qualitative difference between the two approaches. They are different kinds of knowing and as such cannot occupy different poles of a continuum.
3. The idea of pure abstractive thought falls under the criticism levelled at essentialism -cf. chapter 11.

"There can be no doubt that all our knowledge begins with experience. For how should our faculty of knowledge be awakened into action did not objects affecting our senses partly of themselves produce representations, partly arouse the activity of our understanding to compare these representations, and, by combining or separating them, work up the raw material of the sensible impressions into that knowledge of objects which is entitled experience? In the order of time, therefore, we have no knowledge antecedent to experience, and with experience all our knowledge begins." (1787, p.41.)

Dooyeweerd, while critical of Kant, agrees that experience alone provides a proper starting point.

"Naive experience is not at all a theory which may be refuted by scientific and epistemological arguments. It does not identify empirical reality with its abstract sensory aspect and it lacks the metaphysical notion of an objective world of things in themselves beyond the world of experience. Naive experience is much rather a pre-theoretical datum, corresponding with the integral structure of our experiential horizon in its temporal order. Any philosophical theory of human experience which cannot account for this datum in a satisfactory way, must be erroneous in its fundamentals." (1972, p.18. - cf. Kalsbeek 1975, p.165.)

Concerning the movement from pre-abstractive to abstractive thought we find the following in Dooyeweerd: that whenever pre-theoretical thinking is opened and deepened into theoretical thinking, this opening necessarily brings an essential change; namely a shift from the enstatic position of the analytic function in reality to the antithetic opposition of this function over against the aspect of inquiry. This opposition is necessarily accompanied by a theoretical setting apart of the cosmic meaning-systasis. [4] (Cf. Kalsbeek 1975, p.163.) What is left as the product of this theoretical setting apart from reality (what logical thinking places over against itself) is, of course, Dooyeweerd's gegenstend. For him naive thought can have no gegenstend. But as noted above reservations are made against this concept - my postulation of a mixture.

Inter alia the following points are noted. (a) Pre-abstractive thought is not a theory of knowledge but a direct given. It follows that it cannot be refuted by theoretical thought itself (e.g. physics

4. This obselete word is used in a special sense to distinguish the natural coherence of our integral experience of reality from the theoretical attitude implied in 'synthesis'. Cf. Dooyeweerd 1969, Vol.II p.429f.)

does not refute the ordinary experience that a table is hard and impenetrable); nor is it to be viewed as some sort of copy of reality. Yet pre-abstractive thought can be altered, educated and deepened by abstractive thought. (b) Pre-abstractive thought, while open to education, can never be destroyed as such. As man's understanding of his cosmos advances so this is reflected in what he holds and experiences in ordinary life. (Cf. Dooyeweerd 1969, Vol.III p.31.) (c) It follows that pre-abstractive thought, like abstractive, can be erroneous (cf. ibid p.29.). This is inevitable in the light of the forming power of the social praxis on pre-abstractive thought. (d) Pre-abstractive thought focuses on things and events, while abstractive thought directs itself to aspects of things and events. When asked if the tree in my garden is still the same tree as of past years I can pre-abstractively know that it is - but it is a difficult matter to pursue on the level of sensory explanation, because that deals with aspects and not the concrete wholeness of the tree. (Cf. ibid p.3f.)

> "The subject-object relations of naive experience are, consequently, fundamentally different from the antithetical relations which characterize the theoretical attitude of thought. Subject and object are certainly distinguished in the non-theoretical attitude, but they are never opposed to each other. Rather, they are conceived in an unbreakable coherence. In other words, naive experience leaves the integral structural coherence of our experiential horizon intact. The theoretical attitude of thought and experience breaks it assunder by an analytical dissociation of its modal aspects." (Dooyeweerd 1972, p.17.)

A further example may be helpful. A book flung on the fire is consumed. What do the sciences tell us is consumed? The 'thing' itself is annihilated, but chemistry and physics can tell us nothing concerning this 'thing' for as special sciences they must eliminate the pre-abstractive totality of the 'thing' from their explantion of combustion. (e) Pre-abstractive thought gives the qualifying modality of a thing or event, and this is essential to its theoretical examination.

21.1.4.4. Summary. The difference between pre-abstractive and abstractive thought can be summarised as the difference of intention, systematic endeavour, the requisition of verification, and method. All science, as such, intentionally pursues knowledge and creates positive antithetical structures to that end. Ordinary thought lacks this intentional structure though of course it may create antithetic relationships without intent. (Cf.Dooyeweerd 1969, Vol.I p.

41.) Science seeks answers in a systematic way. Pre-abstractive thought may be systematic, but if so it is not intentionally so. Science seeks answers to the why, the wherefore, and the how of the knowable; it seeks to further understanding, description, explanation and the evaluation of knowledge, and it does this intentionally and systematically. Thirdly; pre-abstractive thought may involve verification but this will not be intentional or systematic. Science has however to intentionally and systematically make observations and draw conclusions which can be tested (cf. 15.4.1.). Lastly; while pre-abstractive thought is not tied to any scientific method, science does employ certain technical methods in the pursuit of knowledge. Which is not to say that there is some specific method, nor that pre-abstractive thought is irrelevant to the development of science and theory formation.

> "Accordingly science (including theology, philosophy, the particular, inter- and intermediate sciences) is knowledge which is by means of technical methods, intentionally, as far as possible systematic (laying bare relations and coherence) and as far as possible verified (founded and proven) knowledge as such of the knowable." (Stoker 1971, p.37.)

21.2. THE KNOWLEDGE OF GOD

21.2.1. Only By God's Self-Disclosure (cf.21.1.3.). The knowledge of God is never the outcome of man's theoretical or general reflection, but exclusively the result of God's self-revelation to man. This seems axiomatic - God can never be true object of our study when we are dependent upon Him (cf. Torrance - 18.4.). This does not, of course, rule out the theoretical study of God - theology - which leads to knowledge about God and His works. This is not to tie the concept of revelation exclusively to God's self-disclosure. Yet the knowledge of God is unique in its origin, object and essence (cf. Bavinck 1909, p.24f.). The origin of this disclosure of the Father resides in the mediating work of the Second Person of the Trinity in terms of creation, Christ and scripture; the object is different from all created objectivity for it is the Creator, the incomprehensible infinite which transcends the temporal knowledge of men. Because of this difference in origin and content, it follows that the knowledge of God is essentially different. It is not the result of scientific reflection but of childlike and simple faith.

21.2.2. Two Dispositions of the True Knowledge of God. First; there is fallen man who, even as such, knows God. Behind all superficial arguments and presentations there is in man a deep ontological knowledge situation - for God does exist, He has revealed Himself; there is a real objective and inescapable revelation in the creation of God; man is in His image and has a sense of deity and therefore knows God truly. Thus even fallen man knows in his heart the reality of God though he suppresses and represses this knowledge, and, in rejection of God, absolutizes the relative in the construction of some idol. But no one can escape being a creature of God, that creation is revelational of God, and that autonomy is impossible.

Second; man as redeemed knows a fuller disclosure of God and of His purposes. As redeemed, he acknowledges his dependence; he acknowledges God as Arche and Christ as the sole external Archimedian point for the cosmos and so directs his heart in faith to Him. Christ is in the redeemed. Calvin opened his 'Institutes':

> "Our wisdom, in so far as it ought to be deemed true and solid wisdom, consists almost entirely of two parts: the knowledge of God and of ourselves. But as these are connected together by many ties, it is not easy to determine which of the two precedes, and gives birth to the other. For, in the first place, no man can survey himself without forthwith turning his thoughts towards the God in whom he lives and moves; because it is perfectly obvious, that the endowments which we possess cannot possibly be from ourselves; nay, that our very being is nothing else than subsistence in God alone....it is evident that man never attains to a true self-knowledge until he has previously contemplated the face of God, and come down after such contemplation to look into himself." (1560, pp.7-8.)

<u>21.2.3. Several Points Briefly Stated.</u> The following points concerning the knowledge of God are briefly noted. (a) The knowledge of God is by revelation alone, and not by theory alone. Theoretical thought about God is absolutely dependent on revelation, whether acknowledged or not. (b) For Theism the basic contention with respect to the self is that God is the ultimate subject of knowledge. (Cf. C. van Til 1969, p.130.) (c) There can be no theoretical knowledge of God or the self because the first involves man's derivation from God, and in the second man can never stand theoretically in relation to the selfhood in its fullness. (d) The knowledge of God that we do enjoy is never anything to do with the idea of God-as-such. God is never an 'object' that can be studied in the way that we study aspects of creation. Creation is subject to man - God is not. (e) The knowledge of God grips the being of man, and subjects him in all his aspects and functions to God, with no area of neutrality. (f) The knowledge of God is connected to the

Word of God. We cannot separate the Word and God; the Word connects to Christ as the Archimedian point for all true thought and living. Nor is scripture merely some authoritative source of information concerning God, some interesting collection of data, revealing His norms - for God comes in the Word and therefore we are faced with an encounter. Our response to this encounter will lie not in our mind but in our heart which is not to say that our response is not reasonable and rational. This encounter does not, however, determine the being of the Word in any way. (g) The possibility of any knowledge, in any sphere, rests ultimately on the knowledge of God. The crux of the Christian position concerning the subject-object relation is that the very possibility of knowledge is unintelligible except on the premiss that all subjects of my knowledge have their existence from God.

21.3. THE KNOWLEDGE OF SELF

Dooyeweerd has commented that the words of the Oracle of Delphi - 'Know Thyself' - should be written above the portals of philosophy. Such knowledge is immensely complicated. To start with the self is always active in the knowing process, there are no independent or self-sufficient functions which come into operation in the process of knowing. Self-knowledge is in fact a presupposita of theoretical thought itself and therefore cannot be gained by theoretical insight. The 'I' can never be grasped by abstract reflection. For Dooyeweerd all theoretical knowledge assumes self-knowledge, while this in turn is only possible in religious self-surrender to the one true God, or an absolutized, but relative, aspect of creation. From this it follows yet again that theoretical thought cannot be autonomous and that it must be dependent on some motive.

Knowledge of the self therefore, like knowledge of God, comes through the Word of God in creation, Christ and scripture. The sciences can never begin to explain the self.

> "As soon as I try to grasp the I in a philosophical concept it recedes as a phantom and dissolves itself into nothingness. It cannot be determined by any modal aspect of our experience, since it is the central reference-point to which all fundamental modes of our temporal experience are related. A logical I does not exist, neither a psycho-physical I, nor a historical, nor a moral I. All such philosophical determinations of the ego disregard its central character." (Dooyeweerd 1972, p.25.)

The question - Who is man? - contains a mystery that man himself cannot theoretically resolve. Undoubtedly there are scientific ways of obtaining knowledge about man, but they never explain who man is in his central unity of being. There are many special sciences which study man, but each examines human life only from the perspective of one aspect or viewpoint of reality. Physics and chemistry, biology and psychology, historiography and sociology, jurisprudence and ethics, all provide detailed information concerning man. But none answers the basic question - who is man in the central unity of his existence? The sciences cannot answer because they are bound to the temporal order of our experience, they are derivative of man, while man transcends the temporal order for he is in the image of God.

As with God, we do not come in the knowledge of self to man-as-such, as an entity by himself. Man depends absolutely on God. The meaning of man's existence is religious. Man is neither an individual in meaning (for the meaning of man is rooted in community - the story of Adam <u>and</u> Eve) nor is man essentially collective. Individualism expresses the ultimate importance, dignity and worth of the individual in all aspects of life but negates the communal; whereas collectivism stresses the overriding 'general will' of Rousseau. Individualism, the child of nominalism, found expression in Hobbes and Locke, who has been seen as the spiritual father of laissez-faire economic individualism; while collectivism has two basic roots, the one in French rationalism, the other in German idealism. In the former stand Rousseau and Comte, while in the latter stand Hegel and possibly Marx. Both these views of man - individualism and collectivism - reside in a pretended autonomy of man and are inconsistent with a biblical pluralism. Man is only free and fulfiling his meaning when he lives in relationship to the God who made him.

<u>21.4. THE KNOWLEDGE OF REALITY</u>

<u>21.4.1. Is Dependent on the Knowledge of God</u> (cf. 12.5.). While Descartes distinguished between thinking (cognito) and the body (extensio) with only a tenuous link between them, Dooyeweerd sees thinking as an internal activity in all aspects of existence. (Cf. Kalsbeek 1975, p.161.) While the knowledge of self is worked in us by the Word and is unbreakably connected to the knowledge of God, the same is claimed concerning the knowledge of reality - that is, of the world which we experience. M. Vrieze notes:

> "The Word of God works in us also an understanding of what this reality is in which we live and of which we are a part. In revealing Himself God shows us that whatever it is in this world around us nothing is a substance, a 'Dasein', a reality-in-and-by-itself, but that it is always and in all of its aspects creature, dependent on the Creator, not being for itself but being for Him, in other words: meaning. The nature of reality is that it is meaning: it is there for God, of God and through God." (undated p.8.)

Nothing is outwith dependence on God and the Law of God. It is critical to be clear that the ultimate subject of our predication is not a reality, or being in general, in which God is some universal with reality providing the particulars. This would make God and the universe co-relative. Christians believe that the universe itself is derivative, both as a whole and its aspects, of its Creator. Thus the unity and diversity of creation can only be understood as derivative of the unity and diversity of the Triune God as an ontological presupposition. (Cf. C. van Til 1971/a, p.23.)

21.4.2. The Law of God (cf. chapter 23; 24.1.). The Law of God in the sense I am using it must not be confused with the Moral Law for that is only a facet of the overall structure of law that God has given to His creation. Created reality is law-ordered and law-structured, but even here care is needed for the tendency has been to posit this concept of law as if it were something that existed in and of itself. But law is not autonomous either, as man's reason and creation are not autonomous. Therefore there is no ding an sich quality attributable to the basic law-structure of reality as some static given.

> "God is taking His creation somewhere, He is driving it into a certain direction and He is 'working' with it. 'My Father works', Jesus said once. In other words, the Law does not only regulate things as they are and exist, but directs them and arranges them and drives them toward the End which God has, or rather: is. It is here that perhaps can be seen best that all aspects of reality are concentrated in man-rooted-in-Christ to the perfect service of the living God." (Vrieze undated p.9.)

Our relationship to this Law is that, as we are subject to it, it will be impossible for us to come to any exhaustive concept of it.[5] The Law transcends us and makes thought possible, therefore we cannot take the Law and examine it under a microscope, for any theoretical work is at all times possible only because of the Law and is itself subject to the Law. However God is not subject to the Law but

5. Cf. Critique of essentialism.

rather these two - God and His Law - are to be seen such that the Law is co-terminus with the character of God.

<u>21.4.3. The Meaning of Creation.</u> Here the word <u>meaning</u> is being used in a particular way: it is used to stress that reality <u>is</u> meaning and not that reality <u>has</u> meaning. Stoker illustrates it this way: take two blobs of blue, each of exactly the same dimensions, texture, tone, etc., such that they are exactly identical (cf. 1971, p.45.). What is their individual meaning? Nothing in themselves determines that - but both are parts of greater wholes, say of different paintings, and exercise meaning within the overall context of their respective pictures. When put in context each blob has inseparable and simultaneously analytical, as well as perspective, moments of meaning. Stoker extrapolates this to point out that this holds for every 'thing' in our created universe.

> "....the whole of creation and every 'thing' within it, as well as every relation between 'things', has not only analytical (intra-cosmical) meaning moments but revelational meaning moments as well; they are revelational of God and his plan, ultimately depending on God and on God's knowledge of himself and of his counsel. Here we have arrived at the <u>ultimate</u> meaning moment of everything created. The rose in my garden, is, of course, a rose; but it is at once also a creature revelational of its origin, God and his counsel (plan). This rose has at once and inseparably meaning moments; fundamentally it is God's work." (ibid p.45.)

It might be contended that this is simplistic in focusing on a 'good' aspect of creation but does not apply to the evils of creation. But the evil 'thing' is also under God for if we cannot refer in this ultimate sense back to God then we must posit an eternal dualism between good and evil.

This can be illustrated from the writer of Ecclesiastes. He had faced up to the reality that as long as he tried to integrate meaning 'under the sun' (within the cosmos, inside the temporal horizon) there was no meaning and all was vanity.

> "For what does a man get for all his hard work? Generations come and go but it makes no difference. The sun rises and sets and hurries around to rise again. The wind blows south and north, here and there, twisting back and forth, getting nowhere. The rivers run into the sea but the sea is never full and the water returns again to the rivers, and flows again to the sea...everything is unutterably weary and tiresome. No matter how much we hear, we are not content...as I looked at everything I had tried, it was all so useless, a chasing of the wind." (Eccles. 1;3-11: 2;11. The Living Bible.)

Discussing the meaning of creation, van Riessen refers to Romans 11;36 - 'For from him and through him and unto him are all things' - distinguishing here between the origin, existence and goal of creaturely being. (Cf. Kalsbeek 1975, p.80f.) What exists has not always existed, nor does it now exist of itself. All has come into existence through the sovereign will of God, and is maintained by Him existentially. Creaturely being is completely dependent being and is only integrated and realised vis a vis God. So it is that we find the final goal of creation lies in service to God. This bond to which we are called is the religious root of our existence.

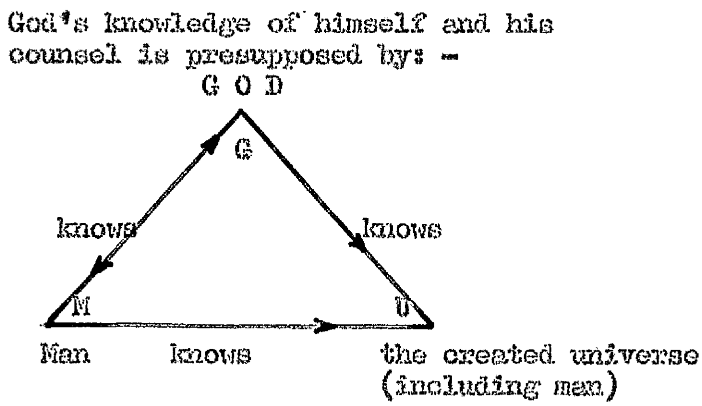
21.4.3.1. The Analogical Dualisms of Cosmonomism. Cosmonomism, then, while rejecting a dualism within creation or heart-motive, points to a deep analogical duality - a two layer theory of reality, thought and interpretation. There are two layers of reality: (a) that of God who is absolute, all-sufficient and self-contained in His Trinity, and (b) the universe of created being which is derivative, self-insufficient and absolutely dependent on (a). There are two levels of thought: (c) the all-comprehensive thought of the infinite God, and (d) the creaturely, derived, thought of man who, in the image of God, can think God's thoughts after Him in the finite realm. There are two levels of interpretation of the universe: (e) the absolutely true interpretation of God, and (f) the interpretation by man of (e). (Cf. Stoker 1971, p.56.)

21.4.3.2. The Plan-Architect / Plan-Content Approach of Stoker (ibid pp.57-70.). There are, for example, two approaches to a building argues Stoker. The one sees the details of the plan (P) of the building in constant relation to the mind of the architect (A) who designed it. The other view, at right angles to this, focuses on the contents (C) in relation to the plan (P) and explains them, their functions and purposes. The (PC) view will always, of course, presuppose the existence of the (PA) approach even if it does not acknowledge it. Much of modern thought has focused on the (PC) approach and avoided consideration of the foundational (PA) aspect.

Concerning the (PC) approach, Stoker argues that there are (a) empirical hypotheses where there is common, but limited ground between all men as they approach the created order to examine, quantify and qualify it. The significance of any hypothesis here will, however, depend on the role attributed to it within a higher and ultimate perspective. (b) There are <u>principal hypotheses</u> which concern the radical diversity of created reality and which are mutually irreducible within a particular law sphere. Both these types of hypotheses relate to the (PC) approach. However the principal hypotheses will basically be co-determined by the choice of ultimate (PA) presuppositions and here Christian and non-christian will disagree in principle. (c) There are <u>ultimate hypotheses</u> which relate to the (PA) approach <u>per se</u> and not as in the previous cases to the (PC) approach. (Cf. ibid pp.66,67.) Stoker writes:

> "A non-Christian (empirical scientific and philosophic) methodology that acknowledges neither <u>ultimate</u> nor <u>principal</u> hypotheses but only <u>mere empirical</u> hypotheses (thereby implicitly reducing the former to the latter) and that accordingly maintains that any sort of hypothesis is as relevant as any other, and likewise claims that it cannot be determined in advance to what conclusions any hypothesis must lead, excludes from the outset not only the radically diversity of created reality, but moreover (as a 'negative universal') God and his counsel, his creation, providence, and grace. But this means that it reduces the <u>ultimate hypothesis</u> as such to the status of a <u>mere empirical</u> hypothesis, thus falling prey to pure empiricism." (ibid p.68.)

He then goes on to explain his 'special problem' (cf. 21.1.3.d.) with the aid of the following diagram (ibid p.69.).



<u>Diagram VII: Stoker's Special Problem</u>

Stoker calls the sides of the triangle 'vertical lines' and the base a 'horizontal'. This then enables him to call a transcendent apologetical theory of man's knowledge of the created universe (M-U) as relating every fact and every relation between facts of the universe; as well as man's knowledge of it, vertically to its dependence on God's knowledge of Himself and of His counsel (G-M; G-U) - this compares with his (PA) approach. His own special problem is put forward as a supplement to this by arguing that a Christian theory of man's knowledge (although necessarily presupposing the truths of the vertical view of man's knowledge of created reality - i.e. M-G, U-G) also has the duty to turn to the right, as it were, and investigate man's knowledge of created reality in a horizontal way - i.e. M-U. This is a (PC) approach and yields specific contributions to a Christian theory of knowledge in addition to the (PA) approach.

A critique of non-Christian theories, according to Stoker's interest, follows the horizontal line. It can accordingly explain specific agreement between Christian and non-Christian scientists as well as the possibility of a profound co-operation between them. But it will also expose differences and the necessity of a fundamental divergence between them on account of their mutually contradictory presuppositions. The horizontal criticism will furthermore always fall back on the vertical criticism because it is not ultimate and is in fact bound to the truths of the vertical criticism.

21.4.4. Enkapsis. The term 'enkapsis' was introduced by the Swiss biologist M. Heidenhain to describe the relationship between organs and the total organism within which they functioned. Dooyeweerd, however, extended the term such that all structures found in created reality were seen as mutually intertwined in an universal, unique and unbreakable way. This is not the relation of the whole to the parts, or the parts to the whole.

In the unity and diversity of reality there is a polar tension of dynamic character that must be maintained if reality is to be disclosed. Reality is diverse; but there are unities that hold this diversity together. Unity can be conceived of in different levels. Basically there is, according to Dooyeweerd, the transcosmic ground of unity which is absolute to all things, and which resides in the Arche. But at a creaturely level there is a formal unity whereby a realm or kingdom, for example the vegetable, possesses a characteristic unity of form and structure which distinguishes it from all other realms. (Cf. Appendix C.) There is also a material unity at the general level of the organic, mechanic, the unity of a piece of art, of an historic process etc.. Finally there is the unity of repair, that unity of being which flows from the renewal, restoration and reconciliation of disunity such as in the family, once broken and diversified, which in reconciliation again functions as a unit. Similarly there is the unity of repair of man and nature, man and himself, and man and God in terms of the significant healing which Christ brings to the fractured existence of man. (Cf. Stoker ibid p.44.)

There are different formulations of enkaptical structure — the enkaptical unity where two structures unite with one founded on the other; or with no founding connection; or in symbiotic foundation. This last is correlative enkapsis where the aspects are reciprocally dependent. Examples of this are that of a painting to the materials used; a tree to its surroundings; and that of animals living together in herds, packs etc.. A sculpture is an example of an irreversible foundational enkapsis. The marble statue is in the block of marble but not vice versa. Again there is the enkaptical subject-object relationship as found in a bird and its nest. There are further enkaptical relationships to be found in the interlacement of societal structures and in certain territorial aspects. (Cf. Kalsbeek chs. 26, 35-37. 1975.)

Take an object which when examined reveals that it belongs to the genotype chair, which in turn belongs to the radical type utensil, as do lights, spoons, clothes etc.. This genotype can be further distinguished as an easy chair, rocking chair, typing chair etc.. The various types of wood or metal in their structure are only external structural peculiarities which produce diverse types. When we look at the materials we find wood, metal, leather, plastic, springs etc., which do not exist in nature as such. Man has processed the things of nature into semi-manufactured products to be used in the chair. The natural individuality structure of wood is enkaptically bound in the structure of a semi-manufactured product in this case. Thus semi-manufactured products obviously have a foundational function but no trace of an actual typical leading function (or function of destination). They await further processing and are therefore characterised by their potential historicotechnical function of destination which is opened and realised when they are made into utensils by this additional processing. (Cf. ibid p.193f.)

Consider H_2O which, as water, is not the summation of its parts of hydrogen and oxygen. Here structures of different genotype — 'H' and 'O' atoms — are enkaptically combined by means of their electron constellations. The nuclei of the atoms do not change and essentially they continue to exist as hydrogen and oxygen atoms.

They cannot therefore be considered as parts of water because the nuclei have not become water as such. These atoms exist quite independently of water, but water cannot exist independently of them. This then is an example of an irreversible foundational enkapsis.

It is important to realise that in the midst of this, man has an unique place. M. Vrieze writes:

> "To grasp the unique nature of enkapsis we must remember that the revelation of God shows us that God has made man the crown of creation. This does not simply mean that man is a much better creature than other creatures or that he is more valuable than other creatures, but it means specifically that man has a unique place in cosmic reality and that he, in his heart - the root, the deeper unity of his existence - transcends temporal reality in this sense that he is not qualified or limited to or enclosed within a temporal end function..... All temporal structures....are directly or indirectly centred upon man. All of creation is unbreakably connected with and related to man as creature of God, man precise: as image of God. It is here that we can begin to see something of the peculiar unity of cosmic reality. It is this unity which now finds expression also in the phenomenon of the enkapsis." (undated pp. 27f.)

21.5. THE INFLUENCE OF BASIC COMMITMENT ON SCIENTIFIC ACTIVITY [6]

It seems to me that we can say a fair amount concerning the influence of a person's basic commitment. The general framework of a person's beliefs will suggest certain types of theory which he will find acceptable; it will suggest which elements of a theory will function as basic concepts in explaining phenomena; it will select the problems to be solved and the data gathered to that end. However there is also a negative stimulus in that a basic commitment (ultimate hypothesis?) will provide a limited horizon of conceptualization which restricts scientists to ignore data that might in fact be more pertinent. This leads to resistance to change which, while often useful, is also harmful; and leaves problems outside the 'paradigm' uninvestigated. These positive and negative features of a basic commitment are, of course, not derived from any Christian perspective per se but have been amply justified in the work of many historians and philosophers of science. It is out of these basic (pre-abstract) commitments that scientists make judgements of which kind of theories will be regarded as possible candidates for descriptions of reality, and define specific research programmes as critical in the welfare of

6. I am relieved to find confirmation of my view here in a short essay by W. Brouwer (undated).

the progress of science. Undoubtedly abstractive elements play a part, but it seems to me that the basic commitment of the heart is crucial in such decisions.

What can be said from a particular Christian worldview? First of all it would seem that the concept of absolute truth, the establishment of scientific certainty, is a failed quest. This idea which is concomitant on the self-sufficiency of God alone is recognised in the non-Christian world. It follows that the Christian worldview provides, in generalised terms, negative limits rather than positive pointers to future scientific theories.

In terms of present theories a Christian worldview should enable some selection of which types of theories are acceptable. For example it would seem to me that no Christian scholar could consistently maintain a strict psychological behaviourism however many valid points that theory makes, in that it clearly undercuts the Christian commitment to the responsibility of man which cannot be reduced to heredity or environment. Thus while more than one competing theory may be acceptable to the Christian, there are certain cases which can be ruled inconsistent (cf. 27.4.2. where I will look at a possible Christian understanding of indeterminancy). So Christian views will project specific interests within a given theory; that is, help to define research programmes. Again, Christian commitment aids definition of the basic elements in a theory. For example, in the science of human behaviour the Christian will also wish to include in his parameters the concepts of sin and responsibility as well as heredity and environment. Similarly we are aided in identifying the types of data needed to solve certain problems and evaluate the methods to be used to obtain the relevant data.

Two caveats should be made. Our basic commitment should not be the source of our data - there should be an openness to change a preconceived order under the pressure of external data. Secondly, the concept of scientific freedom should be prominent in Christian thought.

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CHAPTER 22

THE THEOLOGICAL BASIS OF SCIENCE: CREATION, COSMOLOGY, COSMOGONY

22.0. INTRODUCTION

There has been a tendency in the 20th century to dissociate theological and scientific matters such that no cosmology can impinge on doctrinal areas. Bultmann claimed that: "The doctrine of creation is not a speculative cosmology." (1956, p.15. - cf. Whale 1952, p.32.) Aulen claimed that: "faith in God as Creator is not a theory about the origin of the world through a 'first cause', etc. It has in reality nothing in common with a rational explanation of the universe." (1948, p.181.) These comments seem to embody two ideas. First: the biblical doctrine of creation is not a scientific cosmology. Second: the doctrine of creation has no implications for cosmology. The former denies the identification of the doctrine of creation and cosmological speculation (I agree); while the latter denies any logical relationship between the two areas (I disagree).

22.1. HISTORICAL PERSPECTIVE

22.1.1. Ancient Western Thought. In ancient times many primitive views of the universe were held. In Mesopotamia, before Greek influence, geometry was not used to correlate astronomical observations and the earth and heavens were viewed as two flat discs supported by water. Later the heavens were seen as an hemispherical vault resting on the waters which surrounded the flat disc of the earth. The sun and moon were gods who controlled terrestrial affairs. Or the world could appear as a rectangular box - the earth at the bottom and the sky at the top, supported by four mountain peaks in the corners of the earth. These worlds were seen as originating out of the primeval chaos of waters, and the heavens, earth, air and water were personified as gods - seen as the process of union between the male and female gods of the chaos. The younger gods continued this work of ordering the universe by word of command and spells. Later in Mesopotamian thought these younger gods used physical force to tame nature as they battled against the gods of chance.

The Greeks tied cosmogony and theogony together, with the gods personifying the cosmic powers resulting largely from the process of love and generation. Nature was herself divine, a living organism, the divine source of all life, the gods included. For Thales and

Heraclitus nature herself was the deity. But already in the pre-Socratics there was a move to remove the gods from nature and to abstract and spiritualise them. This stood in tension with the strong earthy matterness of their basic view (cf. 1.3.). For Plato the demiurge (a) had to bring together two existing aspects, plan and material; but (b) left the sustaining of the universe to the world-soul as the perfect Form could not be defiled by contact with material. Thus (c) man was made, not in the image of god, but in the image of the secondary powers. Man was an image of an image. In Aristotle the emphasis on the invisible Forms shifted towards the world of the visible. God was the prime-mover in the sense of a final, not an efficient, cause - but he was not creator. It was from this source that Ptolemy drew, and formulated his earth-centred cosmology with its circular orbits and epicycles for the planets (cf. 2.1.4.).

<u>22.1.2. Ancient Eastern Thought.</u> From the 4th century onwards, Taoists and others in the East held that the two principles which produced all things by their interaction were the Yin and the Yang. The Yin was a passive, dark and female force, while the Yang was the active, light and male counterpart. These two principles originated from the primordial mixture of matter and energy, and separated out from one another by gyratory motion. Thus the Yin principles gave rise to the earth and the Yang to the heavens; while their interaction gave five elements - water, fire, wood, metal and earth. (Cf. Mason 1962, pp.76ff.)

In Chinese thought several world systems were held. By the Han period (c. 200 B.C.) there were at least three - the Ka Thein, the Hun Thein, and the Hsuan Yeh systems. The former was the 'hemisphere heaven theory' which held that the heaven was a regular hemisphere and the earth an inverted bowl with linear edges such that it formed a convex square. The second was the 'Celestial Sphere theory' and here the universe was a spheroid. Chang Heng compared the universe to an egg, the yoke being the earth supported on water and the shell being the heavens supported on vapours. The third is the 'Empty Infinite Space theory' where the universe had no shape, nor substance beyond the earthly and heavenly bodies. This last theory was associated with Taoists; while the second was identified with Confucianism.

These Eastern pictures have similarities to the early Western (or Ancient Near Eastern), but two fundamental differences stand out.

First: the astronomical calculations of the Chinese were almost entirely algebraic, not geometrical, and therefore they did not derive a picture of the configuration of the universe from this. Technical astronomy and cosmology were separated areas and cosmological speculation remained qualitative in character. Second: there was no divine law-giver controlling the universe and the cosmic processes were a matrix of interactions between diverse objects of nature.

22.1.3. Biblical Perspective. In contrast to the foregoing the biblical material stands in marked contrast. At first glance it may appear that the Bible reflects a primitive geocentric outlook common to Babylonian, Phonecian and Hebraic thought, but this cannot be consistently maintained. Undoubtedly crude literalism will lead to all sorts of conflicting cosmological pictures, but it seems clear that in the Hebraic expression of this issue we have, not a series of world-pictures, but a worldview; not a detailed scientific explanation but a representation of the pre-abstractive appearance to man. So the cosmogony of the Bible is largely the common-sense view of things from the perspective of man - except in didactic revelation. In marked contrast to the ideas of the surrounding nations the Bible de-deified nature. Unlike the Greeks or Egyptians, nature in Hebraic thought was given no status of divinity. Similarly their God had no origin or boundary - He was infinite, eternal, the creator God on whom man was totally dependent for existence and preservation. As Hookyaas writes: "The Bible knows nothing of 'Nature' but knows only 'creatures', who are absolutely dependent for their origin and existence on the will of God." (1973, p.8. - cf. p.13.)

22.1.4. The Intervening Years. By the Middles Ages a certain impasse was reached. The Schoolmen made the earth-centred theories of Ptolemy integral to their philosophy and theology. But Aquinas moved towards treating this as a working hypothesis. (Cf. Hurd & Kipling 1964, Vol.I p.64.) The problem was that any alternative which was a-centric to the earth was equated with atheistic chaos. A world-picture and a worldview were being identified. But there was also a growing reaction against the cosmologies of Aristotle and Plato, even though much of the truly modern era of science from Kepler on was still caught up in their influences. Nevertheless, there was a distinctive move away from the Greek idea of orderliness as an expression of Nature's own intelligence to the concept of an intelligent divine ruler and creator who was independent of his creation. (Cf. 1.5. and 1.6.)

When the conflicting strands of thought had settled down and the Platonic, Aristotelian and Pythagorean ghosts finally laid to rest, the world was left with the Newtonian model as the 'final' explanation of the cosmos - or so it seemed. The universe, created by God, was a self-existent machine subject to various laws of nature which governed its behaviour. This is still probably a popular picture. But what room was there for mind in this picture? It was a problem which exercised the great men of philosophy. Berkley, Hume, Kant and Hegel all tried to resolve this fundamental problem and: "In every case their answer was at bottom the same: namely, that mind makes nature; nature is, so to speak, a by-product of the autonomous and self-existing activity of mind." (Collingwood 1965, p.7.)

<u>22.1.5. Laplace's Nebular Hypothesis.</u> This brings us to the first of the 'modern' cosmologies which is associated with Kant and Laplace.[1] Known as 'Laplace's Nebular Hypothesis' it in fact originated with Kant. Laplace postulated the existence of a denser central region whose power of attraction maintained the whole system which he conceived in a state of rotation, relying on centrifugal force to keep the planets in their places. Kant had ommitted the element of rotation, such that his system would have been lacking any angular momentum. But neither Kant nor Laplace explained why the four major planets - Jupiter, Saturn, Uranus and Neptune - which account for only 1/7th of 1% of the total mass of the system should possess 98% of its angular momentum. It was to get round this problem that Moulton and Chamberlain became the first of many to attribute the origin of the planets to a close encounter/collision between the sun and a passing star (i.e. a tidal/catastrophe theory). (Cf. Coudero 1964, p.365f.)

Picking up Aquinas' point about time and creation, Kant found himself in an embarrassing position. To the question as to whether the universe had a beginning in time he found he had a proof which said 'Yes', and one which said 'No'. Kant also denied the reality of space and time as empirical and real in the sense in which physical things are empirical and real. He went on to argue that the cosmos bears the imprint of our minds - thus providing a climate of thought which would seem to underlie and make possible the theories of men

1. Kant's first important book was 'The Theory of the Heavens' and was subtitled, 'An Essay on the Constitution and Mechanical Origin of the Universe, Treated According to Newtonian Principles.'

like Einstein, Bohr and Eddington.

22.2. MODERN COSMOLOGIES

<u>22.2.1. Introduction.</u> Today there is a new awareness that change is progressive and not cyclical; nature is no longer viewed as a machine, but rather that which is developing, and while it may contain or suggest machines, it is not itself a machine. Thus there has been a reintroduction of teleological concerns, substance has been resolved into function. It is necessary to be clear concerning the difference between 'cosmology' and 'cosmogony'. <u>Cosmology</u> is that branch of theoretical astronomy which deals with our knowledge concerning the universe as a systematic whole. <u>Cosmogony</u> deals with the genesis, evolution and future of the universe. The one is based on observation and the formulation of scientific laws, while the other is highly speculative. In practice the further we probe the more blurred the distinction becomes. Indeed the first real attempts to penetrate the sidereal universe were made by philosophers and not astronomers <u>per se</u> (cf. ibid p.363.). Due to this prominent philosophical nature we enter in cosmology into a more speculative area of science where theories come and go with amazing rapidity. Indeed one science historian parallels cosmological theories today to the numerous and varied ether theories of the 19th century and claims that "they are in a sense the historical heirs" of them. (Mason 1962, p.567.)

Cosmology is not experimental in the same way as physics or chemistry, but is typified as observational. The Principle of Uniformity assumes great significance (cf. 7.1.4.). We assume that the laws we do know, or think we know, hold throughout the universe. Hence a starting premiss is the assumption of far more than we have evidence for - but the alternative is to give up this branch of science! The principle of uniformity has two forms - the narrow, where it is believed that there is no preferred place in the universe but that the broad features, including scientific laws, are the same from any point of integration; and the wide view which includes the former, but contends that not only are the features the same at every place, but also at all times.

Compared with other disciplines, and considering its historical lineage, astronomy was slow to gather momentum. Not until 1782 did Herschel, with the aid of technological improvements, see a double star; and it was only in 1832-33 that a finite stellar parallax with the earth's orbit as base was discovered by Henderson. (Cf. Pledge 1966, p.290.) The existence of the galaxy was first deduced by Herschel - but only about 1800; and not until 1918 did Shapeley determine the centre of the galaxy and provide a serious modification to this picture. Now it appeared that the sun was situated about 30,000 light years from the galactic centre, and neither the earth nor the solar system was the centre of the universe.

Now while some cosmological models had been constructed on Newtonian physics, the modern cosmological movement cannot be seen as truly inaugurated until Seeliger and Neumann independently raised objections against the infinite Newtonian universe. (Cf. Kilmister 1969, p.34.) Essentially their objection was that when the volume of a Newtonian distribution of matter tended to infinity the gravitational potential became non-existent as did the gravitational force. To this was added the factor that the darkness of the night sky suggests a finite universe. Indeed as early as 1823 Olbers had calculated that if the universe were homogeneous and infinite, then the night sky would be as bright as the average surface brightness of a star. (Halley had noted this phenomenon in 1720.) It was difficulties of this kind in the Newtonian cosmology that gave rise to the interest in relativity for cosmology.

In 1917 Einstein tackled the problem as to whether space and matter in the universe were infinite or finite. Following Mach, he suggested that in an infinitude of matter each object would have infinite mass and inertia. Conversely, if the universe had a finite boundary in Euclidean space, the matter inside would not be in equilibrium with the empty space outside - thus basic instability. So Einstein postulated that the universe might possess finite volume but no finite boundaries - much like a two dimensional ant on a three dimensional orange. (Cf. Mason 1962, p.568.) From general relativity he derived an expression relating the average curvature of space to the amount of matter in the universe, and then calculated the mass of the universe and the curvatures of its space, assuming that the density of matter in our own galactic cluster and others was the same as the density of the whole universe. This was all done before the red shift of distant nebulae had been observed. Einstein further assumed that the velocities of bodies was small compared to the speed of light such that the spatial structure of his model did not vary with time. De Sitter challenged this - also in 1917.

"De Sitter's world was full of motion but contained no matter, while Einstein's world was full of matter but contained no motion. Both were extreme models, and later they were considered to be possible representations of the initial beginning, or the final end, of cosmic evolution, but not models of the universe as it is." (ibid pp.568-9.)

The special cases of Einstein and de Sitter's models were reconciled in 1922-24 by the construction of expanding models by Friedmann and Lemaitre. Such models could start from the Einsteinian model and expand asymptotically to the de Sitter form, or they could expand and contract. The question at the heart of all this was: could uniformity of laws be justified in an expanding universe?

It is clear that even if a theory could be found that adequately covered all data, this would not necessarily give a true theory for no one set of data has a unique solution. And in this particular area "the proportion of fact to theory has been smaller than is usual in science, and the trains of deductions have been unusually long." (Pledge 1966, p.294.) Cosmologies are highly underdetermined and this has led to a multiplicity of models within the cosmological field such that by 1932 de Sitter postulated nine main types of possible world models based on the conditions that both the cosmological constant and the curvature of space could be negative, positive or zero. (Cf. Mason 1962, p.569.)

22.2.2. The Big Bang/Superdense/or Evolutionary Model.[2] This is usually associated with Gamow's instantaneous creation theory which assumed that the universe started from an exceedingly dense concentration of neutrons which decayed within half an hour to produce atoms. Gamow, however, proposes no explanation as to the origin of this primeval nucleus - it is simply assumed. The temporality of the universe has been argued from various aspects - the oldest rocks on the earth are finite; radioactive decay suggests finitude; entropy points to a time arrow of finite magnitude.

There are several problems directed against the superdense theory. There are the problems of: infinite density at zero time; the assumed given primeval nucleus; and the red shift in the face of recent discoveries such as quasars and pulsars. As Shapeley wrote of this, and the next, theory: "Both hypotheses have plenty of trouble ahead of them and a paucity of observations behind them." (1954, p.484.)

2. Presently this theory or 22.2.4. is in favour with a general dismissal of 22.2.3.

22.2.3. The Steady State or Continuous Creation Theory. This reacts against the idea of a temporal universe and proposes that matter is continuously created. Matter lost by recession is replaced by new matter such that the observable universe is maintained in a steady-state - it has always been there and has neither beginning or end. The main advocates of this have been Bondi, Gold and Hoyle who have shown that by modifying the General Theory of Relativity the observed expansion of the universe can be accounted for as the result of this creation of matter in the form of hydrogen, as a property of space itself. These thinkers extended into the dimension of time the principle of equivalence of all observers in space, and this 'perfect cosmological principle' as it was called, led them to posit that matter was created ex nihilo continuously at the rate of 10^{-43} grammes per c.c. per second; or to put it another way, the creation of about one hydrogen atom in a space equal to a living room every few million years. Such a rate is of course too small to measure. (Cf. Hoyle 1955, pp.317-8.)

But there are problems. The theory has an ad hoc character about it to get round fiat, but must still face the question of where do laws come from. There is the problem of the creation of matter ex-nihilo which is blatantly ad hoc, as well as violating the theory of the principle of the conservation of energy/matter. Again, the newer radio astronomy which reaches further into space has established that the number of radio sources in a given volume of space increases with the cube of the distance from our galaxy - a result contrary to continuous creation which indicated that the number of sources in a given volume should stay constant or decrease as the distance increased. (Cf. Mason 1962, p.574.) The newer radio data coupled with the interpretation of the observed brightness in elliptical galaxies, radio noise background data, observed helium-to-hydrogen ratios in nebulae and stars in our galaxy, has led Hoyle to modify this theory. But he still holds to creation ex nihilo, positing an infinite and eternal universe consistent with the observable data so far obtained. The problem is that the previous and the next theory also adequately cover the known data. (Cf. Dingle 1954, p.519.) Interestingly, as support for this theory has diminished it has caused embarrassment in Russia where it was allied to a scientific confirmation of atheism.

22.2.4. The Oscillating Universe. This in essence is a return to the Greek concept of cyclical processes (cf. Gosse - 22.3.3.). Oscillation of the universe is finding wide acceptance and simply states that the whole universe expands out to some maximum radius and then contracts to a minimum before once again expanding. Gamow, once associated with the first theory, is a prominent advocate of this view, but confesses that his hypothetical formulation of an eternal oscillation is purely metaphysical and has no objective scientific basis. (Cf. Gamow 1955, pp.23-4.)

22.2.5. General Problems. Space precludes a proper discussion of the many problems in this area but several are noted. (a) Even if man discovered some instrumental tool that allowed accurate prediction and adequately covered all known data, even this would not be enough for theoretical science. (b)The above theories deal with the origins of the universe by excluding (a priori) the possibility of a creator God who was, and is, causitive vis a vis the created order. (Cf. Hess 1976, p.29.) (c) The observable universe is not necessarily the universe observed, thus making predictions and data relative. (d) The above theories give no reason why one thing happened rather than another. (e)The second law of thermodynamics seems to militate against the steady state theory which cheats both conservation and entropy laws. (f) The act of creation per se cannot be subject to the scientific laws that pertain to created reality.

22.3. DOCTRINES OF CREATION [3]

22.3.1. The Literal-Naive View.[4] This contends that all was created about 6,000 years ago in six literal 24 hour days. This view is often wrongly identified with conservative Christians though it does find wide support from fundamentalists.

22.3.2. The Linguistic Solution. This proclaims that Genesis states the origin of the universe in religious and theological terms (poetic and literary) alone. It views Genesis as a purified mythological Babylonian cosmology, but sees the religious truths enshrined therein as inspired. It lies behind many modern views (cf. 22.3.8.1.).

3. The doctrine of creation depends to a large extent on how the first two chapters of Genesis are interpreted and there have been diverse understandings of this. The limits of space again necessitates virtually a listing of the views rather than a proper presentation of them. (Cf. Ramm 1971, pp. 119-178.)
4. It may be possible to hold more than one view at one time.

22.3.3. The Ideal-Time or Pro-Chronic View. This comes from P. H. Gosse who argued that all organic life is cyclical, and that creation was a violent irruption into the cycle of nature.

22.3.4. The Creation-Ruination-Recreation Theory. This has the advantage of allowing in the 'gap' between Genesis 1;1 and 1;2 a time scale suited to any geological or evolutionary process.

22.3.5. The Age Day Theory. This considers the 'days' of Genesis as periods of time.

22.3.6. The Divine Day Theory. Following Augustine, this envisages the 'days' as God-divided (periods of revelation) and not sun-divided.

22.3.7. Roman Catholic Views. In 1909 the R.C. Pontifical Commission listed among the 'fundamental truths' of the Genesis story - the creation of all things by God at the start of time; the special creation of man; the formation of the first woman from the first man; and the transgression of a command given by God to the first man resulting in the Fall. The first Papal encyclical to deal with evolution (1950) divided man into body and soul, granting an evolutionary origin of the body, but insisting on the special creation of Adam's soul. So we find a point of correlation between science and theology in that the Roman orthodoxy links evolution in science and the doctrine of creation by two actual historical events - the beginning of the universe and the advent of man.

22.3.8. Protestant Views. Neo-Orthodoxy knows no such link and the opening chapters of Genesis are viewed as symbolic expressions of religious truths on a quite different sphere from science or history. There is a radical disjunction of science and religion which leaves men like Barth and Bultmann quite unperturbed by the discoveries of science.[5]

22.3.8.1. The Existential Impact. Bultmann[6] sees creation as the constant action of God with man, but in no way involving a cosmological vision. His view is typically existential with the meaning of creation shut up to a personal confession. He wishes to demythologise the idea of creation and point to its existential significance in terms of man's dependence on God.

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5. They tend to remove into an upper storey religious mysticism - cf. Appendix A, and Dumas (1976, p.32.)
6. Cf. the excellent critical monograph by Ridderbos (1960).

"The affirmation that God is creator cannot be a theoretical statement about God as creator mundi in a general sense. The affirmation can only be a personal confession that I understand myself to be a creature which owes its existence to God." (Bultmann 1958, p.69.)

Similarly Gilkey distinguishes religious and scientific concerns along existential lines - creation affirms existential dependence and not temporal origins; creation is a relationship entered into and not an event as such; we are concerned with ontological dependence and not temporal history. (Cf. Gilkey 1959, p.260.)

From a different doctrinal basis Brunner (1952, p.3f.) insists that the doctrine of creation is not an hypothesis about origins but simply a form of the basic religious affirmation that God is Sovereign. He draws a contrast between God as the one who stands 'before and above' the world, and the world as viewed in Greek philosophy where God and the world are necessary complements. So he affirms a rigorous dichotomy between Creator and creation. But with reference to evil and suffering he drives a wedge between God as Creator and God as Redeemer; between law and love. This means that his doctrine of creation is reduced to a confusing statement that God created the world; but that our world cannot be identified with this.

<u>22.3.8.2. Karl Barth.</u>[7] It is axiomatic for Barth that creation be seen as a revealed doctrine, and consequently that it be viewed within the context of the revealed covenant between God and man. As God deals with man through grace, so the very ground of creation is also grace, while its goal remains the glorifying of God. Hence there is an inner interwovenness of nature and grace (in dualistic motive?). But this does not avoid the fact that the same history of redemption, just like the history of creation is fundamentally non-historical. (Cf. Zuidema 1972, p.314.)[8] Genesis 1:1 is where the story of grace starts for Barth - indeed it starts even before this, for the covenant precedes creation, it is from everlasting. The eternal covenant is the inner ground of creation which binds creation and redemptive covenant in an inner unity. (Cf. Berkhouwer 1956, p.55.)

Creation as saga discloses an event and not something ontic; it is sacramental as well as salvation history. But creation is not tied

7. As well as Barth's own writings I would draw attention to two useful critical studies - Zuidema (1972) and Berkhouwer (1956).
8. Barth, of course, is not overmuch interested in any scientific or historical concern as one normally considers such topics.

to God, it is quite distinct. (Cf. Barth 1949, p.55.) God created heaven and earth 'in tempore' as well as 'cum tempore', and it follows that the days of creation are simply taken as days because when God created creaturely time He was creating in creaturely time. But basically he is not interested in creation as an objective historical event, but in the concept of dependence it portrays. Striking at the heart of the Kantian ding an sich he writes:

> "...heaven and earth are not a reality in themselves, which are understandable and explicable in terms of themselves, but that they, with man in the centre, as the meaning of their existence, derive from God, belong to God." (ibid p.60.)

Thus he views Genesis One as giving creation as the external basis of the covenant and Genesis Two as giving the internal basis, drawing out the Christological centre of his theology. Christ works in creation: "The world came into being, it was created and sustained by the little child that was born in Bethlehem..." (ibid p.58.) Nothing could be clearer, and in a sense more refreshing a statement than this. But as I see it, he carries his exegesis too far. For Barth, Christ is the real ground of creation where God says 'Yes' to creation. So he reads Christ out of Genesis 1;1 and therefore our real and original condition is not derived from the figure of Adam but from Christ. Our being in Adam stands from the beginning in the light of the fact that we are in Christ.

Having espoused such views it is not surprising to find that he has no clear conception of the Fall. The triumph of grace is from before creation and not after the 'good' creation had fallen. Hence when Genesis 1;31 talks of 'goodness' it is nothing to do with some original condition but refers to a unique 'being good' of the room which God had made for the unfolding of the covenant. Thus Barth denies that man is given a freedom to choose between obedience and disobedience; such freedom is not granted man; he occupied no middle ground between obedience and disobedience. Yet sin has come to pass, has become reality. But the choice which man made was irrational and absurd, the impossible possibility of sin. (Cf. Berkhouwer 1956, p.62.)

The triumph of grace in creation implies a triumph over something. This hinges around his interpretation of Genesis 1;2 where he sees the 'was without form..' as referring to a past time, something that God had bypassed when he created the world. It is that which was negated by God's creative act; it is the boundary of created reality, and only here does the un-godly and the anti-godly have reality. God, in His grace and mercy, pushed this reality back to its periphery. In Barth's view this excluded possibility receives a deeply profound significance, for simply in that it was excluded, it is a reality at the boundary of that which God did create. Thus the chaos exists only at God's left hand, not as His creature, but subject to His power. Barth deals with this at length (this 'das Nichtige') seeing it as essential to his view that God could not be gracious if not threatened. (Cf. ibid pp.56,72.) The Devil is essentially the chaos; and the chaos essentially a kingdom of unreality. But dialectically the chaos is not only appearance, for in the attempt to establish a power of its own, the kingdom of unreality, of chaos, is a reality even if the reality of a lie. (Cf. ibid p.78.)[9]

While this is the briefest of summaries it indicates how divorced from any scientific interest is Barth's formulation. Several objections can be raised even if there are valuable insights here. First it must be said that Barth does not seem to allow the passages he deals with to speak for themselves, such as in his attempt to read Christ out of Genesis 1:1. It might even be asked if he exegetes Genesis 1 to 3 at all. In his over-Christologising he tends to confuse Christ as mediator of creation and mediator of redemption. Obviously one does not want to undercut the identity of the ontological Trinity where all participate in creation; but it is erroneous to equate the history of creation and the history of salvation. This seems to me a crucial flaw in Barth's whole theological construct. It is a view which blurs the reality of the Fall and sees no clear distinction between God's good creative act, and the Fall due to man's free choice of disobedience.

I have long had the impression that Barth in his doctrine of creation tends to an incipient Gnosticism in that he has little interest in nature and heads immediately for a theological anthropology, which in turn heads at once for a soteriological Christology. Prenter in fact speaks of his 'creation docetism'. (Cf. Zuidema 1972, p.316.) This stems, I believe, to a large extent from his *a priori* disjunction of religious concern from history and science *per se*.

22.3.8.3. Process Theology (cf. 16.4.6; 17.1.). The process theologians number men such as Birch and Barbour, as well as Whitehead,

9. Cf. Barth's 'Church Dogmatics' III/3; III/1; IV/1.

Cobb and Hartshorne. They arrive at their concepts from a personalistic model. In all approaches a model of reality is crucial and here, in reaction against the physical-empirical models of the Newtonian era, we find a biological model which has less emphasis on rigidity and more on the fluid processes of becoming. Models are, of course, ever a danger and Birch rightly points out that: "To mistake the model for reality is to be guilty of what Whitehead called the 'fallacy of misplaced concreteness.'" (1968, p.199.) Yet Birch also writes:

> "For process thought the personal is the model for all entities. It starts with the personal and a process of reduction from the higher to the lower levels of creation... It is a form of reductionism in which process and mind never disappear." (1976, p.44.)

Immediately one wants to know precisely how this may apply to a stone, or an atom - are they too personal?

Within this scheme it is meaningless to claim that God causes this or that physical or biological event for God is not an agent of mechanical causation - though He is a 'divine causation'. Birch contends therefore that "creation is not something that happened. It is not a doctrine about past events. It is a doctrine of the present." (ibid p.44.) He draws heavily on the Einsteinian destruction of the Newtonian model, contending that: "There is no such thing as a particle. Reality is not things but process. Process involves becoming. Becoming involves something akin to anticipation." (ibid p.42.) Thus the universe is seen as a living organism, not a mechanism. "Mechanism", he claims, "is an abstraction from organism; to fail to see this is to reify process." (ibid p.43.) It follows that Genesis is not about temporal beginnings but concerns the basic relationship between the world and God.

Here we find an existential influence as well as what appears to me a philosophical absurdity, for if creation is not something that happened, how do we answer the problem of being at all. It is all very well to shift the emphasis from being to becoming, but there can be no becoming apart from being.

How does Birch view God? (Cf. Birch 1968, p.194.) He suggests that we can either view God as spectator of the created object or as integrated with creation such that no sharp distinction exists between

Creator and creation. But this posits a false dilemma - are these the only two alternatives? It seems to me that because he has abandoned the idea of a real creation as a beginning he is forced into equating providence and creation, which, as I see it, are two distinct realms. For Birch, God neither rules sovereignly nor causes all being and becoming to be (for accidents occur). The creation of order in nature is a trial and error process of autonomous nature. Thus the conclusion is forced on us that for process theology the world is in God - panentheism - in a new attempt to combine the transcendence and immanence of God.

22.3.8.4. Francis Schaeffer (1975, p.27f.). Schaeffer is one of the most influential conservative scholars today and has suggested seven areas of freedom and two of absolute necessity in respect to a biblical doctrine of creation. The seven areas of freedom are: (a) the possibility of a break between Genesis 1;1 and 1;2; (b) the possibility that God created a grown-up universe; (c) the possibility of a 'long day' (period) in Genesis 1; (d) the possibility that the Flood affected the geological data; (e) in Genesis 1 the use of the word 'kinds' is not equivalent to 'species'; (f) the possibility of animal death before the Fall which would account for fossils from that period; and (g) only the word 'bara' must mean an absolute new beginning - used only for the original creation (Gen.1;1.), for the creation of conscious life in contrast to vegetation (v.21.), and for the creation of man (v.27.) - the other words being used, 'asah' (made) and 'yehi' (let), do not necessitate absolute new beginning. Schaeffer also posits two limits on these areas of freedom: (a) the use of the word 'bara' gives discontinuity with what went before - although the other words can fit continuing creation; (b) Adam was historic.

22.4. TOWARDS A BIBLICAL DOCTRINE OF CREATION

Creation is connected to questions such as: Why is there something rather than nothing?; Is there reason and purpose in existence?; Why are things the way they are? In seeking to formulate answers the humanistic trap of excluding revelation must be avoided. The question of the origin of the world apart from revelation is unanswerable as Genesis 1;1 and John 1;1 indicate, as does Popper (cf. 1972/a, p.29f.). Humanly speaking we can think of creation in several ways - in the mystery of new life, of birth, of procreation; or in the poet who creates, as does the painter and sculptor, by forming out of pre-existent materials. But such analogies break down for in 'the' creative act of God we deal, not with finite man, but the infinite God who is truly there.

Biblical statements do not give a (primary) scientific picture - but represent a world view. Even Flew realises the validity of this approach, as does MacKinnon who notes: "To believe in Creation is to see the world in a certain way; to have one's responses to its manifold being coloured in a certain style." (1969, p.175.)

The creation doctrine reveals God as Sovereign and Transcendent; the idea of ex nihilo indicating that He is not limited by anything (such as Plato's Demiurge). Thus we have firmly established the fundamental ontological dependence of creation. God is free and purposeful, giving to time and history significance and direction. The world is affirmed as real and orderly, not an illusion or the product of chance; essentially good, even if marred by the Fall.

There is a basic distinction, then, between the Creator and the creation. But how is God related to the cosmos? First: through the Word-based doctrine of creation where Christ is mediator of creation, granting meaning to it before the Father. Second: through the covenant of God with man and nature - which is not to assert a covenant of grace prior to the Fall, but to realise the implication of a covenant of works. Nature has its own intrinsic value apart from man before God.

22.4.1. The Universe Is Not Eternal But Began To Be. From ancient times, and even in the early church fathers (Origen) it was considered that the world was eternal, that it had no beginning in time. It was argued that if God was Creator, then He was eternally such as this was His intrinsic character, and therefore creation itself must be eternal. (a) But the idea of creation per se implies finitude (cf. 2 Chron. 6;18.). (b) While God is Creator, and this is attributed to His character, it is not therefore necessarily of the essence of His being. The essence of His being and that which are His attributes must not be confused. (c) If time is created such objection falls to the ground. (d) Scripture clearly implies a beginning - Gen.1;1. Jn.1;1. Ps.33;6,9. - a creation through the Word, and through the brooding activity of the Spirit.

The whole Trinity is involved in creation. The Father primarily is the One who creates; but it is also by Christ that all things are created, He is the Alpha and Omega, the eternal, infinite and divinely perfect expression of the image of God. All thoughts of God in relation to all things are taken through and out of the Son. In creation the Word gives existence outside of Himself to all creation, which is a thought of God, a creative Word of God. As Pannenberg comments: "the Johannine Logos simultaneously has cosmological (as Mediator of the creation of the world) and soteriological (as Redeemer through revelation) functions." (1968, p.160.) But Pannenberg, like Moltmann, views creation eschatologically - it happens from the future, from the ultimate end. Creation is not viewed from the perspective of the beginning of the world. So referring to a passage like Colossians 1;15 he constructs an eschatological mediation of creation by Christ - mediation, not with respect to the origin of creation in time, but to the world process as a whole. Christ does not provide a creational law, but an end reconciliation of the cosmos. (Cf. ibid pp.169,392,395f.) But it is my contention that this ignores the plain meaning of Colossians as well as the philosophical problem of why there is being in the first place, and hence leads into a metaphysical labyrinth where the future finishes up determining the present (cf. Betz, Alves, Moltmann). Rather, Christ mediates and upholds creation from the beginning and the structure of Colossians is (a) Christ creates all things (v.16); (b) preserves them in temporal existence (v.17); and (c) reconciles all things (v.20). The creative aspect belongs logically to a beginning in time.

As the light and thought of God in creation is through the Son, so the force of life, its harmony and communion, are in the Holy Spirit. (Cf. Gen.1;2. Job 26;13. Ps.33;6.) Thus <u>of</u> the Father, <u>through</u> the Son, and <u>in</u> the Spirit are all things created. The Spirit of God was not merely a source of supernatural knowledge in the Old Testament, but in a fundamental way the ground of life in its inclusive sense. Thus Psalm 104 describes in impressive language the vitalising effect of the Spirit of God and the total dependence of creatures on their Creator. (Cf. Ps.104;29,30. Gen.2;7. Ezek.37;5f.)

<u>22.4.2. The Universe Was Not Formed Out of Pre-Existing Material.</u> I reject any form of pantheism (that the universe is the existing form of God, the living garment - <u>das lebendiges Kleid</u>, Goethe); or hylozoism (that there is intelligence in nature). Theism believes in an infinite extramundane mind to whose power and will the origin of all things are dependent, and that all things are quite distinct from that power and will. To the objection <u>ex nihilo nihil fit</u> I reply

that we are not here dealing with the undoubted limitations of man and his thought, but with a transcendent God who can do *precisely* that which is humanly impossible. God is not a mere super-human being.

There is, then, the immediate creative act of God and His mediate acts to be considered. In His immediate act God calls matter into being - 'In the beginning God created the heavens and the earth.' He calls into existence the things that do not exist (cf. Rom.4;17.). But there is also His mediate acts where He forms, shapes and moulds. One example is sufficient to establish this: in Genesis 1;27 and 2;7 we find that man was not called into being immediately, but that God used the dust of the ground to form him, to mould and shape him. Therefore it is clear that the forming by God out of pre-existent material is not taught, but that the forming out of created material is. So it is reasonable to argue for an instantaneous creation _ex nihilo_ by the Word of God; and a mediate, progressive creation by the power of God and/or secondary causes under His rule.

It is a common assertion that _creatio ex nihilo_ is nowhere explicitly taught in Scripture, and Simpson (1925) and Barbour go as far as to contend that it is not implicit either - arguing that the concept only appears in 2 Maccabees 7;28. (Cf. Barbour 1968/b, pp. 383-5.) That this has some substance is confirmed by the hyper-orthodox Hoeksema (1973, p.170f.) who concedes that this is a concept foreign to Scripture, and that the basic thrust of the Hebrew words 'to create', 'to form' and 'to make' all imply a process of separation, moulding and forming. Nevertheless he implicitly allows _creatio ex nihilo_. Most attempts to establish this point appeal to Genesis 1 and the use of 'bara' and Hebrews 11;3. So while there is no tight linguistic argument for _ex nihilo_ it should be borne in mind that there is _no_ word in Hebrew, Greek, Latin or English which is exclusively expressive of this single concept.

The doctrine was, of course, articulated in the early centuries of the Christian era as a refutation of Gnostic heresy. That it should be given a prominent role today seems clear to me, and certainly there is no scientific or Scriptural reason why it should be negated. Indeed Flew, in his discussion of creation with MacKinnon, grants the concept as valid within the Christian framework. (Cf. Flew 1969, P.171.)

I would defend the doctrine of _creatio ex nihilo_ on the following basis. (a) Scripture gives no explicit statement of there being a pre-existent material out of which God formed the universe, nor is the universe anywhere seen as an emanation of God, or identified with Him. (b) Scripture says: 'Let there be and there was...' 'For he spoke, and it came to be; he commanded, and it stood forth.' (Ps.33;9.) (c) The universe is consistently seen as of God. He is the source of all, not in a Gnostic sense, but in line with other biblical representations which refer the existence of all things exclusively to His command. "The universe, therefore, is 'of Him' as its efficient cause." (Hodge 1960, Vol.I p.559.) (d) Hebrews 11;3 depicts creation as the fundamental doctrine. It is a basic tenet of the faith, understood by faith and given to us through revelation. (e) God alone is infinite, all else is temporal and dependent (cf. 2 Cor. 4;18. Ps.102;25,26.). (f) A beginning in time necessitates *creatio ex nihilo* or we end up in an eternal dualism of God and matter. (g) The temporality of created reality is implicit in the idea of God's preserving grace (cf. Col.1;16,17. Rev.4;11.).

It seems to me there are only four logical possibilities concerning this topic. (a) Either we have an absolute nothing, not even God, out of which all came to be; or (b) we have all beginning from an impersonal something, that is, there was primeval energy or something which was somehow sparked into what is; or (c) we have a beginning out of a personal something, who caused temporal created reality to be; or (d) we have an eternal dualism of good and evil, God and energy/matter. It seems to me that Scriptural warranty can only be found for (c). (Cf. Augustine 426, p.506.)

None of this negates that there is also in time a continuing act of God. Barbour sees this as merging with the idea of providence and excluding *creatio ex nihilo*. He points out that traditionally creation and providence were seen as distinct - creation was temporally God's initial act, while providence was His subsequent acts. There was an ontological difference here in that in creation He acts immediately, while in providence He acts along with or through secondary causes; and a theological difference in the former pointing to His transcendence and the latter to His immanence. This is a fair statement of the difference, though Barbour rejects it and adds:

> "Now if creation is continuing, the first two distinctions vanish. If time is infinite, there was no intial act, no state of 'nihilo', and God has always been working along with other causes. Even if time is finite, creation occurs throughout its span and in the midst of other entities." (1968/b p.385.)

Thus he loses a valid theological distinction by reducing creation to the continuing concept alone. In opposing such a reduction I reaffirm that I accept the idea of continuing providence (cf. Ps. 104; 14-30.). In distinguishing creation and providence, I do not wish to make an absolute separation for "without proceeding to His providence, we cannot understand the full force of what is meant by God being the Creator." (Calvin 1560, p.93.)

<u>22.4.3. Creation Was Not A Necessity Imposed On God.</u> God did not have to create to fulfil His love, to have someone to respond to that love. The ontological Trinity with its love and communication between the three persons obviates this objection. Again such an idea (that God had to create to fulfil Himself) would be an unacceptable limitation on the being of God who is free and independent.

22.5. PRELIMINARY CONCLUSIONS

The following definition of creation is posited: Creation is that act of the Almighty will of God by which He gave that which was eternally in His counsel, existence in distinction from Himself in time. We are faced with an ultimate problem of why something is there rather than nothing, and to this science has no answers. Even if science uncovered the mechanics of creation as exhaustively as humanly possible, it would not explain why a primeval mass was there in the first place. Nature derives from God, it does not stand autonomous from Him but "is simply the efficacious expression of the Divine wisdom and will." (Simpson 1925, p.78.)

If there is one thing the Bible insists upon throughout it is the priorness of God and the total dependence of creation. It seems to me that this is compatible in a thoroughgoing way with the idea of <u>creatio ex nihilo</u>, while the continuing work of God within creation relates to His existential holding-in-being of creation. God reveals Himself in His works such that we understand all things to be out of the Father, through the Son and in the Holy Spirit; all things are of God, through God, and to God. (Rom.11;36.)

The cosmos is other than God but depends on Him; the cosmos is contingent and derived in being, while God is necessary and underived in being and creates and sustains the world by fiat. "In Genesis, and in Christian thinking, the world exists entirely by the <u>fiat</u> of God." (Peacocke 1976, p.49.) The doctrine of <u>ex nihilo</u> is a denial of pantheism, panentheism, Manichaeism and atheism; but it is also a reasonable act of God.

It needs to be reiterated that the Bible does not give a full blown model but a worldview depicted in a pre-abstractive manner. Thus, in broad terms, a biblical cosmology states that the universe, as created by God, is real; that man is real; and God is real - but that there is an ontological discontinuity between God and creation. It asserts that in the search for meaning we only know something truly as our knowledge of it conforms to God's interpretation. So only in the widest sense can Scripture indicate what is scientifically possible and what is not. Obviously Scripture suggests dependence and Theism instead of autonomy and atheism. The problem is the scientist who plunges on into his scientific intricacies and loses sight of the overall perspective of which any part is but a facet and not the whole; loses sight of the personal truth of the wholeness of creation in the seeming impersonal particulars; loses the true integration point.

Cosmologically the Copernican and Newtonian episodes have shown that Christians can and do make mistakes - indeed all men do - in confusing world-picture and worldview; that there should be a willingness to change our mind in the face of accredited evidence; a need to examine deeply the essentials of belief and refrain from dogmatic statements in areas not pertaining to salvation. Perhaps the Reformation attitude of an open book that was alone supreme and an open mind before God are worth remembering.

But lest we endeavour to usurp God, let us remember also that we are creatures before the Creator, that we have been set limits and boundaries.

> "....let us willingly remain hedged in by those boundaries within which God has been pleased to confine our persons, and, as it were, enclose our minds, so as to prevent them from losing themselves by wandering unrestrained."
> (Calvin 1560, p.74.)

Our calling is to live in creation, to take a pious delight in the work of God, and to praise and glorify Him in all things.

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CHAPTER 23

TOWARDS A CHRISTIAN PERSPECTIVE OF 'LAWS OF NATURE'

23.1. INTRODUCTION

Science is dependent on the concept of law, of an underlying pattern and order in nature which the scientist seeks to uncover. Indeed without an initial assumption of uniformity science becomes impossible for this rationality is of the essence of scientific activity. As an assumption it is, however, in need of examination for the concept is an article of faith. As Whitehead noted:

> "Science is founded on the notion of Law - The Laws of Nature... ...the restless modern search for increased accuracy of observation and for increased detailed explanation is based upon unquestioning faith in the reign of Law. Apart from such faith, the enterprise of science is foolish, hopeless." (1947, pp.51,173.)

The origins of this concept of law are in the Christian religion, and especially in the Reformation (cf. 23.2.3.). It cannot be denied that science arose in the context of a Christian worldview that stressed the reality of the Creator who had formed the world and imparted law to it. Davies argues that in the 15th century:

> "The Intellectual power of man was being rediscovered, but in a new context - that of Christianity. This religion involved a belief in a governing Lord, leading directly to a belief that there were governing laws." (1975, p.31.)

However today the concept of 'laws of nature' is often used with a strong honorific intent but little precision. It is not a technical term peculiar to a particular empirical science but a generic term present from the start. Nagel (1974, p.49.), in fact, contends that because it is a general term it is futile to try to define it and that anyhow the term has undergone historical changes. Undoubtedly the term has altered meaning through the centuries, but that should not stop us trying to come to some understanding of the concept - especially as it is perhaps 'the' foundation on which science is erected.

Often we talk as though the 'laws of nature' caused events to happen, but as related to science they never cause anything, they simply state a pattern to which events, once induced, conform. (Cf. Lewis 1960, p.63.) In the formulation of laws, science does not so much discover as uncover the form of regularities whose existence has already been recognised or hoped for. Ptolemy, Bacon and Kepler could never have studied the refraction of light as they did if they had not believed in some regularity to be discovered in this phenomenon, but it was not until Snell that the 'form' of this regularity was uncovered.

23.2. HISTORICAL REVIEW OF THE CONCEPT OF 'LAWS OF NATURE'

<u>23.2.1. Two Basic Sources.</u> It has been suggested that there are two basic sources for the idea of 'laws of nature'. The first from an analogy based on the practice of civil government by statute law introduced by the absolute monarchs of the 16th and 17th centuries; and the second from the Jewish-Christian conception of God as Law-giver. (Cf. Mason 1962, p.173.)

<u>23.2.2. Law In Greek Thought.</u> The term itself was first used by the Greeks but not with any general reference to ordered patterns in the external world. It referred to the internal world of human passions. The Stoics used the term a little to refer to the universe, probably under the influence of Babylonian astrology. Essentially, however, in Greek thought the idea of law was placed within creation. This could be achieved subjectively and/or objectively. Subjectively the law was found in the subject functions of reality; while objectively the law was founded in the object functions of reality. When 'I smell a flower', both 'I' and 'flower' are subject to God, both object; but in the Greek perspective the former accentuates the 'I' and the latter the 'flower'. Now undoubtedly when 'I smell a flower', 'I' functions subjectively and the 'flower' objectively <u>in relation to the 'I'</u> of the above action, but neither is the true norm for reality or knowledge. In other words in Greek thought the lawful functioning of reality as governed by, and subject to, the Law of God was confused and identified with the Law itself in one of its aspects.

<u>23.2.3. The Reformation Basis.</u> The Middle Ages saw no real emphasis on the term and the concept only comes to the fore from the 16th century onwards. It would therefore seem that this is an inheritance to science from the Reformation period (cf. 3.5.). Mason, after reviewing Zilsel's attribution of the origin of law to sources in civil law and the thought of Jean Bodin, goes on to suggest that:

"Perhaps it was not also a matter of chance that some forty years before Bodin another Frenchman, John Calvin, in the field of theology, was working towards the conception of God as the Absolute Ruler of the universe, governing by laws decided at the beginning." (ibid pp.173-4.)

Certainly it cannot be denied that through the 17th century nature's laws were seen as testimonies to the wisdom and providence of God by theologian and scientist alike. Indeed the study of nature was to become a prelude to the study of revealed theology for men such as Derham, Ray and Paley (cf. 5.2.). Coupled with this was the Baconian desire to have knowledge of the order of nature that man might gain power over nature to predict and control, and so fulfil the cultural mandate. But as time passed the quest became inverted and an autonomous law was granted power over man.

23.2.4. The Absolutization of Law.[1]

23.2.4.1. Following Descartes and Newton. Descartes was crucial in the development of the concept of law, effectively marking a break from the Reformation concept of the term. The Reformation worldview envisaged no autonomous law, but Descartes identified the laws of nature with the principles of mechanics. Hence in the Cartesian dualism which was to be so influential, events were seen as determined by the mechanical law of the universe and not by divine action. God was introduced merely as an initiating cause to avoid a solipsism.

There was little resistance to this emancipation of the concept from its religious origins in the providence of God - though conservative thinkers such as Boyle became increasingly unhappy with the idea of 'laws of nature' seeing the term as 'an improper and figurative expression.'(Cf. ibid p.172.) By the time of Newton the

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1. Gillespie (1959, p.13f) gives an interesting discussion of this, from which the following two quotations are noted. Gravesande wrote in 1726 that: "A Law of Nature then is the rule and Law, according to which God resolved that certain Motions should always, that is, in all cases be performed. Every Law does immediately depend upon the Will of God." (ibid p.13.) This is not dissimilar from another definition by Musschenbroek in 1744; that laws of nature are "those constant appearances, which are always the same, whenever bodies are placed in like circumstances....The wisest of mortals could not have discovered any of them by reason and meditation, nor can pretend to have any innate ideas of them in his mind. For they all result from the arbitrary appointment of the Creator, by which he has ordered, that the same constant motions shall always obtain on the same occasions." (ibid p.13.)

concept was in general, if not widespread, use in a manner that would gather strength as an autonomous principle of law. The trend was to absolutize the idea of law; to loosen the concept from the providence of God and shut it up to Deistic implications (cf. 4.1; 4.2.).

<u>23.2.4.2. Following Deism and the Enlightenment</u> (cf. ch.5.). The Deists, of course, made law into an autonomous principle and it is from the contention of people like Schweizer (about 1863), who opposed miracles against the given order of the universe, that the modern concept of a miracle as a 'violation' of a law of nature stems.[2] The Deists and the men of the Enlightenment were the twin forces which enthroned the autonomy of reason (law) above man, and indeed above God. Interestingly it is with the Enlightenment that the phrase 'law of nature' becomes extensive in literature as something determinate and objective; nature was compelled to follow law (cf. Laplace).

<u>23.2.4.3. In Theology.</u> The debate over the 'reign of law' was prominent in the evolutionary debate of the 19th century (cf. 7.3; 7.4.). Here were diverse reactions - from the attempt to derive spiritual analogies from the physical world by Drummond in a subjectivising response, to the more conservative response of Hodge. It should be noted that Hodge deals with this topic in terms of the providence or government of God and not with respect to creation alone. Nevertheless he seems caught in the autonomous principle of the Enlightenment and makes certain ambiguous statements. He rightly asserts that there is in Scripture the recognition of an external world, a material universe, and that in this universe matter is active. (Hodge 1960, Vol.I p.606.) This however leads him to what seems an autonomous statement of the principle of law when he writes: "These physical forces act of necessity, blindly, and uniformly. They are everywhere and always the same." (ibid p.606.) He maintains that the 'reign of law' gives laws which are immutable, uniform in operation, and which cannot be disregarded. (cf. ibid p.609.) So he is caught in a curious tension between the concept of autonomous law prevalent in his day (from the Enlightenment) and the idea of the sovereign providence of God (from Scripture). This tension is well displayed in the following extensive quotation.

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2. David Hume is also critical for this 'miracle as a violation of a law of nature' concept.

"The phrase 'Laws of Nature' is....generally used in one or the other of two senses. It either means an observed regular sequence of events, without any reference to the cause by which that regularity of sequence is determined; or it means a uniformly acting force in nature. In this last sense we speak of the laws of gravitation, heat, light, electricity, etc. That there are such laws, or such physical forces, acting uniformly, which are not to be resolved into 'uniform modes of divine operation,' is....an important Scriptural fact.

The chief question is, In what relation does God stand to these laws? The answer to that question, as drawn from the Bible, is, First, that He is their author. He endowed matter with these forces, and ordained that they should be uniform. Secondly, He is independent of them. He can change, annihilate, or suspend them at pleasure. He can operate with them or without them. 'The Reign of Law' must not be made to extend over Him who made the Laws. Thirdly, As the stability of the universe, and the welfare, and even the existence of organised creatures, depend on the uniformity of the laws of nature, God never does disregard them except for the accomplishment of some high purpose. He, in the ordinary operations of his Providence, operates with and through the laws which He has ordained. He governs the material, as well as the moral world by law." (ibid p.607.)

While this may seem a fair statement of the Christian position it tends to elevate law into an autonomous principle of nature which God can set aside or violate to achieve higher purposes - yet at the same time it is His law. So God is seen working against Himself, violating His own operations, or setting Himself aside to achieve more immediate purposes. (Hodge may be covered here in the last sentence of the first paragraph). But he also writes that:

"It is manifestly inconsistent with the idea of an infinite God, that any part of his works should be absent from Him, out of his view, or independent of his control. Though everywhere thus efficiently present, his efficiency does not supersede that of his creatures. It is by a natural law, or physical force, that vapour arises from the surface of the ocean, is formed into clouds, and condenses and falls in showers upon the earth, yet God so controls the operation of the laws producing these effects, that He sends rain when and where He pleases." (ibid p.608.)

However it may again be thought that this creates an hiatus between God and the laws of nature. Hodge goes on to distinguish between the general, special and extraordinary providence of God. He sees the 'laws of nature' as under the general providence of God for controlling his creation; special providence does not violate these laws but nevertheless prayer in sickness is not irrational for God, while not setting aside or counteracting the laws of nature, controls them and causes them to produce the effects that He sees fit. A real problem comes with the question of miracles (cf. 24.1.2.3.).

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This brief review indicates some of the changes and problems in the concept of 'laws of nature'. The basic problem is that of the (pretended) autonomy of law, and perhaps it would be better from a Christian point of view if the phrase 'law of nature' was substituted by 'law of God' or 'law of science' for the former tends to contain the assumption of law as a property of autonomous nature existing in and of itself, instead of dependent existentially on God.

23.3. CONTEMPORARY REVIEW OF THE STATUS OF 'LAWS OF NATURE'

23.3.1. Various Viewpoints. It is popularly said that scientists discover laws of nature; that orderliness implies some rule of law; and that the scientist uncovers the complexities of phenomena, thus exposing the underlying regularities to reveal natural law. This viewpoint rests on an essentialistic view of science (cf. ch. 11.) for if laws were truly discovered in this fashion they would endure for all time, and this is not so. A more critical view would be that which sees a natural law as "merely a resumé of behaviour or activity, whether in the animate or the inanimate world." (Simpson 1925, p.146.) Thus the late Professor Simpson went on to suggest that: "The laws of Nature represent at any selected time the manageable relations of things as registered on the basis of experience at that time, and within limits the phenomena of Nature comply." (ibid p.150.) (Note, however, the personification of nature.)

As the 20th century has progressed and worldviews become steadily distanced from Christianity, a certain ambiguous relationship has arisen. The idea of law is not conducive to much of modern philosophy; further it has come under attack from those who see science based on a fundamental level of disorder. So many are unhappy about the use of the term 'law' in reference to the world of science. Harré actually points out: "The term 'law' is a survival in this use of a certain theory about nature, in which there was a law-giver....I do not hold this theory." (1967, p.107.) This statement is revealing. Firstly, we have confirmed by yet another source the roots of the law-idea in the Christian worldview and the reality of God. Secondly, Harré is in a dilemma, for although he does not want the term, and refuses to accept the worldview from which it comes, he is nevertheless forced to use the phrase 'law of nature' albeit "as little as possible." (ibid p.107.) Take law away from science and there is no science for even random approaches depend on the 'laws' of thought, of averages and statistics.

When we survey the modern scene three concepts of laws of nature are evident. (a) There are those who consider them as brute facts, known only by observation; we know 'that' not 'why'. (b) Others envisage them as the application of the laws of averages on a random nature. (c) Others see them as necessary truths and any alternative as meaningless nonsense. (a) is patently inadequate in defining the concept; (b) relies in its explanation on 'law' anyway; while (c) carries in the concept of 'necessity' an idea of some coercive force or law. Nowhere can law be escaped.

Popper (1972/b, pp.41,61.) claims that laws of nature are laws because the more they prohibit the more they say (cf. civil law); and that the search for laws is equivalent to a search for causal explanations which can never be ultimately accomplished. Despite this he states, in opposition to Heisenberg, that laws are precise even if we cannot reach them; and we can never know if we have finally reached a law because it is always of the nature of a hypothesis. Both Popper's and Heisenberg's views are ultimately founded on a faith in law and indeterminism that is incapable of demonstration.

In opposition to Popper, Toulmin (1967, p.70.) asserts that as far as laws of nature are concerned the words 'true' and 'probable' have no application. Here hypotheses yield laws in terms of a fruitfulness of the hypothesis being established. A law of nature is neither true nor false but a statement about its range of application. The basic approach to science is crucial for he is working out of an instrumental concept of science (cf. 10.4.1.); whereas Popper, closer to a Christian view, is prepared to see that laws must either be true or false even if we can never be sure (cf. 10.4.3.). It would seem reasonable to me to concur with Davies (1975, p.8.) that laws are simple well tested general theories about our universe that can be disproved. Openness to disproof - for example the disproof of the law of parity - indicates that the terms true/false have some application. (Cf. Wilson, 1952, p.30.)

Holton and Roller, incorrectly interpreting the relationship of law and its religious roots, write that:

"Although the laws of nature are usually called inexorable

> and inescapable, probably because the word erroneously suggests analogies with divine and judicial law, they actually are humanly formulated generalisations that are neither eternally true nor unchangeable." (1958, p.259.)

Now I could agree with this conclusion if, and only if, by laws of nature is meant 'laws of science'. It seems to me that we are needing to make a careful distinction between three quite different concepts -- the laws of God; the laws of science (as in Davies above); and the autonomous concept of laws of nature.

__23.3.2. The Necessity of Law.__ The above section (cf. Harré) shows that we cannot escape from the idea of law. Modern science, and modern humanistic thought, utilises a Christian concept as a fundamental premiss. [3] The very idea of law is itself interesting:

> "For if there is a law, there is an indicator of direction, and then there is direction, and thus meaning. Or, on the other hand if existence has meaning, it must emphasize relationship and order, and then law is implied, for the examination of existence is possible only in relation to a standard." (van Riessen 1973/b, p.26.)

The idea of law held will determine a man's philosophy. Is law the law of God's provision; or is man the lawgiver on the basis of social necessity, instrumental or idealistic constructions; or is there a law without a lawgiver; or even no law at all? (The same holds for meaning.) The above alternatives contain the Christian, secular and nihilistic views. Today it seems clear that secular thought has lost the concept of a lawgiver other than man who alone discovers, decides and evaluates. It is interesting to note that some commentators (e.g. Oppenheimer) have suggested that modern thought could never have produced modern science because its concept of law is too weak and limited. When man becomes the lawgiver laws and values begin to fade away and are lost as anything real and objective to man -- hence the dominance of the instrumental view in science, pragmatism is all that is left. Van Riessen writes of this pragmatism, noting how it has developed out of the reaction to the earlier positivistic approach:

> "But this system (sc. positivism), too, was speculative, and it too became more and more divorced from real life. Men began to see that science was incapable of disclosing essential truth. It appeared as - though science was

3. That this concept is twisted in application does not alter this borrowing, and to date in my reading I have not come across a satisfactory humanistic justification of the usage of law -- it is simply an article of faith unsupported by any humanistic rationale.

stripping from reality all of its important characteristics - continuity, individuality, freedom and so forth.

In order to solve this problem, philosophy adopted a very subtle and dangerous method, that of pragmatism. According to this new position, the task of Wissenschaft of science and scholarship, was not to discover truth. Wissenschaft was simply an instrument which man used to maintain social practices and to help to realize his practical goals. The question of whether science was true or not was completely unimportant, unless it affected the question of whether it was useful....When closely examined, pragmatism turns out to be a philosophical nihilism, a nihilistic denial of objective truth." (ibid p.33.)

Nevertheless, it remains that every philosophy - even nihilism - starts from some law-order which is believed; even to speak is to acknowledge law. [4]

23.3.3. The Ambiguity of Today's Thought. It is evident that there is uncertainty and confusion surrounding the term 'laws of nature'. Indeed Toulmin, in noting this, concedes that most text-books used to start by trying to define the concept, then cleared their throat, forgot about their attempt and got on with it by simply assuming that laws were there to be uncovered. Modern text-books often do not make the attempt. Are laws of science, then, discovered, imposed on nature by man, or simply definitions? Depending on the particular philosophy embraced scientists make their choice. But simple discovery is ruled out on the basis of there being no uninterpreted data; simple definitions are clearly inadequate in the face of the history and practice of science; while simple imposition on nature by man tends to idealism.

23.3.4. Some Provisional Parameters. My tentative suggestion is that the laws of science are impositions mixed with discovery, or man made representations of the patterns of God. Ideally all the laws that science formulates should be true to the reality of the external world; they should all tend to form one seamless web of truth. But our equations come inevitably from our definitions and biases and not from external reality alone. (Cf. Feather 1970, p.14.) In the final analysis the basic laws are those that describe that which determines the structure and behaviour of spheres of being; that give the universe its character of stability and change. These laws are much wider than physical, arithmetic, biological and so on.

4. We might well think of Wittgenstein's 'silence' at this juncture - cf. Wittgenstein (1961, p.74.)

Scientific laws in the arithmetical, spatial, kinematic, physical and biotic spheres tend to be formulated as mental ideals - the concepts used are 'rigid', 'exact', 'straight' and so on, which have no correspondence in reality. (Cf. Popper 1972/b, p.64.) Laboratory experiments set up to test and uncover are necessarily artificial. For example: to test light refraction we use special optical glasses that are human artifacts, and the whole procedure tacitly assumes an hypothesis that optical properties depend on the constancy of density and the degree of homogeneity of this glass.

Before progressing to an examination of the concept of law and attempting to derive some positive guidance for an understanding of it, three features of the modern scene need to be borne in mind. (a) Science today is governed by an agnostic approach such that even where an individual believes in God, He is (generally) excluded as having nothing to do with science per se. (b) Science cannot operate without the concept of law, but as a consequence of (a) this has become an autonomous principle. (c) Much of science is seen as mechanistic and determinate, or random and indeterminate, leaving little room for the dignity and responsibility of man.

23.4. THE IDEA OF LAW IN THE COSMONOMIC PHILOSOPHY

23.4.1. Dooyeweerd's Critique. (Cf. 19.7.4.)[5] In the Cosmonomic Philosophy the world is seen as governed in all its modes by the 'hand' (law) of God. Dooyeweerd maintains that logical thought exhibits an inner restlessness of meaning until it finds its Arche, and that this restlessness is seen in the tendency of philosophical thought to move towards origins thus revealing that the ego is subject to a central law that effects the selfhood which operates in all philosophic thought. This law derives its fulness of meaning from the Origin of all and limits and determines the centre and root of our existence. (Cf. Dooyeweerd 1969, Vol.I p.11.)

For Dooyeweerd the created cosmos has two correlative 'sides': a law-side and a subject-side. The former is simply the aggregate of God's laws or ordinances for creation, while the latter is the totality of created reality subjected to those laws. It is crucial to note that in the Cosmonomic-Idea the law-side is unaffected by sin and is therefore always universally valid. Since sin is disobedience to the law, we find sin only in the subject-side of the

5. Cf. Dooyeweerd 1969; Vol.I pp.11,12,93-113; Vol.II pp.8,37,134, 138; Vol.III pp.212,281; Vol.IV pp.132-133.

cosmos. Another feature of the subject-side is that it is only here that individuality is found.

By the law, God controls all things and gives all norms for creation. The law, like God and the selfhood, is a supratemporal reality which is not bound by creation but refracted into different aspects within temporal reality. This is not to suggest that we have here some entirely new idea in philosophy although Dooyeweerd has undoubtedly given new emphases. As he himself notes, different systems of ancient, medieval and modern philosophy (he cites Leibniz (ibid p.93.)) expressly orientated philosophical thought to the Idea of a divine world-order which was qualified as lex naturalis, lex aeterna, harmonia praestabilitia, etc.. In this basic orientation there is nothing intrinsically new. What is different is the insistence that this Cosmonomic Idea is actually at the basis of every true philosophical system, even when that system denies creation (cf. ibid pp.93-95.). Thus there is a dependence of all modal concepts of law, subject and object, upon the Cosmonomic Idea.

> "In pure mathematics, for example, the logistic trend conceives of the numerical and spatial laws as purely analytical, and the series of real numbers is considered to be continuous by reason of the logical continuity of the principle of progression; this concept of mathematical laws is grounded on a cosmonomic Idea of a logicist and rationalist type. The mechanist trend in biology conceives of the special laws of organic life merely as physical-chemical ones; this concept of biotic law is entirely dependent on a cosmonomic Idea founded upon the deterministic Humanist ideal of science in its classical form." (ibid p.98.)

Dooyeweerd takes the root idea of law (Wetsidee) and contends that God has given this law-structure as a boundary between Himself and creation; that law-order is the 'law-side' of temporal reality. He argues that every philosophical system is based on some sort of law-idea whether or not it is explained or acknowledged. Thus he tries to expose this idea in other philosophies and to give a detailed account of its role in his own system of thought. That wetsidee is not directly equivalent to 'law-idea' is best explained in his own words:

> "From the start, I have introduced the Dutch term wetsidee (idea legis) for the transcendental ground-Idea or basic Idea of philosophy. The best English term corresponding to it seems to be 'cosmonomic Idea,' since the word 'law' used without further specification would evoke a special juridical sense which, of course, cannot be meant here." (ibid p.93.)

So he seeks to drive back to uncover the hidden presuppositions, to expose the basic religious orientation, of all thought. Either a man will presuppose God or self; either he will affirm God or himself at every point of life. The Christian must ever start with God, while the humanistic denial of God necessitates an inadequate integration point in man. The Christian assumes God as the final self-contained reference point, that man and the facts around him are created; while the non-Christian assumes man as the final point of reference, that man is ultimate, and that his environment is uncreated. (Cf. C. van Til 1957, p.27.)

In the final analysis only by accepting God's Word as the ordering principle of our scientific work can we hope to make sense of the vast array of so-called 'facts' around us. True knowledge is only made possible by true religion, and this can only come through the knowing activity of the human heart being enlightened through the Word of God by the Holy Spirit. If, however, abstractive thought is unable to reach the true Origin of all meaning in God it is forced to elevate some aspect of being to the status of the absolute. Dooyeweerd maintains that this is the cause of all absolutizations of the relative; and hence his definition of religion as "the innate impulse of human selfhood to direct itself towards the true or pretended absolute origin of all the temporal diversity of meaning." (Dooyeweerd 1969, Vol.I p.57.) This means that the choice before an individual is not that of science or faith, but a choice of two faiths (cf. 19.3.3.3.). (Cf. C. van Til 1955, p.119.)

We are therefore driven back to a two-fold presupposition of philosophical thought at the beginning. Firstly, philosophical thought assumes an Archimedian point for the thinker from which the ego in this activity of thought directs its view of totality over the modal diversity of meaning. Secondly, it assumes a choice of position for this Archimedian point in the light of the Arche which transcends all meaning. (Cf. Dooyeweerd 1969, Vol.I p.11.) Dooyeweerd then suggests three basic requirements of the Archimedian point. (a) It must not divorce itself from our own subjective self, for it is 'I' who am engaged in philosophic thought and only in the heart can I transcend the diversity of the modes of being. (b) It may not be divorced from the concentric law of the ego's existence for apart from law the subject slides into chance and nothingness. The law alone determines and limits the ego. (c) It must transcend the modal diversity of meaning and be found in the unity of being (cf. ibid p.12.). We do not live in part of the creation but in the totality of its aspects.

The Cosmonomic Idea points to the origin and meaning of the cosmos-nomos, and to its relation to subjectivity, therefore giving expression from the outset to the limiting character of this idea itself. Essentially it focuses on preliminary questions concerning origins, totality and modal diversity. It seems to me that here we find a Christian justification for the assumption of law which is lacking in humanistic science. As Schaeffer contends with respect to positivism: "One must always judge a system in its own total structure; you cannot mix systems or you get a philosophical chop-suey rather than any real thought." Then he goes on to point out that positivism cannot prove its own first move: "You have no reason within the system to know that the data is data, or that what is reaching you is data." (Schaeffer 1972, p.56.) And secondly, this system cannot guarantee any difference in its first move between reality and fantasy. (Cf. Morris, T.V. 1976, pp.40-56.)

The Cosmonomic Idea also relates to the subject-side of reality every bit as much as the idea of law. "For the cosmic nomos has meaning only in indissoluble correlation with the subject-side of the cosmos." (Dooyeweerd 1969, VolI p.96.) The Cosmonomic Idea implies the idea of the subject as pointing toward the factual-side of reality with respect to the basic relation between totality, diversity and unity of meaning. This is important. For the Christian the concept of law is based transcendently on the sovereign will of God; everything within creation is subject (Fr. sujet: 'placed under'). This stands in marked contrast to Kant's ding an sich which derives from a concept of law immanently based on autonomous thought. God certainly holds to His sovereign law, but only creation is subject.

God is sovereign; He is creator, designer and sustainer of the physical universe and its laws. As sovereign He stands outwith time, therefore all time is now, and all space here, for Him. Yet He has also entered into creation in the Incarnation. In His sovereignty God uses His creation to intervene and interact within history. Sin is revolt against God's sovereignty, it is the usurption of His power; it is the absolutizing of meaning in some aspect of reality to the level of God's being. In sin the logical functioning of reason is affected though Dooyeweerd maintains that only the subjective activity and not the logical laws of thought are affected.

23.4.2. Law As Boundary Between Creator and Creation. Law originates from the sovereign God and constitutes the boundary between God and His creation, a boundary between the Being of the Arche and the meaning of everything created, as subject, in subjection to law. (Cf. ibid pp.99,108.) Final meaning and comprehension is found only in Christ; in Him the heart confesses God as Creator and bows under the law as the boundary between Creator and creature. But care is needed here for the idea of God enclosed by a boundary has been attacked by Frame (undated pp.27-32.). However Dooyeweerd is at pains to draw out the point that this boundary is merely a mark of the basic distinction between God and man, as Lawgiver and subject, in their relation to lex. God is never subjected to, or limited by, lex; while man is always under it.

It follows that in reality the law is not of temporal reality, but rather is a law for it prescribed by God. The law is not a boundary for God but for creation. This idea of a boundary does not mean that we have a third area between God and creation, for the law is ultimately co-terminus with the character and Being of God. (Cf. ibid p.29.)

Obviously man (as are all things in creation) is under the Law of God. This is quite different from the Greek concept of law where, in the matter-motive, lex was conceived in a juridical sense of nature as unescapable fate (anangke); while in the form-motive, lex was seen in a more teleological way by Socrates, Plato and Aristotle. (Cf. Dooyeweerd 1969, Vol.I p.112.) In Greek thought the subject was never viewed as (sujet) subjected to the divine law in the integral biblical manner. Similarly Christian-scholastic concepts of nature-grace concerning lex were dominated by a dialectical ground-motive.

For the Christian there should be no absolutizing of any relative temporal reality in its meaning. The meaning of creation and the Being of the Arche can never be viewed on the same level. Nor must we confuse the temporal-meaning of the faith aspect with the fulness of meaning in the religious orientation of the heart which transcends the boundary of time and cannot be enclosed in a modality of meaning. In the religious fulness of meaning there is but one Law of God, but under the boundary this law separates into a rich diversity of modal aspects of meaning. Dooyeweerd illustrates this by reference to the way in which a prism breaks up one beam of light into the different colours of the spectrum, and goes on:

> "The unrefracted light is the time-transcending totality of meaning of our cosmos with respect to its cosmonomic side and its subject-side. As this light has its origin in the source of light so the totality of meaning of our cosmos has its origin in its 'arche' through whom and to whom it has been created.
>
> The prism that achieves the refraction of colour is cosmic time, through which the religious fulness of meaning is[6] broken up into its temporal modal aspects of meaning.
>
> As the seven colours do not owe their origin to one another, so the temporal aspects of meaning in face of each other have sphere-sovereignty or modal irreducibility."(ibid p.101.)

23.4.3. The Refracted Law Spheres. Dooyeweerd uses the term 'ontical apriori' to describe law-spheres or aspects of meaning. Law spheres are a priori constant foundational structures of empirical reality which form the basis upon which are enacted all the changing phenomena in creation. As such they possess an ontical character, not, as Kant affirmed, grounded in subjective consciousness, but in the created temporal order of reality. (Cf. Spier 1966, p.35.) Every sphere has its own irreducible kernel of laws which means that it can never be validly reduced to another sphere. This is the problem of all immanentistic philosophies which must absolutize an aspect of reality and thereby reduce the temporal diversity of creation to one sphere for explanation. But every part of creation belongs, not to an aspect, but to the diversity of law-spheres. No one law can ever fully describe or qualify an event because all events, and things, are complex. Hence personality, for example, cannot be reduced to mathematics; or morals to the historical development of a social contract.

23.4.3.1. An Illustration of Sphere Universality/Sphere Sovereignty. No aspect or sphere exists in itself but points beyond to a greater unity and diversity. The richness of these concepts are best indicated by an illustration which I borrow from Kalsbeek (1975, pp. 36-42.). In this specific example of a human activity - the launching of a manned space vehicle - it is easy to distinguish the

6. 'Time' has caused controversy in the Cosmonomic school. Dooyeweerd envisages cosmic time over the cosmos as temporal in all its aspects. He therefore refrains from reducing time, as Kant does, to space-time in the psychical modality. Instead, time is seen in the 'succession' of numbers, in the 'synchronisation' of the spatial mode, in the 'duration' of the kinematical, in the juridical period of 'validity' etc.. (Cf. Hart 1973.)

aspects clearly and in an ordered fashion.

ASPECT	TYPICAL ACTIVITIES
1. Arithmetical..	Calculations of all kinds - from the number of food packages to time schedules.
2. Spatial.......	The amount of space needed for the crew, their instruments, waste materials etc..
3. Kinematic.....	The predictable movements caused by the moon's gravitational pull; the types of movements expected at each stage of a normal lift-off.
4. Physical......	The peculiar properties of fuels which make them ignite, theory of materials etc..
5. Biotic........	The precise tests on the crew's breathing, digestion, circulation etc..
6. Sensitive.....	Tests to determine emotional and psychological reactions to weightlessness, cramped quarters etc..
7. Analytic......	The detailed planning of every part of the project long before it was commited to publication.
8. Historical....	The development of a culture capable of conceiving such an enterprise; a stage of technique capable of accomplishing it.
9. Lingual.......	Development of new sets of symbols to describe new activities.
10. Social........	The social cohesion developed among the crew; their relationships with ground control.
11. Economic......	Careful budgeting to finance each item.
12. Aesthetic.....	The beauty of the technology which inspires all sorts of works of art.
13. Juridical.....	The questions of 'free space'; negotiations to determine whose laws and courts will control activities carried on in space.
14. Ethical.......	The efforts to justify spending huge sums of money in the face of starvation on earth.
15. Pistical......	Man's opinion of himself and his work revealed in the vision of space travel: wanton arrogance? the pioneering spirit? the urge to control the universe through the sovereign power of technology? an effort to obey the cultural mandate? Both questions and answers relate to the faith aspect of the whole project. Also the faith placed in technology.

To expand this concept in a different direction let me illustrate in more depth something of the content related to the first four modes of meaning - arithmetical, spatial, kinematic and physical.

<u>23.4.3.2. The Arithmetical Sphere</u>[7] This is the first aspect in the temporal order. The meaning, or nuclear moment, of this is seen by Dooyeweerd as 'discrete quantity'. Numbers are discrete quantities which are always mutually distinct, so that 2 is more than 1 but less than 3 etc.. The transition from one number to another is not gradual but always a leap, a bridging of a distinct gap - even between 1.99 and 2 there remains a certain gap. There is no essential continuity in numbers. Around the nuclear moment of number there are only anticipatory moments which point forward to the higher aspects. There are no retrocipatory moments as the arithmetical sphere does not have a modal foundation. This means that this sphere is the least complicated in structure, and that it is the foundation of all other spheres. There is nothing in the universe in which number does not play some role. Space has a specific number of dimensions; motion involves the travelling of a distance which can be expressed numerically; a living organism has a number of organs; feeling involves a complexity of sensations; while thought is only possible in a multitude of concepts. Like all spheres there is a law and a subject side. Numbers themselves belong to the subject side for numbers - 1,2,3,4,.n - and are always subject to the laws which God has established for the world of numbers - 2 x 2 is always 4. We can make mistakes but this is a trangression in the thought world and not in the numerical. (It is interesting to note here the discreteness of modern particle physics where physical phenomenon have been reduced to mathematical equations.)

<u>23.4.3.3. The Spatial Sphere.</u> Space has its modal origin here and all that is spatial is original to this whether it be atmosphere or outer-space (though such spaces have physical qualifications). The nuclear moment, or kernel, of space is extension which is intrinsically different from discrete quantity. Numbers are discrete, but in the spatial sphere we are presented with continuity - continuous extension. A plane is extended in all horizontal directions and reveals no gap or boundary where two-dimensional space terminates. Three dimensional space is continuous in horizontal and vertical directions and is not terminated within the cosmos.

7. This is a gross simplification and follows Spier (1966, pp66ff.)

This sphere has a numerical retrocipation referring to the nuclear moment of the numerical sphere. Numbers are presupposed in everything spatial. Anticipations also exist – movement is only possible on a spatial assumption; organic life cannot function non-spatially; and so on through all the spheres. Things are subject to spatial laws in their subject function for all things are under the rule that no two things can occupy the same space at the same time. Cosmic time is seen in simultaneity while the scientific discipline which examines these first two spheres is mathematics.

<u>23.4.3.4. The Kinematic Sphere.</u> There is a tendency to merge motion and energy but scientifically it is not permissible to identify them, though we do so in pre-abstractive experience. A uniform movement without any reference to a causitive agent is a meaningful topic in the kinematic but not the physical sphere. In the latter, physical movement is always related to energy, to cause and effect. The science of kinematics can, however, deal with diverse motions without reference to a causative energy.

Here the kernel of the sphere is the idea of continuous flowing, and cosmic time is expressed in the succession of moments. Here there are two retrocipations – space and number. Spatially there is the sense of flowing space or extension which occurs in the kinematic aspect but is founded on the spatial. The moments of this form a series of moving moments, while the simultaneity of positions in the spatial aspect is a statical matter. The direction of a movement in flowing space is a spatial 'analogy' referring to spatial dimensionality. There is also the numerical retrocipation in that not only several moments, but successive moments of one motion are numerable.

So far in these three spheres we have seen aspects of things but not yet anything that would qualify concrete reality. They are qualities of all existing reality but not things.

<u>23.4.3.5. The Physical Sphere.</u> This sphere is characterised by energy. In this aspect of reality movement appears but not motion as such, but simply motion in a physical sense caused by energy. Energy is the kernel of this sphere, revealing itself in chemical substances and their reactions, in light, sound, electricity, the atom etc.. Fields of gravitation, electro-magnetic fields, electrons, neutrons, etc. are real physical things with their movement, position

and number founded on the first three law-spheres. The totality of physical reality is variable from moment to moment.

All energy assumes motion, space and number and therefore the physical modality has three retrocipations as well as many anticipations. Growth in organic life is possible only because the physical modality anticipates the biotic. Conversely growth in organic life is a physical retrocipation in the biotic modality. The law of gravity is an example of a simple physical law - all is subject to it in their physical subject-function. Time is seen in terms of the duration of working energy; while it is the province of physics and chemistry and the related natural sciences with respect to investigation.

<u>23.4.4. Further Points.</u> Here we see several features which are readily distinguished. For each sphere there are particular laws and norms which are peculiar to it alone, a certain irreducible kernel which cannot be defined or interpreted in terms of other spheres. Immediately it becomes clear that we have an explanation of such things as Zeno's paradoxes. The paradox of the arrow which never reaches its destination, or the hare that never catches the tortoise, resides in an attempt to analyse motion in terms of a lower sphere, namely the spatial. But this is to fail to realise the irreducible element of motion and to deify another aspect of reality. Therefore the antimony resulted. This reduction is still present when, for instance Levy, a professor of mathematics, asserts that: "A scientific law.....states a numerical relation between qualities that are capable of being isolated." (1947, p.72.) (Cf. 18.6.) Here is a twofold error: that number can be used to express all laws, and that qualities can be isolated. In the classical tradition the empirical subject was reduced to a complex of causal relations by which it could be completely determined. In more modern statistical approaches law is dissociated from the modal structures of the different spheres and conceived of as autonomous products of scientific thought which try to order, by way of 'logical economy', the so-called facts understood as sensory data. Philosophically speaking, rationalistic views absolutize the laws, while irrationalistic views absolutize the subjective individuality. But each sphere has a nucleus which is an unqiue refraction of one law of God's cosmos.

Within the overall schema there are different realms which in turn divide into different sub-groups. (Cf. Appendix C.) For example, there is the animal kingdom which possesses a common structure up to the psychical aspect; the plant kingdom which possesses common structure up to the biotic and so on. For any realm - man, animal, plant or thing - the last modal individuality subject function is termed the qualifying function; that is faith for men, psychical for animal, biotic for plant, and physical for thing. But though this qualifies, it never describes the essence of anything. There is an exception to this in that all things formed by man are qualified by their use. Thus a painting is not merely a physical object but designed with an aesthetic end-purpose, and therefore qualified by the aesthetic aspect.

This points in turn to the reality of individuality structures which are entities operating as object in certain spheres and as subject in others. (Cf. Dooyeweerd 1969, Vol.I p.493.) Individuality structures function in some way in all modal structures and the two must not be confused - aspects are not individual structures. Aspects ask the question - how? ; while the latter ask the question - what? (Cf. Kalsbeek 1975, p.72f.) There are therefore several levels involved in the law-spheres. There is the plastic dimension which is the dimension of individuality structures; which in turn is enclosed by the modal dimension; which is enclosed by the horizon of cosmic time; which, finally, is enclosed by the religious horizon or origin.

From this discussion of law in the philosophy of the Cosmonomic Idea it is evident that a scientist never investigates reality as an object <u>per se</u>, but is concerned with aspects of meaning, fields of investigation. It is wrong for the scientist to disregard the view that a rose is red and beautiful because he has reduced the experience of this rose to subjective perception. Likewise it is wrong for ordinary experience to scorn the insights of science.

23.5. PRELIMINARY CONCLUSIONS.

A <u>scientific law</u> never controls events in that it is a human means of correlating experiments to a pattern which is built round concepts. Our scientific laws do not prescribe what must happen but represent what has happened and allow predictions to be made. The so-called <u>laws of nature</u> are in reality the ordinary operating patterns of God's will which science seeks to reflect in its formulations and are not to be associated with a Kantian <u>ding an sich</u> character. Reality never distinguishes between the measurable and the qualitative as does science. Scientific laws are therefore to be seen as man-made representations in word and mathematical symbol of the personal God's constant patterns of operating His creation.[8]

The hypotheses and laws dealt with in science are essentially special cases of theories which may be true or false in their reflection of the patterns of God. Davies helpfully suggests that we can distinguish between hypothesis, law and fact in the following manner: an hypothesis is a theory of low generality, low testedness and therefore has a low inner perfection; a law is a theory of reasonable generality, simple and well tested, therefore possessing not too low an inner perfection rating; and a fact is simply a theory of high confidence but which is not theoretically general or precise, but which has been well tested and never refuted (cf.15.4 - 15.6.). But in as much as a law tells us nothing about phenomena if taken by itself, and in the light of the non-mechanistic approach now advocated in many circles, it seems to me that the Dooyeweerdian approach gives helpful insights to the nature and status of 'law'.

In the final analysis there is a personal Creator who is in control of all things. It seems to me that we are needing to recover in our day something of the force of the reality and doctrine of creation, and the need to integrate thought in God. Thus we are in a better position to understand the nature and status of our scientific laws. Much of modern science has been forced by the reality of God's creation to a position that is not altogether hostile. It aids in distinguishing reality and man's representation of it; scientific laws are symbolical approximations but, hopefully, can reflect a degree of truth. Yet the true law which our constructions seek to reflect is not the property of an autonomous nature but the objective and regular pattern of operation by which God sustains and controls His creation. These laws are not alterable by man though his approximations are. It is also important to see that the law-structured creation provides laws for all aspects of meaning and not just for a mathematico-physical sphere. There are spiritual and moral laws as well as physical, though they are normative rather than objective. But we must never deify an aspect of creation and lose sight of the primary agent of causation.

8. It might be objected that 'representation' is vague, but I would suggest it was no more imprecise than 'explanation' or 'description'.

".....cause and effect is our statement of the way He is continually working in and sustaining His world, and hence, we must never elevate this aspect of reality to a point of ascendancy over Him. The servant must not be seen as king. In fact, in this case, the servant would cease to exist were it not for the King who not only has created it and given it its distinctive character but constantly sustains it as such. The word of God stands in a most obvious antithetical relationship to the tendency to see any part of creation whatsoever, laws included, in any measure independent or self-existent." (Ream 1972, p.56.)

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CHAPTER 24

THE THEOLOGICAL BASIS OF SCIENCE : LAW AND CULTURAL ACTIVITY

This chapter seeks to pinpoint aspects of the theological foundation which calls science to be a God-glorifying activity. It is not exhaustive. Neither does it seek to establish a theology of science, nor analogies between science and theology, but to derive a theological framework within which science becomes possible and coherent.

24.1. THE DOCTRINE OF LAW (Cf. ch. 23.)

24.1.1. The Biblical View of Law. A consistent Christian philosophy of nature will include biblical data, a philosophy of science, and the data available from the sciences. These three features will interact with one another, and need to be consistent. The biblical material is important as the Word of God is always consistent with the work of God. The status of this material is interesting, even from a humanistic viewpoint, for the Bible, unlike other contemporary writings, is remarkably free from error. The Greeks, for example, held that the universe was non-created and therefore eternal, and that it moved in a purposeful way under the indwelling influence of diverse divine forces. They never really doubted that there was some order; nature was not totally capricious for it obeyed certain regularities that were capable of explanation. But in contrast the Hebraic-Christian worldview was a totally dependent universe. The universe was non-eternal and its very existential existence depended upon God; the natural order was in no way divine, or the home of the divine, but simply the creature of God.

I therefore wish to consider the biblical concept of 'law' and its relevance for a modern scientific understanding. It is necessary, for a Christian view of science, that a consistent biblical concept of law be established. In pursuing this I will ignore the role of civil, moral and religious ceremonial law.

24.1.1.1. Nature Is Creature. The first feature of the biblical view of nature is the frank creationism presented in both the Old and New Testaments. In the creation all things are in a unity of creaturehood before the Creator; God is nowhere equated with His creation or seen as contained within it; nor is there any division into nature and grace, soul and body — the Hebrew word 'soul' (nephesh) is translated 'body', 'life', 'heart', 'man', 'person', 'mind', etc.. It follows that no sphere of created being is to be worshipped or absolutized; worship is only to be given to the Creator. (Cf. 20.1.2.)

<u>24.1.1.2. Law Is Not Creature.</u> A second feature is that the 'law' that governs creation is not intrinsically a created feature. The law of God is not <u>in</u> nature but transcends nature as the controlling ordinances of God upon created being; it is not a created structure within the cosmos; nor is it something to which God must conform in creating. To posit law over God is to absolutize law and make it God. Law is rather a boundary between creation and the Creator - from man's perspective. (Cf. 23.4.2.)

<u>24.1.1.3. Creation Is Ordered.</u> It is evident that the biblical records recognize law, order and regularity within the created sphere of being - cf. Gen.8;22: Jer.5;24: Job 28;26. However the number of references that might pertain to a modern concept of law are few in number. There are the references to God's controlling ordinances - Heb. <u>chuqqah</u>: custom, statute, ordinance, appointed. The following four instances are noted.

<u>(a) Job 38;33,34.</u> "Do you know the ordinances of the heavens? Can you establish their rule on the earth? Can you lift up your voice to the clouds, that a flood of waters may cover you?" (RSV) This points up the regularity within creation. However it emphasises, not the regularity itself, but the overriding control of God. It stresses His omnipotence.

<u>(b) Jer. 5;24.</u> "They do not say in their hearts, 'Let us fear the Lord our God, who gives the rain in its season, the autumn rain and the spring rain, and keeps for us the weeks appointed for the harvest." (RSV) Here the emphasis falls on the ordination of God; regularity is attributed to the Creator. There is no evidence of a concept of an autonomous law intrinsic to nature.

<u>(c) Jer. 31;35,36.</u> "Thus says the Lord, who gives the sun for light by day and the fixed order of the moon and the stars for the light by night, who stirs up the sea so that its waves roar - the Lord of hosts is his name: 'If this fixed order departs from before me, says the Lord, then shall the descendants of Israel cease from being a nation before me for ever'." (RSV) Here the thought of a 'fixed order' is perhaps more to the fore in terms of the stellar regularities, but

again the writer is pointing to the Who - He outshines the how or the why.

<u>(d) Jer. 33;25f.</u> "Thus says the Lord: If I have not established my covenant with day and night and the ordinances of heaven and earth, then I will reject the descendants of Jacob and David..." (RSV) This could appear to be a closer reference to modern concepts, but again it is couched in terms of a covenant with the Almighty Creator.

These references contain no thought of any autonomous existence of laws of nature, for the emphasis falls on an existential divine control and sovereignty. There is therefore no regularity of independent operation within the realm of nature which God might, or might not, act into, but rather the continuous upholding power of God ordaining certain regularities within His creation. Nature obeys God's ordinances (cf. Ps.119;89-93.). Scripture clearly teaches the regularity of the created order as due to the constancy of God - the laws of nature are the laws of God. So the uniformity of nature is a biblical idea and not the invention of modern science; the idea of the world as a vast, ordered, law-abiding system under God was deeply imbedded in Hebraic thought. However, because the Hebrews used a different vocabulary from us this is often missed, as is the point that they had no word equivalent to our term 'nature'. (Cf. Ramm 1971, p.58f.)

The universe is created by God and sustained by Him. Miracle and prayer are facets that do not infringe an autonomous law but occur within the overall will of God. Biblical Theism is not forced into an impossible choice between God and nature for within the Theistic view of nature "a normal, natural, credible doorway was left open for God to answer prayer, work the miraculous, and even send His Son into the world..." (ibid p.61.)

We need to distinguish between primary and secondary causation. Scripture clearly declares that the secondary laws of the world are God's laws/order in the first instance. God causes the mists to rise, the lightning to break forth, the rain to fall, the winds to blow (cf. Jer.10;33.); He makes the grass to grow and feeds the fauna (cf. Ps. 147;8-9.); He sends the snow, frost, hail and warm winds (cf. Ps. 147;16-18.). In the New Testament we find the same: God sends His rain upon the earth, and lets His sun shine (cf. Mat. 5;45.); He feeds the birds and clothes the flowers (cf. Mat. 6;26-30.); it is

God alone who gives life and breath that we might exist (cf. Acts 17; 25.). It is the upholding power of the Word of God that allows being to exist at all. (Cf. Col. 1;16,17.)

__24.1.1.4. Scripture and Science.__ __Inter alia,__ four reasons can be suggested why this view is remarkably free from clashing with any established scientific view. (a) The Hebrews were not an artistic or literary people and therefore tended to draw directly from nature rather than impose symbols between nature and themselves. (b) But neither were they specifically scientific. They possessed no great scientific tradition, but precisely in this they formulated no fallacious theories; they remained close to a simple common-sense approach and in the final analysis attributed all to the primary causative agent - God. (c) Their strict monotheism excluded any animal or plant mythologies or worship, therefore keeping them free from the deification of some relative mode of being. (d) Overall they saw nature as the creature of God.

God, of course, in His Word gives no direction as to the detailed scientific structure of the universe, nor should we look for that there as His Word is concerned with the special revelation of His plan of salvation. Man, then, is part of a natural and a spiritual order and does not have to choose between God and natural law, for the laws we live under are the laws of the Creator. Scripture sees neither man nor the cosmos depersonalised before the Creator. But modern science often excludes the __who__ of God in its disciplinary thought and therefore the __why__ looses significance and integration. Thus in a sense we are today, when caught in atheistic concepts of science, worse off than the ancients whose __how__ was quite wrong, but yet recognised the existence of the __Who.__[1] The Christian worldview sees God as the ground of nature; the materialist sees that ground in matter, energy, etc., as intrinsically autonomous.

__24.1.2. Law and Providence.__ The Christian position clearly affirms that existence depends on the will/word of God. This undercuts any concept of self-existence or attempt to elevate science into a self-existent arena of autonomous neutrality. Autonomy and providence are mutually exclusive concepts. Under the providence of God "no

1. Cf. Schaeffer (1969, p.124.) where he gives the illustration of a savage and a technologist in an aeroplane, and asks which understands the world best. The answer is the former because he has not shut up reality to one dimension.

law is a self-existent or self-sustained operation." (Ream 1972, p.45.) While in practice this might not affect a particular part of scientific research, it will affect the overall understanding of the cosmos by a scientist. (Cf. 21.4.3.2.) So there is a decided attitudinal difference between the Christian and non-Christian. The Christian believes that the regularity of the relations he perceives and seeks to unfold are preserved by the constancy of God. It is only in the continued upholding of the universe by God that creation is law-structured and sustained. It is necessary for the Christian view that God be seen everywhere and not just brought in as an added, superfluous benediction to an essentially autonomous science.

> "The essential point made in the Bible, and in a sense, I think, the key to the whole problem of the relation of science to the Christian faith, is that God, and God's activity, come in not only as extras here and there, but everywhere. If God is active in any part of the physical world, he is in all. If the divine activity means anything, then <u>all</u> the events of what we call the physical world are dependent on that activity." (MacKay 1974, p.57.)

MacKay continues his argument by pointing out that in the Christian view, laws of nature are "not alternatives to divine activity but only our codification of that activity in its normal manifestation." (ibid p.60.)

The idea of God as the <u>celestial mechanic</u> or craftsman has long since been dispensed with as lacking any relevance in terms of the providence of God. Another analogy has been that of God as <u>creative artist</u> which lays more stress on the immanence of God but still leaves much to be desired. Probably no model can ever be satisfactory, but <u>Mackay</u> has given a useful extension of the 'God as artist' model where he makes use of modern technological inventions. Instead of an artist using oils and canvas he uses a television screen to display his creation, using the transmitting station to generate whatever he wishes to display on the screen. Here the picture continues to exist by the will of the artist; it continues to have form only as long as the artist continues to generate the programme. When he stops generating the picture ceases to exist. Thus the continuing activity of the artist is highlighted, but this still leaves the participation of the Divinity in His creation to be accounted for - the Christian God is more than creator, He is Creator-Participant. (Cf. Jeeves 1969, p.24.) However the thrust of the analogy is that nothing continues to exist except under the existential activity of

God. So it is meaningless to ask if the laws of nature leave room for the activity of God.

> "How could they leave room for God's activity, since God's activity is present all the time? Or again how could God intervene and suspend His laws from time to time, since He is there all the time holding everything in existence? In what sense could God use natural laws, since natural laws are only our way of summarizing our experience of the regular occurrence of events in the creation which God holds in being all the time?" (ibid p.27.)

As H. van Riessen pictures it: law is the sceptre in the hand of God by which He rules the universe. (Cf. Kalsbeek 1975, p.75.)

The laws of chemistry or statistics are, in the final analysis, God's laws and so all processes have a transcending dimension to relate particulars with the whole. It means that processes, while natural, have a supranatural dimension, though we need to be careful in the designation of normal and supranormal. One of the major myths of our time would seem to be that there is a thing called 'Nature' defined as "a creative, controlling agent, force, or principle, or set of such forces or principles, operating or operative in a thing and determining wholly or chiefly its constitution, development, well-being, or the like." [2] This grants autonomy to nature and, in effect, equates it with God. Indeed nature and God would seem interchangeable terms in many cases. But God alone is responsible for natural phenomena, there is no law inherent in nature for law is over nature. Natural phenomena, like man, are subject to law.

There is no dichotomy in the Christian perspective between nature and grace. Such dualistic thought is prevalent in our modern world for the two-realm *a priori* of humanism drives a wedge between fact and value, theory and practice, mental and physical, freedom and authority, faith and science, church and world. A modern Dutch philosopher writes that "the cause of this dualism lies in the exiling, from our concrete and daily activities, of faith in God as Creator of heaven and earth." (Dengerink 1977, p.12.)

24.1.2.1. Law and Chance. The biblical view conceives of no basic element of chance. The concept of chance is often used in an ambiguous way to mean an unexpected incident or incident whose immediate cause is unknown, and this is quite consistent with biblical usages. But the specific scientific formulation of chance as an

2. From: 2nd edition Merriam-Webster Unabridged Dictionary.

assertion that events can occur which are absolutely uncaused and unconditioned is unbiblical. (Cf. Nagel 1974, p.324f.) Today scientists may posit a chance origin of the universe; they may posit an intrinsic indeterminism in the sub-atomic world -- but in the nature of the case this can never be scientifically established. It seems to me the indeterminism in the sub-atomic world is there (a) because of the limitations of finite minds, and (b) because of the irreducible kernel of the physical modality which is undefinable. (Cf. 27.4.2.)

We need to reject both hard determinism and strict indeterminism (cf. ch. 27.) as formulated scientifically at present for in all things the Theist is called to be aware of the hand of God underlying the secondary level of immanent experience. (Cf. Calvin's 'Institutues' - 1;16;6-8.) As Proverbs has it: "The lot is cast into the lap, but the decision is wholly from the Lord." (16;33.) Or to turn to secular sources: Martin Gardiner (1968) has argued that in the realm of mathematics, not only is there no apparent objective way mathematically to define a completely random series, but that most mathematicians presently agree that the concept of an absolutely disordered series of digits is logically contradictory. Or to quote a piece from Nagel:

> "To fix our ideas, consider the atoms in a given piece of radium, and suppose that the time at which each atom disintegrates is recorded. Now there will doubtless be no obvious formula connecting the number of disintegrations with the times at which they occur. Nevertheless, since by hypothesis there is a correspondence between the disintegrations and the times, a mathematical function relating the former with the latter is thereby <u>defined</u> in extension. It is therefore not logically impossible that a general formula can be constructed which states this correspondence, even if the formula should turn out to be forbiddingly complex. Accordingly, there is no 'absolute' disorder in the distribution of the atomic disintegrations in time, since there clearly is <u>some</u> order in their arrangement. In short, the notion of an absolute, unqualified disorder is self-contradictory." (1974, pp.333-4.)

Law, not chance, is the basic presupposition of science and it is theistic in character. Ream contends that "what we call chance and what we call accident are in fact neither chance nor accident but actually God working in His world and unfolding history." (1972, p.51.)

<u>24.1.2.2. Law and Causality.</u> Cause has historically been conceived in a legal association, as an efficient agent and as an

invariable functional dependence. From Hume onwards there have been attempts to explain cause in terms of temporal spatial contingency, but this has remained psychologically and philosophically unsatisfactory for there is another class of causality hidden in the denotation and connotation of words like 'produce', 'reason', 'why', and 'move'. As an initial limitation on any investigation of causality is the fact that to initiate and carry out any discussion the category of cause and effect is required!

Many examples of diverse attribution of cause can be cited. Simply the act of naming a thing involves an elementary concept of cause. On the temporal level we can cite that iron rusts in moist air, or that Peter broke the window; numerically we have the causal relationships involved in Ohm's Law or the lever principle; while on the general scale we have a concept like gravity. These examples involve cause - but not as defined in any one way. To put it another way: consider the following questions. Why does ice float in water? Why do humans have blood? Why did Hitler invade Poland? Why did Luther posit his 95 theses? Why is the sum of any sequence of consecutive odd integers starting from 1 always a square? In all these we can search for a cause, for some invariable order, but obviously the status of our answers and their meaning will vary.

Toulmin (1967, p.80f.) suggests four classes of statements found in scientific writing: (a) abstract, formal statements of laws or principles; (b) historical reports concerning the scope of a law or principle; (c) the application to particular cases of the above; and (d) conclusions and inferences. Nagel (1974, p.75.) - noting causes as involving invariable uniformity, spatial contiguity, temporal continuity and asymmetry - suggests four classes of laws (pertaining to (a)). These are: (i) pervasive and basic types with respect to the notion that there are natural kinds; (ii) invariable sequential orders of dependence with respect to events and properties; (iii) invariable statistical relations between events and properties; and (iv) relations of functional dependence between two or more variable magnitudes associated with stated properties.

From Locke and Hume argument has raged as to whether laws of nature are necesary or contingent. Locke envisaged laws of nature as principles of natural necessitation; while Hume and Mach argued they were merely statements of constant conjunction. To add to this confusion, Whitehead has argued in more recent times that laws of nature are conjectures about uniformities holding over limited space and time; while Toulmin and Ramsay hold that they are not propositions which are true or false at all, but merely instructions for the formation of such propositions. Toulmin suggests that Locke and Hume are both right and wrong: in that Hume was correct with respect to contingency in terms of (c) above; while Locke was correct concerning necessity with respect to (d) above - but that neither refers to the actual 'laws' envisaged. Popper sees laws of nature as possessing a contingent, accidental character with them as necessary to singular facts, but contingent when compared to logical tautologies! (1972/b, p.429.) He argues that 'necessity' leads to essentialism which he rejects.

As already noted this discussion must ever remain speculative for the category of cause and effect is necessary to go deeper into cause and effect! So all that a coordinate or antecedent expression gives is that man can recognise temporal and positional relationships. Here is another type of relationship that is irreducible and undefinable. This realisation is fundamental to both perception and thought, and cannot be denied without first being assumed. Since causal realisations are necessitated by any rational observation and thinking they are recognised <u>in</u> observation and not derived <u>from</u> it. This is neither a cultural development nor a product of human inventiveness, but a gift from God.

Today the scientific determinism of pre-atomic physics has given way to the suggestion that physical laws are probability statements. Determinism claims that scientific laws are statements concerning the necessary, invariable behaviour (universal) of things; while the probability view sees laws as statements which merely have a high probability. However modern physics does not necessarily lead to a denial of uniformity and causality. Heisenberg introduced a two-level concept of causality about which Northrop writes:

> "....modern physics permits the concept of causality to have two different scientifically precise meanings, the one stronger than the other, and there is no agreement among physicists about which one of these two meanings the word 'causality' is to be used to designate." (1971, p.19.)

There is a moderate view opposed to statistical irrationality - that causality operates according to statistical laws. This is no contradiction between law and statistics though the fact of there being laws means that there is order superimposed on the statistical chaos of the atomic level. Thus some have concluded that we are not faced with a choice between 19th century determinism and 20th century statistical irrationality, but can achieve a resolution in terms of a statistical determinism. The most common view of determinism - hard determinism - assumes that all events are determined, that freedom is the absence of determinism and is therefore illusory. Soft determinism, however, assumes that all events are determined, but not that freedom is the absence of determinism. Rather freedom is also a kind of determinism, namely self-determination (cf. ch. 27.).

The Theistic view will, however, maintain that God does not work with, or in conjunction with, laws of nature as this attributes autonomy to law - whether determined or statistical. This will necessitate a distinction between first and second causes and this seems perfectly reasonable. The first cause is ever God who originates all matter and motion, without falling into pantheism or deism. Secondary causation secures the free will of man as a true causative agent and of levels of causality within creation.[3]

> "Although, in relation to the foreknowledge and decree of God, the first cause, all things come to pass immutably and infallibly; yet by the same providence, he ordereth them to fall out according to the nature of second causes, either necessarily, freely or contingently." (Westminster Confession of Faith V;2.)

Inevitably there is a mystery here, but then there is mystery in all scientific theories. A simple formula such as $s = \frac{1}{2}gt^2$ may be a precise mathematical statement of what happens in certain 'ideal' situations, but it can never explain how it happens. The 'how' may be sought in 'g' (gravity), as equivalent to 'something that makes something go'; but scientific explanation is never final or exhaustive of even the simplest phenomena (cf. sphere irreducibility).

The fact that historically laws are seen developing and changing - for example Boyle's Law modified by van der Waals correction - does not change the status of the law of God. It is a reflection of our changing interpretation/comprehension of the behaviour of gases.

<u>24.1.2.3. Law and Miracle.</u> It is commonly accepted as a basis for debate that miracles are essentially a setting aside of the laws of nature and something extraordinary happening. However objection has

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3. Stoker's 'coherence of contra-polar dinstinctions' is useful here. (1973, p.144f.)

been voiced throughout the centuries. Augustine, for instance, objected to the idea of law being violated or set aside, for if the laws of nature are but expressions of the will of God then they can hardly be set aside much less directly violated. (Cf. Augustine 426, section 21;8.)

The definition of a miracle as a violation of a law of nature is of the essence of the Humean view and has resulted in much discussion. This definition seems plausible but has serious difficulties and as formulated cannot be accepted.

> "A miracle is a violation of a law of nature; and as a firm and unalterable experience has established these laws, the proof against a miracle.....is as entire as any argument from experience can possibly be imagined." (Hume 1971, p.210.)

Hume was assuming laws of nature as a body of positivistic knowledge based on experience - a view stemming from Newtonian determinism.

This standard view is deeply ingrained even with orthodox theologians. Hodge defined a miracle as "an event, in the external world, broughtabout by the immediate efficiency, or simple volition of God." (1960, Vol.I p.618.) He divided events into three classes: (a) those due to the ordinary operations of secondary causes; (b) events due to the influence of the Holy Spirit such as regeneration; and (c) events which belong to neither of the above. He noted the objection of Augustine but felt able to argue that: (cf.23.2.4.3.)

> "The form in which the objection is presented by those who make nature the will of God, is answered by saying that nature is not the will of God in any other sense than that He ordained the sequence of natural events, and established the laws or physical causes by which that regular sequence is secured. This relation between God and the world, assumes that nature and its laws are subject to Him, and therefore liable at any time to be suspended or counteracted at his good pleasure." (ibid p.620.)

The premiss here is tending to view God in a Cartesian manner, in terms of the Deistic clockmaker. While accepting that the absolute immutability of natural laws is a gratuitous assumption, Hodge goes on to point out that God is not subject to the laws of the universe, but is absolutely independent in all His works. Thus God can set aside the laws of nature. The problem is that he locates law 'in Nature' rather than 'in God' and so grants effective autonomy to nature. The Westminster Confession of Faith is also caught in this viewpoint when it states that: "God in his ordinary providence maketh use of means, yet is free to work without, above, and against them, at his pleasure." (Section V;3.)

The problem revolves not just round the question of 'law', but also around the word 'miracle'. We have seen something of the problem connected with the former, but the latter also is used loosely. Miracle is derived from 'mirror', to wonder, and in this sense can designate any extraordinary event which arouses wonder and evokes attention. In Scripture the several words used indicate the design of the event, rather than the nature of the event to which it applies, as crucial. Hence it is a perfectly correct assertion (e.g. by Luther and Drummond) that a great miracle is the conversion of an individual sinner. But a conversion is hardly a violation of the physical laws of nature, indeed it is nothing to do with them.

Kuyper considered that a miracle was "nothing more than that God at a given moment wills a certain thing to occur differently than it had up to that moment been willed to occur." (In Ream 1972, p.62.) If the laws which are observed in creation are not independent autonomous functions of some self-existent machine, but the operating patterns of God, then it follows that a miracle is not a violation of these laws but simply an unusual operation of God. Scripture itself nowhere presents the miraculous as antithetical to a self-contained universe, and the whole idea of miracles working against laws of nature implies a strong allegiance to the idea of the self-sufficiency of reality and its laws. Perhaps we are still suffering from the mechanistic self-sufficiency of the Newtonian era, but the modern autonomy of chance is no better.

When God acts in a different way/will from His normal operative will there is no clash between that norm and the unusual; it fits neatly into the flow of secondary causation. (Cf. Lewis 1960, p.63.) It is simply a question of viewing the law-structured reality around us as the ordinary operations of God (cf. Mat. 5;45. Is. 10;5.) while His extraordinary operations we see as miracles (cf. John 2;1-11.). Within this schema a miracle will be seen as something that is interlocked in a forward direction in time with the natural world, whereas the ordinary operative patterns of God are interlocked in the natural world in both a backwards and forwards direction in time.

The question is really not as to the miraculous but as to how it is that the world is as regular as it appears to be. This is the assumption of science but it can only be justified from the theistic aspect of the personal faithfulness of God. It is God's world, not our world, and all things from the Scriptural viewpoint have a rationale in the will of the Creator.

> "The biblical claim is that wherever God did 'work' or 'bring into being' an event which we call a miracle, whether or not it broke with scientific precedent, he did it because in the over-all pattern of his drama it made <u>more</u> sense at that point: because his total plan and purpose for our world would have been <u>less</u> coherent had it not occurred in the way it did." (MacKay 1974, p.64.)

<u>24.2. THE DOCTRINE OF CULTURAL ACTIVITY</u>

<u>24.2.1. The Doctrine of Common Grace.</u> Common grace (cf. 19.3.3. and C. van Til 1974.) makes Christian action in the world possible. It means that the Christian can act Christianly as scientist, philosopher or what have you. It is not merely a doctrine which attempts to justify certain aspects of the world but which seeks to stimulate the Christian to positive action in the world. Common grace gives to the believer the material for fulfilling his cultural calling, to be culturally formative and to struggle for the Kingdom of God in the world of our culture. It is the basis for Christian scholarship to be developed, providing the platform on which cultural tasks may be acted out. "Common grace is <u>the presupposition of the possibility</u> of Christian cultural activity." (Zuidema 1972, p.57.)

<u>24.2.1.1. Every Thought Captive.</u> Yet for our present purposes the doctrine has an equally important meaning in establishing the worth of non-Christian thought and activity within the creational order. God's word also lights the mind and philosophy of the non-Christian. Paul writes: "We destroy arguments and every proud obstacle to the knowledge of God, and take every thought captive to obey Christ..." (2 Cor. 10;5.) Now often this has been misread by taking only the first phrase - about casting down every high thing - and seeing it as a simple mandate of destruction spoken against worldly wisdom. But the second phrase - about taking captive all thought - indicates that there is a positive relationship between Christian and non-Christian thought that transcends negation and exclusion. The thoughts of the non-Christian are to be brought into the Christian worldview and made acceptable to God.

<u>24.2.1.2. A Negative and a Positive Side.</u> Common grace, therefore, applies to both Christian and non-Christian. It is a motivation to

the Christian to work in the world, and it also is the means of preserving men and the earth from the ravishes of sin - preserving that which is of worth in the mind in rebellion against its Creator. Common grace, then, has a negative and a positive influence. It has a constant role in restraining sin and has its effects in both man and the universe. It has a positive progressive action where it functions as a culture-forming and activating power in history with man as both instrument and co-worker of God.

(a) Common grace restrains sin. It restrains the process of the sinful development of history. This presupposes the doctrine of total depravity - in extension, not intension. Thus the effects of death and decay are held in check, not wholly but in part. Not wholly, so that the fearful results of sin may be obvious; in part, so that the wealth of God's creation and re-creating power may be manifested. It is, however, quite distinct from God's saving grace. The constant restraining influence of common grace means that God holds on a leash the curse pronounced in Genesis 3 upon nature and the effect of sin in the human heart and mind.

(b) Common gace founds culture. In contrast with this there is also a progressive operation of common grace by which God equips human life and brings it to a deeper and richer understanding of the universe in which He has placedman. Kuyper has pictured the difference between these two operations by seeing in the former, restraining impact, God working quite independently of man; while in the latter God working in colaboration with man.

> "It was in his common grace to all mankind that God as the supreme architect of the world brought progress in his providence, which is the fountain of human history.....The world must continue, men must be born, the course of history must show progress; for all of these things to take place, common grace is necessary, whereby the original powers latent in creation may come to fruition, and find their highest development to the glory of God.....we may speak of a continuous development of the human race by which it collectively exhibits the image of God." (H. van Til 1974, p.120.)

24.2.1.3. Common Grace and Particular Grace. The domain of common grace is outside that of particular grace and does not bear a necessarily christologic, distinctive stamp. A Christian marriage is an ordinary marriage, a Christian family is an ordinary family, a Christian association is an ordinary association, a Christian society is an ordinary society, a Christian state is an ordinary state - ordinary with respect to the ordinances that pertain in creation for marriage, family, association, society and state. A Christian view of science is also an ordinary view of science - with respect to the creational ordinances.

Common grace nevertheless rests on the Second Person of the Trinity (as distinct from the Incarnate Christ) in His mediatorial role in creation; while particular grace rests in Christ as the Incarnate Word who accomplishes the mediatorial work of redemption and renewal. But even the former must be tempered with the fact that as Saviour, Christ re-creates, re-stores, re-deems, not just the inner personal life of the believer, but all things (cf. Col. 1;20.). In Colossians 1 we read how Christ is not only creator (v.16.) and preserver (v.17.), but redeemer of all things: "and through him to reconcile to himself all things, whether on earth or in heaven, making peace by the blood of his cross." (v.20.)

Therefore it would appear that Christ has a twofold claim to kingship over our scientific activity. First as the Creator within the creational ordinances; second as Redeemer within the kingdom (rule) of God.

In this way common grace, while independent in character, also reveals a dependent character upon particular grace. Common grace always operates in our fallen world within the perspective of particular grace. The raison d'etre is outside itself in particular grace. Common grace points beyond itself; it seeks to bring creation to its destination which lies only through the redeeming work of Christ for men and cosmos. We see something of the indirect positive influence of particular grace upon common grace in, for example, the Protestant ethic; while we see something of the direct positive influence via the mediation of the Kingdom of God into the world in the lives of individual Christians. For common grace means above all that there is to be no 'gnostic culturophobia' in Christian living. To be active in the sphere of common grace most certainly does not mean that an individual is dirtying his hands or soul - a needed stress against much Pietistic, evangelistic and charismatic thinking today.

Advocates of common grace never maintain that the actual cultural artifacts of man will survive into the eternal, for the fashion of this earth passes away. But on the basis of Revelation 21;26 - "and they shall bring the glory and honour of the nations into it" (i.e. the new Jerusalem) - there is a case that the cultural development of mankind will carry over into eternity, minus, of course, the influences of sin. The meek are to inherit the earth — and surely it is not to be an earth naked, robbed of all accomplishments of man under God (cf. Rev. 14;13.). Our works are the products of our labour, under both common and particular grace, and we are told 'their works shall follow them.' This is summed up in the supposition that the whole of creation is not to be destroyed but rather shall be glorified. The form may pass away, but the substance remains.

<u>24.2.2. The Cultural Mandate.</u> A basic biblical given for man is the cultural mandate (Gen. 1;28.). Man is called to build the creation up and keep it (Gen. 2;15.); he is to work as a citizen in the kingdom of God so that all things in the creation will unfold and find their proper place in God's purpose. Of course the Fall meant the usurption by man of the rightful place of God; it meant sin and the curse of God on man's relationship to nature, fellowman and self, as well as to his Origin; it meant that he worshipped and served the creation instead of the Creator. But now in Jesus Christ reconciliation and redemption have been accomplished. Despite dislocation, destruction and death in the cosmos there is behind all this the working power of Christ. "History is placed in the sign of a total recreation, the full revelation of the Kingdom of God." (Schuurman 1976, p.12.) Christ is not only the head of the individual believer but has power over all things whether they be in heaven or in earth.

<u>24.2.2.1. A Fourfold Motive.</u> There is the basic motive of <u>creation</u>, <u>fall into sin</u>, and <u>redemption</u> in Jesus Christ. But if the first aspect of the creational mandate is expanded and fulfilled in the third aspect; so also the second aspect — the Fall — is continued today in <u>disobedience</u>. Not everyone follows the motive of the Kingdom of God and even the deeds of Christians are often out of harmony with it. This fourth feature extends and crystallises the characteristics of the second aspect, and unfolds the chaotic and destructive powers of rebellion. Thus we have:

(i) CREATION
(ii) FALL INTO SIN
(iii) RE-CREATION
(iv) DISOBEDIENCE

24.2.2.2. The Place of Science/Technology. It is against the background of common grace, cultural mandate and the fourfold motive that the place of science and technology in the world should be considered. Some Christians seem to think that technology and science are intrinsically bad. But this is not so. Technology and science are both blessing and curse because in our fallen world everything temporal is mixed - bearing the stamp of creation and fall, the mark of redemption and disobedience. Alongside the appeal to the cities of Cain and the tower of Babel, we can posit the Ark and the Temple as instances of God-inspired technological artifacts. The problem in our culture is man's determination to gain control, the will to power for and of himself. In pursuit of this, Western man often attributes absolute power to science and the application of a techno-scientific method. Consequently by shutting man's diverse callings up to this, there has been a restriction of human creativity and responsibility. We see this in the destructive will to power; in the pursuit of technology for technology's sake; and in the pursuit of technology for economic ends. God-given motivation and goals are eliminated from the mind of modern man. This wrong motivation means that science and technology can, and do, bear a positive reflection of the curse. "Technology as a curse will increase if the motive of technology is not changed." (ibid p.17.)

The Christian seeks to unfold God's original cultural calling to man which despite the Fall has never been abrogated. The biblical motivating force in history is the task of building, keeping and preserving the creation. Not preserving alone, for this reflects a choice for nature against culture; and not building alone, for this is a choice for culture to the detriment of nature. These two aspects must be held in creative tension within the calling of God.

24.2.3. Man - God's Office-Bearer. The Psalmist tells us that the heavens are the Lord's but that He has given the earth to man. This focuses on man's function and place within God's creation where he is called to be servant and steward. It is crucial that the full thrust of God making man in his own image and placing him in the world to have dominion over it be grasped. "Man has a royal position in the world." (Dengerink 1977, p.13.) Man is called to be God's office-bearer. One of the reasons why we have lost sight of the concept of the scientist called by God within the parameters of sphere-sovereignty, seems to me to reside in a loss from modern consciousness of an awareness of the role of office in life. This was one of the great themes rediscovered by the leaders of the Reformation. The idea of office as presented in the Bible brings us to the centre of religion. The word 'office' itself may not occur very often but the idea is expressed in such terms as 'service', 'servant of the Lord', etc.. It relates naturally to the previous concept of a cultural calling or commission, where man is given a delegated authority, a definite appointment to carry out a task. Office, then, refers in Scripture to the allocation of a particular task and the granting a particular right to carry it out. This implies in turn the Sovereign One who delegates, who grants authority, who gives the commission. Office always means limitation. Evan Runner, a philosopher, writes:

> "Office is not merely service (dienen); it is also administration (bedienen): it is service of God and an administering of God's love and solicitude to the creature at the same time. Office as administration (preserving and orderly form-giving) includes the idea that the future weal or woe of what is being administered depends upon whether the office-bearer does or does not serve God." (1970, p.147.)

So office points us to man's administration of the entire world which God has given him. Genesis clearly points out that man is appointed over creation to rule it in obedience to God. The office of man involves his position before God, his relationship to his Creator as servant called to obedience. Man is therefore servant. He is also guardian, called to bring his charge (creation) to maturity. So God, in equipping man for this task, has given him the gifts which enable him to rule and exercise dominion - the gifts whereby he executes his science and technology. But having thus provided man in his tasks with gifts, and called him to a particular obedience - responsibility is involved. Man's office involves his stewardship of life, that is the way he orders his life and his goals, and the things God has given him in life to control. He has to give account to God as to how he carries out the designated calling.

Hence within the biblical perspective we see that the cultural activity of man in positive response to the mandate of Genesis 1:28 is worked out in cultural, scientific, political and economic terms. As office-bearer man functions in a diversity of institutions - family, church, state, school, scientific community and industrial enterprise. Each of these societal structures stands in God's world before God's calling for that situation. The norms that He gives are not to be arbitrarily changed by man or judgement will result.

One of the problems today is that Christian witness has all too often been restricted to a limited concept of personal testimony (evangelical) or restricted by absorption of secular presuppositions (liberal). But we must call into question any tendency to atomise the faith so that it loses the sense of Christ's Lordship over earth and heaven, individual and society. Christ is the transformer of culture for He continues to create, here and now in the midst of a rebellious world, a kingdom of truth. [4] It was against the background of this thought that Calvin could not rest with a preaching of the Gospel alone, important as that was, but strove to transform the social life of Geneva into a model of Christian living. The Christian is called as renewed person to present his body (Rom.12;1,2.), that is the things of his daily task, as a living sacrifice and in service to God. Under his calling as God's office-bearer within creation man is called to exercise his dominion over creation through his science and industry as well as art and learning. This is man's basic task in life - namely to take the raw materials of God's creation and by means of his industry, artistry, science and techniques unfold the possibilities hidden in creation. (Cf. chs. 25 and 26.)

But it is essential that this calling over the fullness of life be consciously pursued and that humanistic motives resisted in the name of Christ. (Cf. Whale 1960, p.266.) As Calvin Seerveld, a leading aesthetician, put it:

> "Art is a symbolically significant expression of what lies in a man's heart, with what vision he views the world, how he adores whom. Art tell tales in whose service a man stands because art itself is always a consecrated offering, a disconcertingly undogmatic yet terribly moving attempt to bring honor and glory and power to something." (1968, p.28.)

As he himself recognises, what is true in this connection for art is true for all of life. Science is a 'significant expression of what lies in a man's heart'; technology 'tell tales in whose service a man stands.' Science and technology are 'a terribly moving attempt to bring honor and glory and power to something.'

4. Cf. H. Richard Niebuhr (1951), and H. van Til (1970).

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CHAPTER 25

RESPECTING THE ENVIRONMENT [1]

25.1. INTRODUCTION

The last few years have seen a new awareness of non-renewable resources, energy consumption, pollution, and food shortages. The remarkable feature of our present crisis being that, while its constitutive elements have occurred individually before in history, they are now all happening at the same time. In this period of rapid world change - as we witness a change from the old industrial structures to automation and cybernetics; the end of the old colonial empires; the problems of the new developing nations; and the increasing trend of urbanisation - there are predominantly two issues of global consequence (excluding that of international harmony), namely economic growth and the environment. Each year the average citizen of the U.S.A. consumes some 20 tonnes of new minerals, which indicates both an environmental impact and an economic consequence for that country and others. This industrial growth is a comparitively new phenomenon and it is only recently that large industrial combines with their concomitant motives of profit, progress and production have been seen as a major threat to the survival of man. But survival is not enough and we need to go beyond the question of a pragmatic manipulation of the environment for the welfare of man to an attitude of honour, respect and regard for the environment which is necessary if man is to find his proper place within the cosmic scheme. (Cf. Ribbens 1976, p.18f.)

25.1.1. The Importance of a Worldview. To respect the environment will involve some understanding of ecological problems, of attendant problems such as population and pollution, and the attitudes of progress and production. But the environment is wider and deeper than ecological concern; respect is more profound than self-preservation or the optimum use of resources. It is my contention that we can only gain real respect when we understand that the environment is subject to the creative act of God, and realise man's creational relatedness to God and nature. While ecological crisis may be alleviated, humanly speaking, by the combined actions of

1. This chapter is a shortened version of an essay for the 1977 Arthur Jones Memorial Prize in Citizenship, Glasgow University. The full text is in the University Library.

scientists, technologists, economists, politicians, etc., I believe that one of the main barriers to effective action is the failure to establish a philosophy of the topic which can provide a basis for action and attitudes which are ecologically responsible. There already is a considerable literature on the politics, statistics, aesthetics, history, biology and chemistry of ecology, but little on its religious connections despite considerable reference, from various stances, to the need for religious commitment. As Lynn White perceives, recognizing that ecology is rooted in a worldview: "What people do about their ecology depends on what they think about themselves in relation to things around them. Human ecology is deeply conditioned by beliefs about our nature and destiny - that is, by religion." (1970, p.77.) He continues, after attacking "orthodox Christian arrogance towards nature" to suggest that: "Since the roots of our trouble are so largely religious, the remedy must also be essentially religious, whether we call it that or not." (ibid p.85.) Accepting his recognition of the religious nature of the topic and the need to establish a sound philosophico-religious base for any valid response to the crisis of the environment, I must note that I do not accept his historical analysis or solution. However I agree that science and technology per se are not the answer.

25.1.2. What Is The Environment? The 'Blueprint for Survival' defined it thus:

> "We can define the environment as a system which includes all living things and the air, water and soil which is their habitat. This system is often referred to as the ecosphere. To describe it as a system is to accentuate its unity; a system being something made up of interrelated parts in dynamic interaction with each other, and capable, for certain purposes, of co-operating in a common behavioural programme." (1972, p.24.)

But it is not simply the environment in terms of the natural, physical resources that is involved for we must take account of the social and spiritual environment within which we live with all their ramifications. Indeed these latter aspects are critical concerning attitudes to resources and the problems of pollution. (Cf. Hetzel 1974, p.180.) Within the social milieu, modern man is faced with an horrible dehumanisation which has accompanied modern industrialisation and urbanisation. Ellul sweepingly denounced this in prophetic manner long before environmental problems became accepted (cf. 1964, p.4 - cf. 26.3.2.1.).

Ecology, then, is the study of all things in their interworking. It is an attempt to see things in their wholeness, relating industry with resources, the right use and the prevalent waste of our society. Ecological concerns will weigh the economic with the social, the benefits of this generation with future ones, they will seek to balance industrial development and the preservation of the world's resources, they will seek to preserve and build up. Moreover they will have to do with the relation of rich to poor, and with social justice for developing nations.

The problem of our environment can only be faced in this overall perspective, in the realisation that modern man faces a crisis that is inner, social and metaphysical as well as ecological. Man has an inner crisis of identity seen in the changing forms of unrest from the New Left to Woman's Liberation. Socially there is the breakdown of relatedness at work and home; while metaphysically there is "the sense of separation from the 'whole scheme of things' because we have no conviction that there is a scheme of things or abiding value in the universe." (Birch 1975, p.306.)

So there are many norms for the environment. It is not simply a question of resources, pollution or survival. Positively we should be seeking harmony between technology and nature, between technology and man, such that the present disadvantages of technology might be excluded as soon as possible and be prevented from recurring in new forms. This will involve an appreciation of the aesthetic relationship between man, his technology and nature. Socially man is part of creation. So often, it seems to me, writers on this subject forget that man is part of the picture - his aspirations and creativity cannot be negated. But we are not to exploit, but rather build and keep the creation for it is not ours. It is given to us. Thus only when we look at the environment religiously can we begin to appreciate it truly.

25.2. THE ENVIRONMENTAL DILEMMA

There is a dilemma facing man today that few would question. Distress signals are flying on all sides: geologists assure us that raw materials and energy reserves are being used up at a rapid rate; biologists warn of decreasing numbers of species and threats to the oceanic chain of life; environmentalists warn of increasing worldwide pollution; even psychologists warn that the psychical pressure of life today causes frustrations that border on shock phenomena. To compound this, the wealthy nations have increasingly become the 'have-nots' in terms of vital resources.

Thus despite the environmental gains that have been made by some bodies the destruction of the environment continues. To act through the correct political and legal structures can take years to secure a ban on one toxic chemical - while in the interim, thousands of such chemicals have come on the market. There is therefore in our situation a rising impact of negative features from industrial 'progress', an increasing number of pressure points where man's aspirations, and indeed life itself, are threatened.

25.2.1. 12 Pressure Points.[2]

(i) The related problems of war, disease, famine and economics. Our world echoes to wars and rumours of war, the threat of internecine war and racialism. The global village increases the threat of epidemics, concomitant with a rising resistance by many pests and microbes to drugs. There is the horrible reality of famine and poverty, especially in densely populated regions. The problems of economic disparity, the increasing gulf between rich and poor, the problem of unemployment or underemployment due to capital intensive industrialisation which is export orientated, the lack of public services such as housing, sewers and transport, the inbuilt segregation of socio-economic groups - all are noted without comment.

(ii) The fear of a population crash following the current population explosion; and more immediately the problem of urbanisation. The gearing of agriculture to large-scale economies where bigger is deemed better and more efficient has led to capital intensive farming with a resulting loss of employment and swing to the cities. Then as fewer and fewer are left in the country the problem intensifies with the collapse of the economic base of small towns. (Cf. Waddington 1974, p.36.)

(iii) There is the fear of an ecological disaster due to the creation of unforseen imbalances in nature and/or pollution. We can think of a nuclear disaster due either to peaceful disaster or war. Currently much pollution control is a 'pollute your neighbour' policy.

(iv) The fear of the genetics race - note the recent, albeit localised and temporary, research moratorium by certain authorities in the U.S.A..

2. Cf. Mishan (1973, p.10.); Guinness (1973, pp.62f.); and W.C.C. (1974, p.36.)

There is also the fear of a genetical calamity through radiation or drugs - radiation mutations are harmful.

(v) There is the opposing fears of rising anti-scientism on the one hand which tends to a tyranny of technology, and on the other hand the call to return to 'simple earth'.

(vi) The recognition by environmentalists of the shortness of time in which to alter the basic patterns and attitudes of the present.

(vii) The existence of a moral vacuum and the attendant increasing threat of anarchy and urban vulnerability to blackmail.

(viii) The problem of vested interest which is the guillotine of effective action. Recent reports suggest that even if the U.S.A. government wished to control its big multi-national companies it could not do so. (Cf. Barnet and Muller 1975.)

(ix) The attitudinal problem of progress. Progress seems the inevitable and inescapable path for modern man. He must get on, consume more, raise his standard of living higher and higher. The drive for progress undergirds the very fabric of society - how many politicians would dare campaign on the basis of the thinking of the Club of Rome. Yet from J.S.Mill to N.Chiaromonte (1972, p.49.) it is realised that progress is no option for man.

(x) The attitudinal problem of production (cf. Vrieze 1973, p.33.). Products presuppose a consumer and the abundance of them presupposes intensive consumption. Production presupposes obsolescence to make way for better and more goods. Obsolescence creates an uncaring attitude, a throw-away mentality; if things are only there to be enjoyed for the moment why try to integrate them into some lasting whole. So production designs not only products but a life-style, a new kind of existence where man surrenders to a reduction of his being. How many have fallen into the trap of saying of a vase of roses that: 'Those can't be real, they're too beautiful, too perfect.' In this way production arouses easy, surface emotions which lack depth commitment. So many are ensnared by production and technology, thinking that it alone unlocks reality in a meaningful way. Indeed a right technology will unfold reality, but absolutized technology shuts it up, reduces it to a consumer-cum-economic reality which forces men to live in an environment that is less than it should be.

The constraints of modern society mean that large firms, motivated by power and profit, cannot tolerate insecure markets and therefore seek to prefabricate the wishes of the consumer (advertising) in order to create stable markets. Within this one might be excused for thinking that production was an impersonal force with man its subject slave (Ellul) instead of in reality being a complex of human activities called into existence by human desires and aspirations. In this way production always reflects a stance-in-life, which in our day reflects a materialistic acquisitiveness and greed. Production processes may pollute, but every bit as harmful to our environment is the fact that it is being buried under a deluge of products.

(xi) An increasing lack of purpose with modern man having no firm base on which to act.

(xii) The Energy Crisis. It is generally accepted that oil can only be a stop-gap solution as it constitutes a non-renewable resource. This raises the question of nuclear and other energy alternatives. The case for nuclear energy is that here is a ready source which can preserve fossil fuels for other purposes and give less pollution. Against this we have the problem of radioactive waste both now and for future generations, the vulnerability of such power-stations to sabotage and centralisation. They would also increase the technical gap between rich and poor nations as well as open up weaponry potential to new nations. Further, non-breeder reactors are dependent on the scarce resource of uranium, while breeder technology has not yet been vindicated.[3] Interestingly while scientists warn of the need to be cautious it is engineers who want to push ahead.

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These twelve points, in no order of importance, indicate the extent of the problem facing any real respect for the environment. The struggle against environmental deterioration will only begin to succeed if man can begin to be satisfied with a lower growth income, and even a lower income, and a lower energy consumption. This drives us back, not to the problem of pollution or production, but to the religious orientation of man's desires.

<u>25.2.2. The Environment and Economics.</u> It would appear that economic and environmental considerations often stand opposed to each other. In fact there is:

"....a profound incompatibility between deeply rooted beliefs

3. This latter statement will no doubt be open to question - but this does not obviate the reality of the energy crisis.

> in continuous growth and the dawning recognition of the earth as a space-ship, limited in its resources and vulnerable to thoughtless mishandling." (Blueprint 1972, p.5.)

Belief in growth is aided, and the environment damaged, by the reality that man is not used to making plans which cost him, and which he is not sure of taking advantage during his lifetime. The desire to steadily increase our standard of living is hardly reconcilable with respect for the environment. Today we are ruled by a faith, a religious commitment to growth. J.K.Galbraith notes: "A rising standard of living has the aspect of a faith in our culture." (1967, p.164.) President Ford, for example, vetoed the more environmentally caring approach being advocated for strip-mining as it would slow production.

The problem is therefore political as well as technological. It is political 'economic necessity' that demands so much waste in our modern world - ordering grain to be dumped, stockpiled, or even paying farmers to keep their fields barren. The dilemma is magnified by a grievous lack of political will, and even where action is taken it often leaves the problem of the developing nations unsolved. Markets are designed for profit and therefore in terms of the world's hungry the capability to produce food is not geared to this need. It is all very well for the affluent to decide not to use D.D.T., but the cost of many such anti-pollution measures pushes up costs in the developing nations to unacceptable levels.

This leads, in a situation where global action is needed, to loopholes being provided for developing nations. Undoubtedly such nations need to be developed, need social justice and status within the world community - but it tends to fling ecological action into chaos. Thus the 23rd principle of the 1972 Stockholm Conference points out that we cannot expect the developing nations to proceed as if they too had reached the point of ecological transition.

In the face of the current situation respect for the environment on national and international levels is no easy option. Cruel choices are faced which cannot be resolved technologically: is it to be continued employment for the chemical plant that depends on disgorging effluent into the nearby river, or a clean river? Employment or environment? This only serves to highlight the need to get behind the symptoms of our dilemma to its root cause. As long as we consider the economic system as some autonomous machine isolated from man, and that by tinkering with it here and there we might get an answer, then we are doomed. Technical countermeasures do not work if they exclude man's basic responsibility. The problem is that we separate economic problems from the responsibility of man which is pushed off to the background. But respect is a human stance, not a technical measure.

<u>25.2.3. The Dilemma In Perspective - Whose Fault?</u> From the above it might be thought that production driven by economic systems, plus the apparently intractable problem of increasing pollution and population are to blame for the present crisis. But in apportioning blame, in seeking some culprit, it is all too easy to miss the central question which must be as to what exactly is being polluted and how. This drives us beyond seeking piecemeal culprits for environmental deterioration, to the deeper reality of our polluted milieu. It is not just a question of the dominance of technic but the underlying values, aspirations, ambitions of men that are crucial.

This raises the question of dominant motives, of various <u>weltanschauungslehre</u>. Several sources have laid the blame squarely on the Judaistic-Christian tradition as seen in the Genesis account of man's dominion over nature. John Passmore (1974, p.18.) considers Christianity dangerous in connection with environmental respect as it lifts man metaphysically out of nature, which can then be ravaged with impunity (cf. L. White). He argues that only when man is seen to be alone in an alien world can he hope to face up to the crisis. Interestingly, this is countered by the economist E.J.Mishan who longingly wonders if the ordering deity which we have lost sight off might not have been able to help in our hour of trial (1973, p.24.). Passmore goes on to argue (in a rather peculiar historical construction) that while he approves of the idea of stewardship, this comes not from the Christian tradition at all, but from Kant!

The World Council of Churches' project on 'The Future of Man and Society in a World of Science-Based Technology' (White participated) while acknowledging that science-based technology is the instrument of the present crisis, the instrument of domination and exploitation, uncritically accepts that: "Theology, in pursuing the doctrine of <u>dominium terrae</u>, has opened the door to thoughtless exploitation and destruction." (WCC 1974, p.36.) This may be true of certain streams of theology, but not all theology. It is a sweeping generalisation which fails to penetrate to the heart of the history of the subject or the philosophically driving ground-motives.

We need a renewed discussion on the basic assumptions of the autonomy of technic; a renewed understanding of our historical context; and an appreciation of the Christian doctrine of creation and man's place in it. To accomplish this we will need to overcome the rupture between nature and history as it occurs in both Marxism and American Pragmatism, as well as in modern philosophy and theology. Another requisite will be the refutation of the dialectical methodology of the influential Ellul - a methodology derived directly from Barth.

Within the Christian era there has always been those who renounced the world and others who affirmed it. In the early history of the church there were the herecies of Marcion and the Gnostics as they struggled with the problem of the imperfection and incomprehensibility of the world, and posited Christ over against the God of the Old Testament - thus driving a wedge between creation and salvation. So the creation doctrine of ex-nihilo was formulated by the church to fight the idea of a non-Christian demiurge. Nevertheless, despite the early affirmation of the validity of the world as created by God, Christians down through the years have had a variety of attitudes to the natural world. Some see the world as a totally ruined creation, marred by the Fall, where the world is simply evil and men are called out of it, to be above the world and to endeavour to impart through Christ something of grace to it as long as they live there. Others see the natural world as a revelation of the divine plan (design) where all is for man's benefit. Yet others, parallel to certain modern movements, have viewed untrammelled nature as the way to God, thus opposing urbanisation and industrialisation (cf. the Amish). The problem of all these views is that - as Christian - they are often unbiblical and certainly largely irrelevant to the modern powers of man over the environment.

Yet the undervaluation of creation is strong in Western thought - both philosophically and theologically. This follows from both atheistic and theistic existentialism, and pragmatism. Barth with his actualistic belief in revelation; Brunner with his deeper respect for creation, but weak point where he drives a wedge between creation ordinances and the redemptive work of Christ; and evangelicals in their Platonic concern for the soul to the negation of the whole personality – all devalue nature. Such views split existence into some form of material-spiritual dualism, instead of holding these two aspects together in creative unity.

It seems to me that the modern weltanschauungslehre stems more from the humanistic motive of nature-freedom which came to the fore in the Enlightenment, than from a wrong view of creation by the church. The Enlightenment saw the secularisation of Western man from God, and from then on humanistic thought has tended to dominate (even in theology). Man has become central on the stage of life with his will to power, while God has been quietly shuffled off to the wings. For modern man God is dead. In this situation I believe that there is a need to recover a biblical doctrine of creation which will be, not a celebration of the goodness and integrity of nature, but a realisation of the initial 'goodness' which is now fallen along with man.

The problem of secularisation is that it establishes man at the centre and gives its blessing to affluent nations which "have been imbued with the ideology of acquisitiveness and greed" (WCC 1974, p.30.) even where this is largely unconsciously absorbed by the majority through the social mores and exposure to relentless advertising. As Paul Abrecht puts it: "One problem is that all rich, developed countries, both capitalist or socialist, have been committed to the goal of material progress." (1974, p.5.) The fruits of this secularisation are a blind faith in scientific capability, education, progress and technological ability. It is a faith which grants these aspects a degree of autonomy over men such that they are not questioned but rather blindly followed – for example the widespread technological tendency to do something if it is possible. (Cf. Mishan 1973, pp.12–13.) We must remember that within the context of the Enlightenment lies the Industrial Revolution. (Cf. Goudzwaard 1975/a, p.3.)

The 19th century scientists were always looking to physics as the key to reality and progress, and this led to the dominance of the methodology of physics – to atomise, to see things in specialised isolation – not environmental wholes. In our century the emphasis shifted to the question of progress in knowledge and cultural deeds, and therefore technology came to the fore in governing our life-style. Only 15 years ago technology apparently knew no bounds – it would tame the raging torrent and the bleak desert, it was the age of technological expectation as the politicians were swift to realise (cf. J.F.Kennedy and H.Wilson). Technology would lead to the new leisured society, it would lighten the burden of man, and the key words became automation and cybernetics. But the crushing irony was that the very technological dominion that led to affluence, led in the end to increasing pollution, the consumption of resources and psychological alienation. Few have awakened to the nightmare reality (cf. Booker 1970, p.71f.).

25.3. RESPONSES TO THE DILEMMA

25.3.1. Introductory Survey. The majority display a total lack of interest - this is of course precisely the problem, that people, both individuals, governments and companies are caught in the growth/progress ideology. Of those showing concern, the majority are notoriously middle-class, the poorer classes viewing environmental concerns as merely another stick to keep them down. Yet despite this interest, the bourgeois middle-class mentality is generally poor in any real sensitivity or respect of nature.

The typical active response is basically one of survival - this is true of the Club of Rome, the W.C.C. project, and the 'Blueprint for Survival'. In contrast the Christian motive will centre on respect for the creation of God, responsible stewardship over it. While survival will no doubt play a role, it cannot occupy a primary place in a philosophy which is integrated in God, not man. Christians have been accused as the cause of the ecological crisis and it must be conceded that in terms of world-renunciation, or two-realm theories, their views have often been defective. They have often failed to realise that the earth is the home of man; they have been, paradoxically, too man-centred in their conception of salvation. But the Bible clearly states that 'God so loved the cosmos' (Jn. 3;16.), not just man. In this realisation the response that advocates a man-centred resacrilisation of the environment (which is caught in an unresolved dialectical tension between nature and civilisation) is inadequate. A better response is found in H.P.Santmire's 'Brother Earth' (1976) where he posits that only a biblical stance can overcome the tension between the adoration and manipulation of nature. He criticises the man-centred domination of Bultmann and Barth, and the manipulation of nature for social justice as found in Cox. For Santmire, Scripture accords nature an intrinsic worth, it too participates in the divine plan, though not as some autonomous Newtonian machine. There should therefore be neither flight to, nor from, nature, or exploitation.

F.A.Schaeffer (1970) also provides an intelligent critique but suffers from brevity. He fails to get behind the symptoms of pollution to the problems of production and economics. He restricts the environmental task to the church and the individual, but it is corporate industry that pollutes, it is governments that allow and foster waste. Man is always man-in-context and therefore we must seek religious direction and take a stand in the areas where we are in daily life. Nevertheless, Schaeffer gives an excellent critique of the failure of humanism and pantheism to give a basis for any true and lasting respect of nature.

<u>25.3.2. The Optimists.</u> The optimists of modern society are varied in belief and derive from such diverse figures as Marx, Skinner, Toffler, Tielhard de Chardin and McLuhan. Dr. P. Abelson, director of the Carnegie Institution's Geophysical Laboratory in Washington D.C., optimistically argues that while man is up against it and there is a grievous lack of knowledge, yet: "When knowledge is lacking, he can develop it, for example by monitoring." (1971, p.6.) But while knowledge may increase the evidence seems to suggest that it will not provide all the answers - ignorance is a real ecological problem.

The most detailed optimistic account I have come across is that of Beckerman (1974) - though Toffler may be thought of also.[4] He points to the dark days of the past, the slums and pollution of our cities in the early 19th century, of the danger of typhus and other horrific epidemics now largely under control. He questions the assumptions of the anti-growth school, that pollution must rise with economic growth such that life becomes unsustainable. He argues that our reserves have been greatly mis-estimated, taking little or no account of the potential of new technologies, recycling or potential substitutes for current materials. He concludes that economic growth will simply slow down of its own accord and that it is politically impossible in democratic countries to envisage any other kind of retardation on growth.

So technology is still conceived as designing and building a

4. Cf. R. Clarke (undated) - a good review of Beckerman.

better tomorrow. Yet the problem remains that man's uncritical implementation and worship of his powers in technology leads to impersonal standards being coerced on man. Impersonal technology co-ordinates and administrates the life of man, speaking to his every need. Therefore we become the sublimated slaves of technological society; we become Marcuse's 'One Dimensional Man'. (Cf. ch. 26.) It must be recognised that we live in a world where the philosophy of Marxism and neo-Marxism is strong, and that in the materialistic dialectical concept of social change, technology assumes a key role, facilitating the reduction of man to technical-man. Technology is placed in the domain of productive forces making possible the production capacity necessary for the development of economic well-being.

The problem is the absolutization of man and his powers - technic, science and organisation (cf. 26.3.) - while negating his created nature, and therefore subject-status as relative, not central. Ironically it is in a W.C.C. booklet that we find the humanistic motive of man-centredness expressed:

> "At the inaugural meeting....President Nicolae Ceausecu has emphasised the necessity of placing man in the centre of all our preoccupations and defining guiding principles for the elaboration of policy projections." (Malitza 1974, p.25.)

But it seems to me that this idea - that man can master the world, control it as he likes, that technology solves all, and that man is the sole object of concern in the first instance - is simple arrogance, materialistic and idolistic arrogance. It leaves no room for true respect and opens the door to manipulation for the ends of man.

<u>25.3.3. John Frame.</u> The W.C.C. project oscillates between optimism and pessimism - probably indicative of its consensus character. While aware of the problems, John Francis, for example, correctly points out that future extrapolations are difficult in that the expansion of the last hundred years was only possible through the discovery and exploitation of petroleum, atomic energy and aluminium. We do not know what the future may yield. But he warns us, quoting the words of the W.C.C. Consultation held in Cardiff in 1972, that: "Any level of <u>use</u> not just increasing use, if sustained long enough, ultimately exhausts conventional resources." [5] He goes on to point

5. In 'Anticipation' Dec. 1972, p.9.

out that economists consider that energy has been, and is, in a condition of high elasticity of supply because it can be produced in diverse ways; because technology seems on the verge of new and more powerful sources (solar and nuclear fission); because distribution can be improved greatly and economies of use can be achieved. Thus given a set of ideal parameters there is hope, but Francis is hardly the naive optimist, for the likelihood of these conditions occurring together seems remote.

25.3.4. The Pessimists. The realisation of crisis has resulted in an anti-science and anti-technology movement which is seen in the strong romantic and pantheistic streams connected to this question (cf. 25.3.4.2.). There are the 'simple earth' types who in one way or another advise a return to the non-technical past, with a few positing structural changes as an escape hatch. This movement generally advocates the breakdown of urbanisation and the creation of small groups based on agricultural economies. (a) The biological determinism of some natural scientists who, absolutizing biology, advise man to return to the simple earth because it holds the key to his origin and existence, often viewing the undisturbed wilderness as the norm with man a foreign intruder. (b) The cult of personality-ideal - the naturalists, nature lovers, conservationist-at-any-price, those concerned to establish an identity with, and dependence on, the natural world. (c) The counter-culture which advocates a radical land ethic. This embodies the misgivings of the (now old) New Left concerning science and technology. The problem is, however, that the ecological platform for this group is often only a facet of a wider and deeper search for meaning and identity - a search where experience dethrones analysis and the East takes over. Conversely, ecological concerns are simply a stick to beat the establishment.

25.3.4.1. R.L.Heilbroner and E.F.Schumacher. Typical of this position of pessimism is R.L.Heilbroner's book 'The Human Prospect'. Here he has moved from earlier optimism to pessimism. Now he asks:

> "There is a question in the air, more sensed than seen, like the invisible approach of a distant storm, a question that I would hesitate to ask aloud did I not believe it existed unvoiced in the minds of many: 'Is there hope for man?'" (1974, p.13.)

Heilbroner gives an analysis of despair seeing the threat to mankind coming from the population explosion, and incidentally deploring the Malthusian solution of checks by famine and disease; from the threat of nuclear war or terrorist blackmail; and from environmental deterioration. He sees, in fact, no hope for man unless a radical change in life-style takes place which would accept a limitation on industrial growth. But despairingly he realises that both capitalist and socialist governments believe in economic growth, "both socio-economic systems are committed to a civilization whose striking aspect is its productive virtuosity." (ibid p.94.) In the end he trails off into mystical, romantic, solutions, unwilling to face the reality of no hope, yet understanding the impossibility of man lifting himself up by his own shoelaces.

One of the most important contributions to this debate has been E.F.Schumacher's book 'Small Is Beautiful'. This is one of the sanest and most practical books on the subject. Nevertheless there is a difficulty in the sentiment of smallness in that it tends to be romantic, a nostalgia for the past. It is quite feasible to write 'Big Is Beautiful' as well. The appeal for a small scale technology is valid - but we need large scale ones also. Water and electricity supplies, the service industries, are obviously better on some nationalised scale - the water crisis of 1976 in some parts of Britain could have been avoided in a national system. Another reservation against Schumacher is that he tends to a vague pantheism. In his appeal for smallness, his concepts of society remain ambiguous, there are no clear societal structures with character and purpose delineated. But in his appeal for a technology with a 'human face' he drives at the heart of our dilemma.

25.3.4.2. Romanticism and Pantheism. The 'simple earth' or 'organic' movement, despite valuable insights, is going the wrong way. Just to move away from money and belief in science, or salvation through technology, is not enough. It is romantic nonsense for nature is neither benevolent nor perfect. Barry Commoner's third law - that nature knows best - is just not true. It would mean the elimination of all doctors and medicine if followed to its logical conclusion! The idea of Thoureau that the salvation of mankind lay in the wilderness is nonsense for mankind can stand only a little wilderness or it perishes.

Equally romantic is the idea that all may be well if we only educate people, or if we could come to regard nature as sacred. In fact societies who regarded nature as sacred have destroyed their natural habitation as Plato (1971, pp.131-3.) records, describing

Attica. Veneration is quite as damaging to the environment as technological prowess. Roszak falls into this romantic approach, hoping that ecology will replace scientific analysis by "a new science in which the object of knowledge will be rather like the poet's beloved; something to be contemplated but not analysed, something that is permitted to retain its mysteries." (1971, p.136.) So he tends to a poetic mysticism - others tend to a more straightforward pantheism.

Richard Means, replying to Lynn White's criticism, postulates a pantheistic solution. But it is a peculiar pantheism. Having quoted Schweitzer's reverence for life, he points up the problem of ethics in relation to ecology by condemning Fletcher's 'Situation Ethics' which has no reference to nature, and Cox who deals almost exclusively with the ethics of the city. So he calls for a return to a pantheistic appreciation of nature, to the need for a moral base <u>vis a vis</u> the environment. But he remarkably dissolves both pantheism and ethics into the pragmatic. "What then is the real moral crisis? It is, I think, a pragmatic problem...."(1970, p.89.) This is philosophical nonsense and Means' answer is no answer, for the ethical cannot be reduced meaningfully to the pragmatic and man live with it. This only serves to highlight the barrenness of his stance which has no firm base, no absolutes. It is no answer because he is using words connotatively, as motive words to a pragmatic end.[6]

Pantheism can never provide a solution to our dilemma or engender real respect for nature - for true respect involves care and control. Pantheism gives no meaning to particulars, for within its philosophy only unity has final meaning. Indeed, those great religions which envisage man as merely part of nature, such as Jainism, Hinduism and Buddhism, tend to be world-renouncing and make little contribution to the world of day to day affairs. (Cf. Guinness 1973, p.208.) Thus while the protest of Western pantheists or mystics may often be justified, it offers no solution, either practically or philosophically to the question of respect for nature. Indeed mysticism often seems to be using the ecological question as a helpful new weapon against rationality. Therefore neither faith in technology, nor reaction against it will solve our problem.

Neither will the romantic solution of men like Koestler, Mishan, A.Huxley and K.Clark, who propose some form of chemical or biological

6. Cf. J.Huxley's 'Religion Without Revelation'.

manipulation of man, be acceptable. This may give an answer to the harmful attitudes that men have - but what would it do to man, qua man? To manipulate man hardly fulfils the respect for man that must surely be an integral part of respect for the environment.

25.3.4.3. The Club of Rome.[7] The thrust behind their thinking is that, while disagreement might remain concerning time-scales, there is a crisis. Whether it is ten years or a thousand, does not alter the need to change our patterns of living. We need to realise that we cannot build paradise on earth - this being the vacuous promise of the religion of political materialism. Three dangerous fallacies need countered: (a) that any nation can ignore the problem, for environmental concern is global; (b) that we can equate pollution and environmental deterioration; and (c) that science and technology can overcome all problems, because already global depletion of resources and destruction of the quality of life-support systems has militated against this.

The three reports show an interesting progression of thought. It used to be generally accepted that the key lay in turning the motivation of people, but this is difficult from humanistic premises for no satisfactory philosophical or religious base can be provided. So while the first report stressed the need for a Copernican turning point in the attitudes of modern man, the second report, more or less, dropped the idea. In the third report a political, and not a religious turning point, is mooted - albeit a political turning point which may 'use' religion.

The first two reports assume that man is blocked by the 'limits' of earth - 'The Limits to Growth' - thus revealing the hidden belief that the earth is too small for man who can expand unlimitedly if allowed to do so. But this is fundamentally to fail to realise the place and role of man on the earth. This primacy of man is borne up in the third report, which sees the problem as one of survival and seeks to design a world-culture. To do this, recognising the highest need of man as religious, it seeks to design an universal humanism compounded of many elements. But Christianity and universal humanism would seem to be uneasy partners in this coalition. The problem is the motive to design, to mould religion to human ends - a most menacing philosophy for many religion that believes in revelation.

7. The three reports are: (1) Meadows et al (1972); (2) Mesarovic & Pestel (1975); and (3) Laszlo (1977).

The report goes on to speak of one world government (cf. Marx and Lenin) where the state will die and man will live according to cybernetic principles. So the solution offered is highly Marxist in principle and in practice calls for a convergence between Marx and the West.

The danger becomes that the problem is buried in statistics and discussion. Statistics, for example, may indicate how well off the affluent nations are, but they cannot reveal the stress, emotional alienation and frustration that is experienced. Talk becomes a substitute for action. The 1976 conference on Habitat organised by the United Nations was carefully steered into academic discussion - not deliberately perhaps, but true. John Francis wryly comments of an earlier U.N. Conference on the Human Environment in 1972, that : "A mountain of print is the sobering aftermath..." (1974, p.23.) Such ventures at least achieve the political success of getting delegates to sit down together, but one fears of 'fiddling while Rome burns'.

25.4. TOWARDS A CHRISTIAN PERSPECTIVE

25.4.1. The Need of a Weltanschauungslehre. There is a general realisation of the need to establish a firm philosophical base from which to tackle this problem.[8] This raises the choice of possible worldviews. As noted, pantheism (or pan-every-thing-ism) is a popular choice, but leaves us in an absurd universe and gives no meaning to the diversity of particulars. It is both theoretically and practically weak, world-renouncing in theory and fostering disease and famine. Further, it offers no rationale to the reality of the Janus-like quality of nature - hostile and benevolent. In pantheism man becomes something impersonal, absorbed into the whole and therefore denied his status as an individual created being. Certainly it must be conceded that Byzantine and pre-Renaissance Christianity were not much better (despite the eulogy of Birch) because of their rather 'heavenly' perspective. But then, neither is the nature-freedom tension of Rousseau or Kant much improvement. It seems to me an answer only begins to become possible in the attitudes and life-stance of the Reformation. Think of the great Dutch painters, like van Eyck, who for the first time began to paint nature as nature; the Puritan earthiness; the rejection of the Platonic dualism of body and soul; the postulation of a non-dialectical motive of creation-fall-redemption.

8. Cf. Blueprint (1972, p.1.); and Montefiori (1971, p.35.)

This is not to say that the Reformation gave a perfect outlook, for we can think of the Black-Stocking Calvinists of the Netherlands who were extremely cruel to animals.

More insidious than the danger of pantheism or Christian aberrations is the philosophy of materialism which so dominates Western society. The materialistic presupposition is that an increasing standard of living must be sought. Now undoubtedly there is a problem here for humanism in that it is not necessarily materialistic in this way. But it has no basis on which to say that materialism is wrong. The problem inherent in this and other approaches is that they are reductionistic of man and nature. The danger of the economic interpretation is that it ignores the spheres of diversity of the being of man as biological, social, aesthetic etc., and indeed the environment-as-commodity mentality that this gives rise to pays little respect to the dictum that certain eco-systems should not be touched (such as marshes). The reduction to one mode (economic) makes for neater analysis, but man is a complex being and the problem of his relationship to the environment is deeper than individual modes - it is essentially a religious relation.

Man cannot be reduced to an aspect of his being, he cannot be reduced to technical man (pragmatism and materialism) or to social man (Marxism). Neither of these faces the problem of death - on my deathbed I am not technical man or social man. Technological innovation or economics cannot deal with the problem of alienation and lonliness - indeed all too often it has furthered such phenomena. So any real solution must be deeper than simply dealing with facets of our being. Certainly there will be economic measures to be taken, policies concerning resources, and the improvement of land use; political measures which will involve democratic establishment of choices of organisation and civil liberties, seeking justice for all; technical measures which will seek to develop energy, and so on. But all of this must be within some overall worldview, some philosophico-religious base. I suggest that the only base capable of coping with all this is the Theistic one - which leaves a large area of discussion.

Within this Christian life-stance certain prevalent assumptions must be quashed. The world does not exist for and through man, but because of its Creator. Man does not have a right to never ending increasing standards of living, this being based on a false equation of happiness and material well-being. Also, technology will be seen in a balanced way as being potentially a blessing and potentially a curse, depending on the religious direction of its motivation.

Many have contended that the biblical approach to the environment will not do (cf. Passmore, White, and Allaby (1972, p.36.)), but it is precisely my contention that only it will do, and that the future can only be faced in continuity with the revelation of God. The biblical position does not mean that we will have instant solutions, but it does mean that we have a perspective, a framework that can contain them and point in the direction of substantial healing. In this context I would point out that this life-stance is not at heart theological, but rather a cosmoscope (cf. Hart 1970), a perspective which governs all of life in the realisation that the cosmos is not man's but God's. Man is viceroy on earth, the created subject. But he is not, despite being made lord over creation, thus God. God alone is God. A cosmoscope is not a theology (that would be reductionistic); it is not tied to church life; it denies any separation of nature and grace; and involves total obedience or disobedience of man before God.

This turns on a correct perspective of creation - not redemption. A correct view of creation is singularly lacking in humanism.
(a) The humanist sees man as different because he has evolved some higher faculty of mind and is therefore conscious of reality and able to control it through the tools and techniques of technology. So he adopts a 'problem-solver' approach, that by the development of new technology man can become as God, both omniscient and omnipotent, knowing and controlling all (cf. President Johnson's words on signing the Water Quality Act of 1965: "Today we proclaim our refusal to be strangled by the wastes of civilisation. Today we begin to be master of our environment." (In Ribbens 1976, p.19.)). Or, (b) the humanist can advocate an abdication of control, to live ideally like the animals close to the earth. An outlook reflected in much of the recent appeals for communal, self-sustained rural living. But people are people as God made them and not as they would like to consider themselves; they are rational, emotional, aesthetic and biological beings who with their God-given aspirations and creativity cannot live consistently at either of these two poles of humanism. Man needs to affirm the world, yet fulfil his transcending nature.

We need a biblical view of history that realises that man does not speak the first or last word, that man does not give final meaning to history, that man is not self-sufficient or autonomous. We need a light from outside, shining into our darkness, and Christ is that Light. In this historical perspective there must be no positing of man-as-nature over against man-as-history. This is often done by theologians who stress the historical aspect of salvation but squeeze out the creational ordinances which firmly root man in creation as part of nature. There must be no spiritual-historical/natural dichotomy. We need a unified motive (cf. 24.2.2.1.).

This view of creation rejects the scholastic view of life as some sort of static whole; nor does it seek to negate socio-economic life by means of a higher realm of grace. The emphasis for man's life in creation as a socio-economic being flows from a stress on man's vocation. (Cf. Goudzwaard 1975/a, p.11f.) Man has a creational calling before God such that all of life is under His creational Lordship. God is over all and therefore socio-economic life is not sinful but rather governed by the idea of stewardship.

<u>25.4.2. Reality Is Relational.</u> (Cf. Sittler 1976, p.15f.) We are driven back to the fundamental question of reality. Reality can only be understood in relations, in an ontology of community, communion and ecology, and not via entitive things. The fundamental relationship whereby all things hang together is with their Creator. If I remember correctly it was Calvin who stated that God was the fountain of all livingness. But care is needed for I am not positing Commoner's first law -- that everything is connected to everything else. This is not true, and if it were would be meaningless (like the dictum to expect the unexpected). Nevertheless we must begin to realise that there exists an interwovenness in reality, that nothing exists in and of itself, but through, before and to God. No milieu exists without positioning.

The Theistic view of nature and man's life therein must originate from a creational understanding which realises that nature is of value as nature apart from man because it is created by God who saw that it was 'very good'. Creationally, man and the rest of creation stand as equals in their origin before the infinite creative power of God. There is one humanity (as created) separated from nature by being the image-bearers of God; yet one with it as creature before the Creator. In this context, reality is relational, demanding that we see it in a way appropriate to its created structure, seeing all things in terms of regard and spiritual honouring. When Jesus calls us 'to behold'

(Mt. 6;26-28.) He invites us to stand in the midst of His creation with a reverence for it; He certainly does not invite us to arrogantly walk through the world with disdain for the non-self. We are called to appreciate the interwovenness of reality; to have a firm understanding of things as they exist individually. Man is to enjoy the 'thingliness' of things. So we need an ontology of relations which will yield a looking/beholding in relations, and in turn yield a thinking-in-relations. Only in thinking this way can we avoid a spiritual-material dichotomy. If we do not achieve such a relational doctrine of creation it seems to me we end up with a reduction, or perversion, of the doctrine of redemption - for salvation affects the whole of creation, including socio-economic structures.

As I stand before a tree I need to feel relationally toward it, both intellectually and psychologically. There is little practical value in a theoretical assent that it too is part of creation if I do not feel toward it, experience that it, like me, is created. We desparately need to overcome what Simone Weil called the 'de-createdness' of our modern world, and it seems to me that by such creational relatedness we can begin to do so. There is a value in all things around, not because they have autonomous value, but because they are made by God. This does not mean that I cannot cut down trees if I need firewood or timber for a fence - we must not become romantic for the tree is relationally there to serve man <u>when he needs it</u>. But we must respect the tree for what it is. Make it autonomous and we destroy it and ourselves.

<u>25.4.3. What Is Dominion?</u>

<u>25.4.3.1. Dominion Is Creational.</u> The creational mandate of Genesis 1;28 has a threefold direction for man: (a) to be fruitful and multiply; (b) to have dominion over the earth; and (c) to replenish the earth. It is in the omission of (c) that the false conception of dominion as exploitation has arisen. Man's dominion is ever under God's dominion and under God's domain. Because of the Fall, man has used his dominion wrongly, and thought of it wrongly, by exploiting the earth and seeing himself as the integration point of meaning. But creational dominion does not mean that we crush every ant we come across; it means that we step over the ant when we meet it on the pavement outside, but also that we have a right to rid our house of them because they have no place there. Similarly, a right respect for our environment will mean that while it is permissible to hunt

animals for food, it is wrong to do so for pleasure. The plant and the animal are not zero before man, but have value.

Dominion means to fill and rule, to eat the fruit, keep and cultivate the earth. In regarding it as this it seems to me necessary to reject the idea of Tielhard de Chardin that human technique contributes to incarnation and redemption. Ellul has devastated this, but in turn unhelpfully sees the Fall as from unity into multiplicity, from freedom into necessity. Dominion means, rather, reception and enjoyment of the diversity of creation as created. But it is secondary dominion, our rule comes after, our activity to subdue is derivative, it is the completion of a task. In Genesis 1:28 the Hebrew (kabash) gives the idea of development, of an effort, not play, the performance of a service responsibly before God. This dominion is also to be characterised by rest, not just for man but for creation. Here surely is a valid principle for our over-worked and groaning environment. It too needs a day of rest, a principle standing in contrast to the Marxian lack of a Sabbath!

The biblical motive, then, is one of preservation and building up. Preservation alone is not enough for such action is romantic and a choice for natural disaster and fate. Building alone is not enough for this, the way of Marxism and Pragmatism, is a choice that leads to cultural upheaval. This call to work and have dominion is only truly fulfilled relationally and respectfully within this motive to disclose creation's potential. To do this man uses technology to honour God and care for his neighbour. Technology is not something anathema, but that which relieves the fallen state of nature, it reduces drudgery and the physical burden of work, it helps cure disease. Thus in its diversity of applications, technology can work towards the redemption of creation marred by the Fall. No doubt it also poses a threat but technology in biblical perspective has no unequivocably evil character.

Man's dominion is to be exercised in responsible stewardship (cf. 24.2.3.); he has to listen to the Master to whom he is responsible, for creation is not his to dispense with as he pleases. Disrespect comes from thinking it is ours and that we can do what we like with it -- but when we realise it is not ours, but anothers, to whom we will have to answer for our use of it, then respect begins to flow from this calling and sense of duty. The earth is not too small for man; we are not to subdue it endlessly (cf. replenish). Our responsibility to care for the earth means primarily to give life-possibility to man, animal and plant, and only then secondarily to seek our own economic ends. We are to replenish the earth which means to fill it to a certain level, not to fill it to its limits of capacity.

<u>25.4.3.2. Dominion Is Fallen.</u> As the above already shows the ideal of the cultural mandate was warped at the Fall and the Bible in no way glosses over the dark side of life. There is disease and disharmony, in man and nature - think of the devastation of trees by the gipsy moth - and the Bible offers no easy romantic solutions. Man is confronted by thorns and thistles; he will have to sweat for a return from the earth. It is equally clear that the earth's troubles are man's fault - and who today would deny that nature groans because of man. Nevertheless this groaning is not hopeless for the Bible sees it in the context of hope, of childbirth (cf. Rom. 8;22f.).

After the Fall there is no absolute break from the creational ordinances. Man still lives by the fruit of the earth - although he remains unsatisfied when the 'tree of life' is missing; he still carries through the mandate to subdue the earth as his technology wonderfully reveals, though this too is a mixed blessing. Again, work is not to dominate life entirely, although clearly in biblical perspective man was made to work and does not work to live. Man subdues creation, increases what he has, what he can do, what he knows; he enjoys more fruits and masters more forces, but at the same time increases his covetousness and lust. In a fallen world all is mixed as blessing and curse.

There are certain biblical principles worth noting. Every man serves god(s) in his life of some form or another (Augustine's law of concentration of the heart); men need some integration point, therefore they either seek rest and fulfilment in God, in creation, or in themselves. Secondly, every man is transformed and driven by the image of his god, for it is axiomatic that any idol, however relative, be absolutized and worshipped - such as technic, science and organisation. Thirdly, we realise that mankind creates and forms a structure of society in its own image, not God's.

<u>25.4.3.3. Dominion Is Redeemed.</u> Creation - Fall - and now redemption through Jesus Christ. Christ alone restores lost harmony to creation, the ability to govern the earth and the sacred rest. His grace takes up nature and holds out perfection to it, not destruction. It was not Karl Rahner, Schillebeeckz, Metz, Moltmann or Birch, but Aquinas

who said "gratia non tollet naturam sed perficit" - grace does not destroy but perfects nature, and here both Luther and Calvin quote him with approval. However, within redemption there is for the present no total healing of the curse of the Fall. I find at this point a concept of Schaeffer helpful - there is substantial healing now with respect to the separateness of man from man, man from himself, and man from nature. Healing in reality but not perfect restoration. This healing will begin to flow dynamically in the lives of men when they realise in a new way their calling to have dominion of a nature that is held in trust from God.

The response of the Christian is not some romantic longing for the past, or some anti-technological aspiration. Within the scheme of redemption technology has its part and is used as a symbol of salvation in the ark (cf. temple and tabernacle). But technology for its own sake, or economic ends, becomes a curse. It was technology for its own sake that led Oppenheimer to become enthusiastic over the H-bomb. The problem of humanism is that "man with his greed has no real reason not to rape nature, and treat it as a reverse 'consumer object'" (Schaeffer 1970, p.67.) But in the realisation of our creational mandate, Schaeffer can write:

> "When we have learnt this - the Christian view of nature - then there can be a real ecology; beauty will flow; psychological freedom will come, and the world will cease being turned into a desert. Because it is right, on the basis of the whole Christian system - which is strong enough to stand it all, because it is true - as I stand, as a creature, and face the buttercup, I say, 'Fellow-creature, fellow-creature, I won't walk on you. We are both creatures together.'" (ibid pp.68-9.)

The danger facing the cultural mandate, and to which it has succumbed in the past, is the secularisation of its motive; the reduction to an unlocking of creation per se, instead of a realisation of a calling to unlock creation in a God-ward direction.

Basic to our dilemma is the ethical failure of man, his short-sighted approach, his greed. But the realisation of this and pragmatic solutions will not help. We need an ethic of the environment that will stand as an ethic and not as a pragmatic manipulation for the end of survival. We must firmly reject Means' pragmatic ethic for it is precisely an ethic subject to socio-economic action and therefore places goods above people. Without exalting man we need to realise that the problems of political will, of economics and technology are human problems, and therefore need to be approached as if people mattered, respecting the rights of individuals and their ethical responsibilities.

We need to develop an ethic of the land which respects nature in itself and not merely as subservient to man; to begin to realise that to care for the environment may often mean simply leaving it alone. We need an ecological ethic that will restore the importance of the biophysical world in human affairs and stress the interrelatedness of existence. We need to overthrow the false gods of individualism/collectivism, economic self-interest and fragmented learning and realise that we stand in the wholeness of our beings as individuals and groups before God.

25.5. PRELIMINARY CONCLUSIONS

The dilemma is seen in the general theoretical acceptance of a crisis and the almost blanket failure to do anything in practice. The challenge is daunting: stewardship that is responsible and fairness between nations. The challenge is global: "The world is our constituency" declared Pierre Troudeau. The problem is not pollution or technology per se, but the high levels of consumption engendered by materialistic values. Here is where a diminuation is required -- in consumption and therefore in production. We need to decrease the tempo of development in order that we may reflect on what we are doing, to take stock of what we ought to do. No area of technology is necessarily wrong, but it may be in the path it pursues.

In a practical way, what can be done? Pollution control often merely shifts the problem; pesticides cannot be controlled except by using less. The Blueprint (1972, p.15.), for example, suggests a premium on durability and a penalty on disposability, the promotion of the smallholding and the upbuilding of real communities. But the question remains as to the feasibility of this in current trends.

Society, as it exists, is quite simply not sustainable. Life is threatened in terms of quality and survival. The new awareness of what Commoner has called the 'no-free-land' theory points to the simple fact that all productive activity by man in some way drains environmental resources. All activity, not only has an economic cost, but ecological costs as well as spiritual and aesthetic. In this situation many now see the goal of mankind being not growth, but survival, an overcoming of the now decreasing standard of life (globally) in terms of the disutilities of environmental deterioration;

while at the same time striving to give an equal standard to all. Against this aim must be set the philosophical inadequacy it possesses, as well as the political reality where nations still regard themselves as in individual life-boats rather than as part of one world. In fact, as Parmar (1974) recounts, the third world is averse to the globalisation of Western crisis of the environment as it is often done at the expense of the crisis of the developing nations which is, as far as they are concerned, social and not environmental. Parmar argues, rightly, that the root cause of the environmental problem lies in the production patterns and consumption of the affluent. There is simply not "enough resources to support more than one USA." (ibid p.20.) But the problem then is that the developing nations are even here trying to emulate the material values of the West. So we come full circle and the consumption-production spiral of the affluent is also the problem of the developing nations.

What is required is agreed to be the creation of a stable, sustainable society. Stability does not necessitate stagnation. But such a sustainable society will be impossible apart from new life-patterns; equal distribution of scarce supplies; corporate social decisions and a need for supply that can be matched by resources. Intermediate technology will be based consciously on the basic needs of people -- food, shelter, health and education; on local resources at present ignored; and aiming at the integration of man and nature.

To achieve this we read of several avenues posited. (i) A policy of zero economic growth - which would involve a cut in production with increasing unemployment, leading inevitably to a deflationary cycle. Therefore such a policy would hit the lower income brackets, the unskilled, and increase the poverty of the already poor. (ii) Government redistribution of economic surplus. While much discussed this fails to deal with the critical problem of production and consumption. (iii) The corporate redistribution of economic surplus. Here firms, in theory, become aware of ecological problems and reinvest some percentage of profits to cleaning up the mess they make. Again this is weak in tackling the problem of resources and pollution, and will lead in any case to the continuing disparity of wealth between rich and poor nations. These suggestions provide temporary relief to specific problems while leaving the basic problem untouched. At the same time they yield new problems.

Are we therefore reduced to living with the system as it is, or accept unemployment? J.A.Olthius (1974) suggests that any solution must involve the following: (a) the conservation of resources; (b) the reduction of pollution levels; (c) a low level of unemployment; (d) consumption patterns that are orientated to quality and not simply quantity; (e) a growth of quality values in terms of marriage, family life, political responsibility, artistic appreciation etc.; (f) a more equal distribution of wealth, while recognising that it can never be totally equal. Solution (i) above meets criteria (a) and (b), part (d) and (e), but not (c) or (f). Solution (ii) tends to meet only (c) and (f); while solution (iii) meets only (c) and part (f). Olthius argues that what is needed is not increase or decrease, but a <u>shift</u> in demand patterns. An aggregate shift, say from colour televisions to paintings, would lead to the conservation of resources, reduction in pollution, low level unemployment, consumption orientated to quality and a more equitable distribution of income.

Socio-economic life is itself a confession, a religious confession of what we believe in. Our beliefs are revealed in our style of consumption, our attitude to work, every bit as much as in our spoken allegiances. It is evident that a conversion is needed in our life-style and attitudes to life. Even if the task seems politically impossible we are individually called before God to be responsible for our creational calling. Therefore while every society should be concerned for a just and responsible society, for the quality of life, for community and the spiritual basis of man's existence - it will only be so as individuals are thus concerned. It is not a question that I as an individual can avoid. We have not yet as a world community made an irrevocable choice for the gods of materialism and technic, and it is incumbent for each to show forth in their lives a true and proper perspective, a real respect for the environment in the little things of life.

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CHAPTER 26

TECHNICS : MAN'S POWER - MAN'S POWERLESSNESS

26.1. THE IMPORTANCE OF TECHNICS [1]

There can be little doubt that one of the dominant facets of life today is the technological achievements of man. Any attempt to understand man, his life-style and attitudes, must therefore grapple with the problems and benefits of modern technics or it will have abandoned a major tract of life. This chapter seeks to introduce the impact and the implications of the powers that man has developed from the impetus of science, and which play a crucial formative role on man and society; and the resulting powerlessness of man before these powers. It is impossible to understand man today apart from the problem of technics and as Mumford writes: "No organic view of man can ignore the weight and significance of man's technics." (1973, p.5.) Yet while technics is of paramount importance in understanding our modern world little has been done in this direction by theologians. It has to be stated that most of the valuable analysis here comes from outwith the theological field - from writers such as Marcuse, Henry, Drucker, Toffler, Mishan, Mumford, McLuhan, Koestler, Ellul, van Riessen, Schuurman and many others.

26.2. THE HISTORICAL BACKGROUND

Mumford (1947) outlines three distinct periods of technological-industrial structure: the eotechnic period (medieval) which survived down to the middle 18th, early 19th, century; the paleotechnic period (the industrial revolution) from which we have not yet fully emerged, and which saw the establishment of the machine age and the enslavement of man to his technologies and gadgets; today we have entered the period of neotechnic.

26.2.1. The Paleotechnic Period. The Industrial Revolution occurred within the line of Christian thinking developing from the 16th century onwards and epitomised in Calvinistic and Puritan thought. It was essentially Reformation presuppositions that exercised a scientific and cultural influence on society as a whole and sponsored

1. I prefer 'technics' rather than technology as it is wider in meaning and not as conceptually limiting - cf. Barzun's 'techne', from the Greek for art, skill, regular method of making, craft and cunning, as well as the work of art, skill, etc.; and Ellul's 'technique'.

progress (cf. 3.1.2; 3.3; 3.5; 6.1; and 6.2.).

Calvin and his followers, despite contemporary mythology, saw nothing inherently evil in the world from which man should seek cleansing - rather, holding to the doctrine of the sovereignty of God and His rule over creation, they saw the world as open for man to exploit the possibilities of his environment, without abuse. Thus the old ideal of withdrawal and asceticism was negated in favour of entry into the world and enjoyment of the creation that God had provided for man. In the early stages of this period, private and business affairs were governed by the same ethical code based on the individual's personal accountability before God. Behind this ethical base was the Reformation stress on the doctrine of the calling of all men to serve God in their daily life which endowed ordinary occupations with Christian dignity.

Turning swiftly to the pre-Depression scene of the 1930's we find a picture where labour was still numerous, the mood of workers largely irrelevant and managerial staffs relatively small. The prime factor had become the product as seen from the technological aspect. "The problem of marketing the product, perhaps even its meaning, receded into the psychological background before the hardness of the material - the obduracy of the technical tasks themselves." (Riesman 1969, p.112.) Work was seen in terms of physical objects and ideas - people *qua* people slipped out of the picture.

The Depression changed the industrial scene. This is readily seen in the simple fact that the chief economic goal altered from achieving more leisure to seeking the ideal of full employment. An ideal reiterated in more recent times in 'right-to-work' protests. But in this shift it was perhaps inevitable that work as an activity of man should degenerate. No longer was work seen as something man lived to do, but rather as something he had to do to live. Consequently work became exposed to the tyranny and domination of the three powers that stand over against man's freedom - the powers of organisation, technics and science. [2] Today these powers are greater and of different character than in any previous age. Man

2. Van Riessen's thesis states that man as he has developed his powers of science, technics and organisation has idolised them by making that which is relative absolute. The thesis is found in many of his writings - though I am familiar with it through his lectures and discussions I have had with him.

has never lived in isolation from some form of organisation and technic, but our century has seen the development of them, based on autonomous philosophies, leading to the 'autonomy' of these powers in and of themselves.

26.2.2. The Neotechnic Period. The third phase of industrial development is recognised as a distinct step. It is variously called the 'super-industrial revolution' (Toffler - 1973); the 'knowledge revolution' (Drucker - 1969); the age of automatism and cybernetics (E.L.H.Taylor - 1970); and 'technopolitan' (Cox - 1967). The critical factor is that this third phase of the technological advance has arrived at a time when Western man has not yet learned to cope with the pressures and tensions of the industrial revolution. He is therefore ill-prepared to face the effects of yet another reorientation in his basic life-style/structures and this has led to a state of heightening crisis.

26.3. THE THREE POWERS OF INDUSTRIAL SOCIETY - THE VAN RIESSEN THESIS

26.3.1. Introduction: Science, Technics, Organisation. Man's ability to face crisis has been attenuated by the confluence in the 20th century of the three human powers mentioned above. We have already looked at science, the first of these powers, in some detail. The power of science is crucial for it is the driving force behind technics and organisation. As Harold Wilson could say during the 1964 election: "If there is one word I would use to identify modern socialism it is 'science'." (In Rose & Rose 1971, p.93.) The second power is the advent of modern technics from the 19th century; and the third the creation of large organisations in the 20th century. These three powers converge in our day with the modern revolution (neotechnic) and intensify man's struggle for significance. Man's powers are of a unique character today and thus assume new importance and meaning for they actualise man's freedom in a sequence of new things and events which constitutes the essence of history. Modern technics, in the widest sense, mediates the other two powers that stand over against man's freedom.

Within the context of this study the problem of technics vis a vis Christian theology will be treated as revolving essentially around the dialectic that has arisen between the power and impotence of man. This theme undergirds the approach of many thinkers to the question of man in modern society.[3] Man is apparently caught in a dialectic of freedom and power - freedom to live his own life and yet caught in the powers that constitute his man-made environment. Never has he been so free - never so enslaved. Behind this dialectic lies the philosophical-theological question of the driving worldview of our age.

Modern critiques vary from the optimistic humanism of Toffler and the metaphysical hopefulness of Cox and Mumford to the deep rooted pessimism of Marcuse (one dimensional man), Ellul (man dominated by 'la technique'), and Henry (culture against man). The first three tend to see technics as cathartic while the others see it as crisis. I partially accept the latter position without accepting the accompanying unsolvable dialectic to which these writers tend. Crisis undoubtedly forms the major bulk of interpretation and it is worth noting that Toffer and Cox exhibit paradoxes within their work between pessimism and optimism. Both strive to present an optimistic view of man in modern society which is often in tension with their data. Time and again Toffler builds up data which is indicative of crisis - technology is seen as a runaway train with no one in the cab - only to jump to unwarranted optimistic conclusions. He sees change leading to 'future shock', breaking up the patterns of life and creating a society where man is no longer in control, and then blandly pronounces that we can "Humanize distant tomorrows." (1973, p.440)

3. Cf. Fromm (1971): "Yet modern man feels uneasy and more and more bewildered. He works and strives, but he is dimly aware of a sense of futility with regard to his activities. While his power over matter grows, he feels powerless in his individual life and in society." (p.4.) Towards the conclusion of this work he writes: "We consciously believe in man's power and dignity, but - often unconsciously - we also believe in man's - and particuarly our own - powerlessness and badness...." (p.212.) Mumford (1973) sees man slipping "Helplessly back from freedom to automatism..." (p.16.) Silberman comments: "Yet contemporary technology has contributed to a pervasive sense of helplessness and impending doom at the same time that it has evoked expectations of nirvana." (1970, p.20.) Jules Henry in his excellent study 'Culture Against Man' (1972) (an expressive title) concludes that man is caught between two cultures - the culture of death and the culture of life (pp.382ff.) Or finally as Marcuse puts it: "A comfortable, smooth, reasonable, democratic unfreedom prevails in advanced industrial civilisation, a token of technical progress." (1972, p.16.)

Before continuing a caveat is necessary: one of the basic weaknesses of many modern critiques is their tendency to subsume all facets of life under one heading. Thus Riesman (1969) tries to analyze all in terms of inner and other directed people; Toffler (1973) sees the concept of accelerating change leading to future shock as the key; while Ellul (1964), who is otherwise penetratingly accurate, is caught in his categories of technique. A consequence is that these writers tend to grant autonomy to their categories of interpretation. Ellul, however, is one of today's most influential commentators despite having written 'La Technique' in 1954 (in this study his 1964). He and Marcuse present the classic example of the dialectic of freedom and power.

Typical of the character of the three human powers - science, technics and organisation - is that they take on an objectified form that is relatively independent of man. This independence is significant for it means deliverance from the limitations of man concerning skill, judgement and quantity of work. Van Riessen writes:

> "The trait of the new human powers is that they work independently of man and that is why man is so powerful. Man is so powerful today because in these powers he has created he has surpassed his limitations. This can be seen best in technic. My energy is not so great but that is not important because now we use natural energy. My craftsmanship is not so good that it can make something very smooth with a tool in my hand, but I can make a machine that can make things very smooth. I can count in my head, but a computer can calculate something I could not perform in a lifetime. So you see by making these tools independent we are able to perform tremendous things which we could never have done on our own, or with tools dependent on us. That is why we are so powerful.
>
> That is one side - we are powerful as never before. Yet we are so powerful we are also, in experience, very powerless - we are bound by all these powers. We are caught in them and are no more free." (undated/b, p.2.)

Elsewhere he has noted that: "Science changes technics into modern technics and organisation into modern organisation." (1973/c, p.52.)

Science is the power behind the throne. The other powers derive from, and are dependent on, science with its method of abstraction and anlysis which cuts up and separates reality, thus distancing man from the object. This abstraction leads to a loss of importance for man and only his theories remain. The centrality of science is evidenced by the role of the scientific community in our culture which is still (despite a swing to the humanities and a new awareness of scientific accountability to society (cf. Goodfield 1977, ch.8.)) the 'cultural maximizer' of our society (Henry 1972, p.36.). They are the ones, the scientists and engineers, on whom we depend; they are the ones who make, create and change our lives and environment.

26.3.2. Technics. Within this broad setting Marcuse (1972) develops his idea of man's one dimensionality today in thought and behaviour. He sees 'technological rationality' leading to the ascendance of technics over man's freedom and causing the integration of opposites, the decline of pluralism, and the paralysis of criticism. This assumption of technical autonomy is on the one hand quite rational, yet "its sweeping rationality....is itself irrational." (ibid p.12.) Both Marcuse and Ellul note that science dominates the technic mentality of our age.

Technics must be seen to include technology but as wider than it - there is technique in politics, education, economics etc.. The best analysis of this seems to me that of Ellul where we are told that in effect 'technique' refers to any "complex of standardised means for attaining predetermined results." (E.L.H.Taylor 1970, p.124.) Technics have become nothing more than means and the ensemble of means, and as such are indifferent to all traditional human ends and values by becoming ends in themselves. "Technique is the totality of methods rationally arrived at and having absolute efficiency in every field of human activity." (Ellul 1964, p.xxv.)

26.3.2.1. Ellul: Five Features of 'Technique'. Ellul sees the basic features of technique as follows (ibid pp.78-147.):

(i)The association of technology with rationalism where technique becomes the quest by man to solve the complexities of life by reason alone. Os Guinness writes: "Technique is the calculus of efficiency, the reduction of facts, figures and even men to procedures in the service of the tyranny of objective rationalism." (1973, p.133.)

(ii) The aspect of artificiality where the point is reached where the natural environment is replaced by the technological. We are increasingly made to live in an unreal, synthesised world, where even the flowers on our table are liable to be plastic. The recent Strathclyde Park Development programme went to great economic and technological lengths to make the countryside 'natural'.

(iii) Automatism: the search for the one best way which when found becomes self-directing. If I remember aright both Mumford and Fromm declare that 'one ought to do whatever it is technically possible to do.' When R.Oppenheimer heard how Ulam and Teller had disposed of tritium and the complicated refrigeration equipment needed to keep it cold and turned to a solid, stable compound of lithium and deuterium, he commented: "That's it! Sweet and lovely and beautiful." The new bomb could destroy every unprotected man and woman within a radius of two miles and he thought it 'sweet', 'lovely', 'beautiful'. (Cf. de Ropp 1972, p.51.)

(iv) The self-augmentation of technique means that any one technique eats up more and more to itself, leaving less and less that has not been directly influenced by the all-pervasiveness of technique. Technology feeds on itself and makes way for even more technology, and all the time it is conditioning man to follow its dictates. "Technology not only transforms the exterior world. It also greatly modifies the way we think." (Cox 1968, p.276.) But even worse than modifying the way we think, technique often denies the luxury of thought. What place has thought when the sequence is preset? (Cf. Ellul 1964, p.395.)

(v) A last feature is monism. Here Ellul pictures technique as an irreversible force rolling its autonomous way over man with man totally impotent before it. He and Marcuse conclude that technique cannot be otherwise than totalitarian (cf. ibid p.125.) Marcuse notes that "the neutrality of technology can no longer be maintained." (1972, p.14.)

26.3.2.2. Implications for Man's Work. These characteristics of technic mean that there is a devastating impact on man and his work. Accepting the primacy of technic means following attributes such as: human relations must be kept within the technical demands of the job - there must be no interpenetration of personal feelings or emotions into the industrial field; human relations must be universal, based on criteria which any arbitrary grouping of the population can satisfy independently of any prior social or group relations unconnected with the work in hand; a third characteristic is rationality, operating to the exclusion of any possible emotional or sentimental disturbance of the mechanical technique; and finally relations must be impersonal, based on the question of optimum validity and not on any subjective choice. The primacy of technic demands these as requisite characteristics in work.

This crisis is heightened when man seeks to identify himself by his work. Henry writes: "Most American workers have learned to put the constantly rising standard of living in place of progressive self-realization." (1972, p.41.) The new power of technics is therefore seen to be an autonomous threat which opposes man's true manishness, its threat existing in the very autonomy man has given it. "Technics," writes Brunner, "has been cut free from the moral and religious context of human life and has become autonomous because its deepest desire was the desire for autonomy on the part of man." (1948, p.11.) Thus we are brought full circle back to the association of this power with rationalism (cf. 26.3.2.1. (i)).

To stay for a moment with work - it is often argued that man has advanced by virtue of his technics and become more skillful than his predecessors. But in what way is he more skillful? Cox, for instance, argues that the advent of cybernetics or automation leads directly to fewer jobs, higher skills, and an adequate productivity level that will banish poverty. But it can be argued that automation has an economic viability in only a limited range of industries and is generally too expensive for smaller firms. With regards to skill there is a loss of applied craft skill. This is not to say people are not skilled, but often work requirements are not for these skills. (Cf. Drucker 1969, Pt.IV.) And without practice skills atrophy. Craft skills have been replaced by mechanical procedures, while in a limited area craft skills over materials have been replaced by manipulative ones over people. But is the ability to manipulate people to be looked on as a progress of skill from a work/technical point of view? To rise in one's profession today is to be forced to abandon it. This is seen in many fields where the professionally skilled man becomes a mere administrator - note the plight of many headmasters. This dilemma is highlighted by the story of an engineer who is offered the more lucrative post of sales-manager.

> "The man loves engineering, but his wife won't let him turn down the promotion. His sponsor in the organisation tells him it is now or never: does he want to be wearing a green eyeshade all his life? He reluctantly accepts. That night he has a dream. He has a slide-rule in his hands, and he suddenly realises that he does not know how to use it. He wakes in panic. The dream clearly symbolises his feeling of impotence in a new job where he is alienated from his craft." (Riesman 1969, p.130.)

The very advancement of technology robs man of his traditional skill. The machine and the organisation now replaces the skill he once possessed - "the industrial process advances by building into machines and into smooth-flowing organisations the skills that were once built by a long process of apprenticeship and character-formation into men." (ibid p.131.) Man becomes an extension of the machine, a machine-hand and a dial-watcher instead of a craftsman.

<u>26.3.3. Organisation.</u> One of the basic manifestations of science and technics today is the organisation. We live in an age of nationalised industries and international companies where the sheer size of enterprise becomes staggering. Thus Marcuse pictures men as "sublimated slaves" at the mercy of any developed industrial civilisation.

> "....the decisions over life and death, over personal and national security are made at places over which the individuals have no control....the surrender of thought, hope and fear to the powers that be." (1972, p.40.)

Man, seeking to flee the dehumanising process of this modern life, "tumbles into the snares of dreams, he tries to comply - and falls into the life of organisations." (Ellul 1964, p.321.) At work he is reduced to a cog in the machine, easily replaceable and quite expendable, for with increasing size of business concern there proceeds apace the loss of the individual's control on his place and function within the organisation. Popper (1973/b, Vol.II p.114.) even remarks that it is wrong to blame the capitalist or bourgeois for the direction they take as they are simply caught in the autonomous system which controls them.

Cox contends that the advent of bureaucracy has led to the 'Organisation Man' who is here to stay of necessity. He sees the organisation as flexible, future-orientated, secularised, exercising limited claims on its members and free from the religious overtones that marked (and marred?) the Reformation period. (Cf. 1967, p.182f.) But despite this hopefulness, Cox recognises the dangers this brings; there are tresspass points where the organisation invades realms that are not its concern (cf. ibid p.178.). But the basic problem he sees is the increasing impersonality of power that the system displays. "The danger of this technological logic is that responsibility tends to be diffused so that no one feels personally responsible for what is happening. There is no one to blame or praise." (1968, p.276.) Men are no longer in control and the power that directs the affairs of men in their daily vocation has become faceless and unknowable.

In this connection E.L.H.Taylor (1970, p.131.) criticises the mania for the implementation of time and motion studies. The price, he claims, for such 'scientific' forms of work is too high, and alternative methods must be sought. The worker is caught between the jaws of increasing efficiency and remaining truly human; caught between being a free and responsible person or a cog in the machinery of Kafka's 'Castle'. Van Riessen, writing as an engineer and philosopher, comments:

> "The price for scientific organisation, whenever consistently applied, is the freedom of man in labour, his personal responsibility, the appeal to initiative, to decision, to effort, to skill, and everything over which man disposes in the scope of his freedom." (1953, p.145.)

The price of modern technical progress in the organisation can therefore lead to the devaluing of the demands of work, the dehumanising of the worker, and the dissipation of the individual into the annonymous mass man.

<u>26.3.3.1. The Law of Working Efficiency.</u> This spells death to the small firm. This law decrees that there must be increasing size, mergers, nationalisation, and international companies - features that mean the end of the family firm. The corner shop cannot compete with the supermarket, or the supermarket with the hyperstore. Increasing size of workforce inevitably means that the individual has a smaller and smaller role to play within the production unit. No longer does he see the final result of his labour, the fruits of which are not shared by his fellow-workers but by the enterprise that hires him. While some see this depersonalisation of work as desirable (cf. Riesman) it must be unequivocably rejected by any Christian approach which stands against a reduction of the individual's personality in any area of life. Work in the Christian view is not something 'done to live' but that which 'man was created to do.'

The governing feature of modern industry is the primacy of production, and the basic unit of production is no longer the individual but three shifts. Man becomes annonymous, a number to clock in and out, a commodity, and it is just this aspect that can easily lead to labour-management conflict. As Juenger wrote:

> "The worker loses his identity; as a person he loses his individuality; he is only noticeable as the performer of a function. As a human figure he fades out; and from the point of view of technical progress it would be desirable if he faded out altogether." (1949, p.75.)

<u>26.3.3.2. The Laws of Production (Henry).</u> Man fades out and production holds the field with its own irrational rationality, its

own laws and commandments. Henry (1972, pp.26f.) suggests the first two laws of production are 'Create more desire', and 'Thou shalt consume'; and in a brilliant exposure of the advertising industry shows just how true these are in our daily lives. This has inevitably involved a psychic revolution in the lives of the consumer who is, after all, only the worker in another role. There is the deliberate creation of needs within people that demands the unhinging of the "old impulse controls" - the freeing of the id to eat up the ego - which leads to a restoration of psychic balance at a new level satisfactory to the commandments of desire and consumption. Man cannot escape - whether as worker or consumer - he simply becomes an economic factor in the system at the mercy of self-augmenting technic. "For the proletariat, as for the bourgeoisie, man is only a machine for production and consumption." (Ellul 1964, p.221.)

In the midst of this perhaps the most frightening aspect is the way in which our children are schooled to accept this state of affairs. Toffler, Riesman and Henry all point this feature out, with Henry's indictment by far the strongest. Children under the pecuniary philosophy of our age are trained to "insatiable consumption" and "impulsive choice", and he goes on to remark satirically:

> "What should businessmen do, sit in their offices and dream, while millions of product-ignorant children go uninstructed? This would be an abdication of responsibility. Besides, the businessman might go bankrupt." (1972, p.68.)

26.4. TECHNIC INDUCED CRISIS

It is the contention of this study that we will only be able to arrive at a proper understanding of science, technics and organisation, and their relationship to faith, when we see man in a state of crisis induced by these three human powers. A crisis which confronts him with a loss of meaning, responsibility, self and identity - themes of much literature and drama today as Tillich (1962) reminded us. Other attendant problems include specialisation, utilitarianism, impersonality of power, and unfreedom.

26.4.1. Loss of Meaning. Man suffers a loss of meaning. Why do many workers - including the technical and scientific - look on their tasks as merely something that must be done in order to eat and live? Why do many regard work as a necessary evil, agreeing with Aristotle that to avoid it is imperative. The key to such attitudes lies in the loss of meaning that characterises man and his activity today.

Man and his science, man and his technics, suffers a loss of meaning because they have become divorced from the structures of creation, and through false doctrines of man.

How can meaning be achieved when we make things we do not need; when we build in obsolescence? The tragedy is that work is considered in terms of something done to make money, rather than in terms of fulfilling the calling of God. How can meaning be attained when we attempt to explain man and his history as the flux of economic forces, the result of blind chance? "Modern man has lost the awareness of being called to a task by an authority beyond the cosmic horizon; he no longer knows what happens....or what his work means." (van Riessen 1953, p.230.)

26.4.2. Loss of Responsibility. Modern industry has little scope for the longing for individuality, responsibility and status which therefore remains largely unsatisfied. The employee is not basically self-disciplined but subject to external controls that remove any real responsibility he might have over his work (cf. the attempts to counter this by the abolition of the conveyor belt). Ellul (1964, p.400.) sees this loss resulting in man being "spiritually outraged", while Henry (1972, p.32.) sees it resulting in "deep narcissistic wounds" that lead to an endless search for the perfect job. This is reminiscent of Cox's allegation that in modern industry it is difficult to find where decisions are made or power actually wielded. Man becomes merely an extension of the machine, required to blindly follow the dictates he receives but which cannot be located.

26.4.3. Loss of Self. Technics leads to the destruction of self - not necessarily but in practice. Laissez-faire capitalism and totalitarian communism both regard man as a function rather than as a person created in the image of God. This attitude behind the cultural manifestations of these systems means the inevitable depersonalisation of the individual and the loss of the self. It leads to a 'swing to fun' in dialectical relationship to the fear engendered in self-loss relationships, whether it be on the assembly line, boardroom, or research laboratory. "This loss of self", writes Henry, "and the rise of the values of the Id have combined to create a glittering modern pseudo-self, the high-rising standard of living waxing like the moon in 'A Midsummer Night's Dream' of impulse release and fun." (ibid p.113.)

26.4.4. Loss of Identity. Man also suffers an identity crisis brought about by immanence philosophies. In a world where thought patterns become increasingly subjective and the reality of the objective world slips away, men often seek identity in their work. So the job is seen to identify, and a magazine like 'Time' repeatedly gives a person's occupation before their name. Conversely he may seek integration in the artifacts of his hand or mind. But a facet of life can never serve to identify the whole of man's being. While man's active involvement in life through his work is a major facet of life it can never provide a starting point from which to build a system of belief or a way of life that will in the final analysis stand up to the pressures of reality. Man seeks meaning and identity for his life, but where is it to be found? The result of the technological age has been plastic man - plastic, one of the supreme products of technocracy. (Cf. Rookmaaker 1970, p.200f.) Man cries out for his humanity but all that is offered is gadgets which enslave him. Man is caught in his work by its one dimensionality, its frustration, its failure to provide a reference point that will integrate reality. Man seeks to identify himself in his work, or his family, but it crumbles to ashes and he is left with the themes of alienation, lonliness, despair and illusion. All that remains is to escape into fantasy, mysticism and irrationality (cf. much modern art - Kafka, Bacon, Ionesco and Cage in literature, painting, drama and music respectively.)

26.5. TOWARDS A RESOLUTION OF CRISIS

26.5.1. The Recognition of a Crisis of Freedom and Power. Before a solution can be sought, acceptance of the crisis facing us is necessary - which is not to accept an unsolvable dialectic. A crisis of freedom and power faces man and the tragedy is that modern man, following Kant, accepts this dialectic, distinguishing a territory of freedom and a territory of necessity. The ground of this dialectic lies in absolutizing something that is relative within creation - for example, existentialism, which shares with Neo-Marxism a protest for freedom against power, would absolutize the autonomy of man's existence to the loss of his essential meaning/being.

Today when man is beginning to realise that he is in crisis, when the myth of progress has been exposed as a 19th century illusion, the Christian message has a new opportunity on a biblical basis to relate to the lives of men; to provide the true integration point of reality;

and to show that science and technology need to be rightly governed and motivated by the Christian ground-motive of creation, fall, and redemption if they are to realise their God-given potential. As long as men fail to realise that they can look up to heaven, that there is a seen world and an unseen one equally real, as long as this is rejected, man is doomed to darkness - morally, spiritually and intellectually.

This is an appropriate point to summarise the argument so far. The relative independency of man's powers is the excuse for the suggestion that these powers are absolutely independent and inclusive of all life. Absolute independency is, however, an idea of man and therefore merely an appearance. When men hold such ideas and work them out into society, they project them on to the world and give the world their shape. Thus the appearance can become effective in a similar way to the idols of any period. Belief in them makes them effective - even though they are false. (Cf. 25.4.3.2.)

26.5.2. The Adoption of the Theistic Arche and Archimedian Point. (Cf. 19.7.2. and 20.1.3.) If true meaning and identity are to be established for man and a viable relationship to his culture found, it is imperative that the correct starting point for thought and action be determined. The motive of creation, fall, and redemption is highlighted by Tillich as the basic feature of all Christian thought, and he further notes that: "Religion is the substance of culture and culture the form of religion." (1972, p.42.) To accept this is to commit oneself to seeking a solution within a unified framework; though there will be diversity within that unity. (Tillich, in fact, advocates a two-realm theory.)

To recap: Western civilisation from the Greeks onwards has been dominated by four basic motives. The early Greek form-matter dualism; the Scholastic motive of grace-nature from Ockham and Aquinas, which is still strong even at the extremes of the Protestant theological spectrum - for example Cox and Barth; the post-Enlightenment dualism of freedom-nature, irrationality-rationality, personality ideal - science ideal; and the motive of creation, fall into sin, and redemption. Within the dualistic approach Richard Niebuhr (1951) outlined four variations: namely the Christ of culture; Christ above culture; Christ and culture; and Christ against culture. His fifth position - Christ as transformer of culture - would seem to approximate closest to the idea of creation, fall, and redemption.

Any Christian attitude to our modern situation must be based on renewed biblical insights and understandings of the divinely ordained structures of creation. After all, true knowledge is only possible under true religion, and it can only arise from the cognitive activity of the human heart being enlightened through the Word of God by the Holy Spirit. In approaching the question of a relevant theology *vis a vis* the problems raised by science, technics and organisations in our society it is essential, if any reality is to be achieved, to follow a unified motive for it alone can give a coherent explanation of man and his place in the world. We must be careful that our theology is not simply a reaction to existential situations, but that it is rooted in the reality of the ontological Trinity and the Creatorhood of God. Only on this basis can true existential solutions be arrived at. It is my contention that to accept a dualism is to posit a fallacious abstractional relationship which fails to appreciate the enkaptical interwovenness of creation, and that any acceptance of a dualism leaves an unsolvable dialectic.

26.5.3. The Realisation of Who Man Is. Nothing within creation serves to identify man. But who is man? Even those who do not seek to identify man by work or family often blunder here in their view of man by seeing him as in principle under the grasp of science, capable of being formalised and analysed without reference to God. Such attempted autonomy has followed two basic and opposing streams of thought which see man atomistically and collectively. The individualistic approach has been advocated by Epicureus, the Nominalists, Hobbes and Locke (whom some see as the founder of laissez-faire economic individualism). On the other hand collectivism has been followed by Aristotle, Aquinas, Rousseau and Comte. The problem of the first is that it sees man only as the individual while the second absolutizes one of the many temporal communities. In answer to these tendencies E.L.H.Taylor (1970) suggests that Christian pluralism is the only possible reality within creation.

Man's identity is aggravated, not solved, by seeing him as the lone atomised individual or an annonymous factor in a group. In the last analysis nothingin this world serves to identify man. As Levin reflects in Tolstoy's 'Anna Karenin': "I work, I want to do something, but I had forgotten it must all end; I had forgotten death." (1972, p.343.) The world comprises particulars and man himself is a particular doomed to death, therefore created particulars cannot identify.

<u>26.5.3.1. Man In Relation To God.</u> Man is only identified by firstly relating to God. Once he does this he can begin to relate to the cosmos and the particulars around him. His environment can no longer be an ultimate threat because he can begin to realise the reality of his being at the apex of God's creative act, and as His regent on earth have dominion over it, to tend and dress it, to categorise and rule the particulars. It follows that as creatures in the image of God, men should be treated as <u>persons</u> and never as <u>functions</u> or <u>variables</u> of a techno-economic system.

The question of identity rests primarily on creational ordinances and not Christological considerations. There has been a tendency to view man in Christological categories today. This is seen in the categorical rejection of the importance of the natural world and history by Barth, and in the evolutionary incarnationism of Tielhard de Chardin. The basic problem is the infusion into theology of a philosophic dualism between sacred and secular, driving a wedge between Creator and Redeemer. But we worship no failed Creator and to posit this wedge in any form is to tread the border of incipient docetism. Creation is good, but infected by sin and suffering from God's judgement it struggles towards the redemption that shall be revealed eschatologically in Christ.

<u>26.5.3.2. Man In Relation To Nature.</u> Cox (1968, p.262f.), though partly a unification of Barth and de Chardin, can point to the biblical basis of modern society lying in the disenchantment of nature. He correctly realises that the biblical doctrine of creation demythologises creation and frees it from holy superstitions where nature is the home of demonic forces which man must placate. The Bible sees nature as part of God's creative act and not an object of fear or worship. But Cox goes too far when he removes altogether the area of society and work from within the sphere of God's calling. This exhibits a dichotomy between nature and grace which is incompatible with the biblical view of creation - even as Cox himself presents it.

<u>26.5.3.3. Man In Relation To His Task.</u> The God of creation is the primary datum for any Christian theological system, and particularly in this instance as theology pertains to science, technics and organisations. Man was given a cultural mandate by God before the Fall. Part of this commission was to subdue the earth and to have

dominion over the things of the earth. Thus work, science and technics are divine ordinances for man's life on earth. As such, these aspects are involved in God's law structure for the universe, and therefore become a requirement placed on man. "The very fact that the Fourth Commandment of the Decalogue is an injunction to rest from labour gives the clearest possible indication of the biblical point of view - that man is by his very nature a worker." (Richardson 1952, p.24.) Work is not an optional extra but something built into our being, a command laid on us. There is to be no 'Gnostic culturophobia' (Zuidema). Science and technics must be seen in conception as a fulfilling of the command of God (though open to misuse and mixed by the Fall). This reveals the place of man in the order of creation; he comes after, his dominion is secondary, he is not autonomous. But man's work is still creative in a secondary sense for it is the reflection of God's work and his own character. "The active dominion of man appears then as the analogue of God's dominion." (Blocher 1973, p.11.) The command to have dominion is a power and a freedom given; the responsibility to respond positively to God and live to His glory - and this has ecological, economic and sociological ramifications.

A special characteristic of man's dominion is that it is marked by a work-rest rhythm. Man is ordered to cease from work. His ability to do so indicates whether he is in control of his work or it is in control of him. Man is to find release from his work and not be swamped by it; and rest performs a valuable function in providing a safety-valve through which "the superfluous steam of self-importance, self-conscious dignity, solemnity, and over-seriousness can be let off." (Brunner 1949, p.390.) A correct doctrine of leisure is a corollary to that of work.

Work is a creative activity undertaken by man for the sake and love of work itself. Because he is in the image of God and work has been commanded, man is simply to work well because it is worth doing.

> "....if his work is not genuine praise of Jehovah God borne out of faith, then it is a dead work, damned and dead... Only when human work is worship of Jehovah...only then does work lose its human chains; only then does that narrow minded daemonic drive to get and get...become stilled, converted into an open-ended rush of joy...only under and out of Grace does work find meaning." (Seerveld 1965/b, p.6.)

The problem is that work is dominated by man's pretended autonomy, and because of this work is bound in human chains. Work, like man, is in chains because of the Fall. The response of man was incorrect. Man became separated from nature as well as from God, with obvious ecological and working implications; he became separated from himself psychologically and from others sociologically with repercussions in community and industrial relations. These separations are not, however, intrinsic features of the cosmos but rather the cosmos in its abnormality due to the Fall.

The original order and ordinances of creation are not abolished, rather they are changed and we have moved from the harmony of the universe to dissonance. This change is not to be seen as a move from work as creative and good to be alien, for the cultural mandate to work and rule over creation remains although new characteristics have developed. Work is not a result of the curse. The result of the curse is that work became a toil, a hardship, a bondage, as well as retaining the positive aspects of creativity and proper responsible service to God.

Man still lives from the fruit of the earth as he uses his skill and mastery to exercise dominion over it, but the fruits of his labours are destined to have a bitter taste as long as he remains in separation from God. (Cf.25.4.3.) Man still subdues the earth and develops science within God's laws. The Concorde is a thing of beauty because technical efficiency necessitates conformity to the laws that God has given. The command to rest from work is maintained -- though not necessarily combined with the command to worship on that holy-day.

26.5.4. The Crux of the Problem. The crux of the problem is that our world lives in separation from God. This means an aggravation of negative features to all societal structures; it means that work does become alien, frustrating, dehumanised, manipulated; it means that workers become machines, commodities, economic factors; it means that craftsmen become dial-watchers; it means that science can become false and technology oppressive - as long as man rejects the renewal God offers. The power of man in our day leads to impotence; his freedom to reach out to the stars becomes his unfreedom as he becomes caught in self-directing technics; his autonomy has led to his imprisonment in a closed room (cf. the artistic representations of this in men like Kafka and Bacon). As van Riessen comments:

"The remarkable history of apostasy is that man has started with the idea of his autonomy; his independence from God. That is his original sin. The outcome of this plan is the idea of a closed world within which are autonomous and independent powers in relation to man who is unfree and powerless." (1973/c, p.58.)

This is the dialectic that modern man realises and yet cannot escape. He is powerful, his technology marvellous -- and yet in the midst of it all he has lost meaning, identity and freedom. It is power and impotence that characterises man in our modern world. This point is clearly seen by Fromm when he concludes that; "Just as primitive man was helpless before the natural forces, so modern man is helpless before the social and economic forces he himself has created." (1963, p.76.)

26.5.5. Christ Offers Restoration. Is there a solution? Within the biblical motive there is no final unsolvable dialectic, no autonomous threat to man by anything within creation. Despite the curse, work and itsreward are not abrogated and there remains an intrinsic call to, and worth in, work. Hence the validity of science, technics and organisations when contained within a correct weltanschauungslehre. The hope for man and his culture is the redemption Christ brings. Christ becomes the crucial gateway to a return to true life and thought before God - though this does not replace the foundational creation ordinances. Nor is this in any way a negation of the value of non-Christian life and thought for it too, under common grace, has value. But only redemption truly restores to man the real possibilities of God's creation. Christ offers renewal and restoration for that which has been marred, as we become united with Him in whom freedom and power are fully present in harmony. Christ holds out the possibility to transform crisis, to change culture and open out in Him the potential of creation. This will demand men who bow before Him who is Lord of all and commit themselves to His calling.

26.5.6. Christ Calls To Work. We are called to all forms of work by God whether it be termed 'sacred' or 'secular'. Some (Cox and Richardson - cf. Hart 1968, pp.85-110.) deny this, maintaining that God calls only to the sacred sphere. But this is to accentuate the dichotomy between nature and grace and grant neutrality and independence from God. Having given autonomy to nature it eats up grace and makes a mockery of it (cf. Appendix A). It leads to the sort of situation that A.A.Milne caricatures:

"Mr Pump was not a hypocrite. He was a religious man, whose religion was too sacred a thing to be carried into his business. The tophat that he hung up in his office was not the tophat that he prayed into before placing it thus hallowed, between his feet, even if the frock coat and the aspect of benevolence were the same. He had two tophats, and one hat box for them. On the Monday morning he put God reverently away for the week and took out Mammon. On the Sunday morning he came back - gratefully or hopefully, according to the business done - to God. 'After all,' he said, 'No man can serve two masters at one and the same time.'" (1947, p.29.)

To posit the dichotomy means inevitably that men are caught in the dialectic that Ellul and Marcuse portray with no real hope of an answer. This replaces the moral dilemma of man's sin by a metaphysical finitude that leaves no possibility of integration for the whole of life in dignity before God. Perhaps we are needing to recover something of the spirit of Brother Lawrence for whom the altar and kitchen were as one, and actions at each seen as adoring worship. "The time of business," he claimed, "does not with me differ from the time of prayer." (1963, p.23.)

26.6. CONCLUSION

We will only begin to realise this when we accept a radical non-dualistic a priori. The modern dialectical crisis of power and freedom, seen as unsolvable, stems from dualistic presuppositions, and only the acceptance of the enkaptical interwovenness of creation offers resolution. Most of the critiques mentioned depict man caught in a struggle for significance in the face of autonomous technics that crush the life from man. The tragedy is that they accept this as inevitable and to some extent as inescapable. The Christian, it seems to me, must reject this for the autonomy that it assigns to science, technics and organisations does not exist. It is illusory, an appearance, an idol. The fundamental conflict is not between two realities of equal power but between truth and appearance, between worship of the true and living God and idolatry. Man's autonomy is only in the final analysis pretended autonomy, for God alone is sovereign. All is subjected to His creational structures and within the law boundary of His creation. All life is derivative of Christ (John 1:4.). There can be no chance behind God. Man is free but not autonomous, he is responsible but not independent. Neither, then, can any temporal structure possess autonomy. The problem is one of freedom and power and its resolution is well summed up by van Riessen:[4]

> "We have to understand that the deliverance of the creation, of history, and of society is already a fact: the cross and the resurrection of Jesus Christ. History is in the control of His victorious Kingdom. The true meaning of the creation will be fulfilled, whether man cooperates or not.. ..Man is therefore not so important that he is decisive. Nevertheless he is important, for he is responsible." (1973/c, p.61.)

There is a struggle involved, the struggle for man in Christ to restore that which is fallen, to carry out his cultural mandate to have dominion over the cosmos. In essence the struggle of the Kingdom of God against the kingdom of darkness. Our call is to transform culture through Christ and to maintain (without paradox – cf. Richard Niebuhr) the antithetic relationship that exists between the two kingdoms. It is a struggle that can be resolved as we obey Christ and work out in reality His claim to be Lord over all things.

4. Cf. Schaeffer (1968/a, pp.23ff, 38, 84.) and Schaeffer (1968/b).

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CHAPTER 27

DETERMINISM-INDETERMINISM AND PROVIDENCE

27.1. INTRODUCTION

Having looked at creation and the universe in a wide sense I turn to the question of man and his responsibility in the face of the problem of causality and determinism. While physics may tend to statistical indeterminism in its mentality this is not true of other disciplines. Psychology, sociology and genetics increasingly point to biological and cultural determination - readily evidenced in the manner in which human behaviour is simulated on computers for analysis. Man's freedom of choice and responsibility is still widely argued against on the basis that every event/act has a cause; that science *per se* involves predictability and determination; and on empirical grounds. On the other hand, from physics, it is claimed that causal laws do not operate and that disorder is basic. So within science there are these apparently irreconcilable approaches. But it should be noted that causality, or chance, in one discipline does not prove or disprove it elsewhere in the created order.

27.2. WHAT IS DETERMINISM?

There are different senses of determinism: the scientific where it is assumed that events have causes; and the philosophical where it is argued that the future is inevitable whether it be scientific or personal-moral determination. The former is an epistemic determination which depends upon facts about knowledge; while the latter is an ontological determination purporting to make statements about the world as it is, independent of human knowledge. (Cf. O'Connor 1972, pp.61ff.)

It is important to note what determinism is not (cf. Flew 1971, ch.7.). It is not equivalent to predestination in theology. Predestination involves the self being influenced by a personal-moral agent, whereas determinism is a closed concept. Admittedly determinism and predestination have a common implication that nothing happens by chance, but the former is a form of necessitarianism while the latter is concerned with God's free will and implies that He has foreknowledge of what He wills. The determinist is committed only to asserting that everything that happens can theoretically be subsumed under universal laws of nature. Thus a theory in physics is deterministic if, and only if, given the values of its state variables for some initial condition, the theory can analytically determine an unique set of values for these variables for any other condition.

<u>27.2.1. Hard Determinism.</u> In this version of the theory it is assumed that all events are rigourously determined; that freedom is the absence by definition of determinism; and that therefore all talk of freedom is illusory. This view has a long tradition stemming from the ideas of Leucippus and Democritus and is given its classical formulation by Laplace. While the idea of this rigourous determinism has to some extent been weakened it is still prevalent, especially in the life-sciences. The deterministic, mechanical structure of man is an axiomatic assumption in behaviourism where man is conceived as a complex stimulus-response mechanism. Before one too readily dismisses this as outdated it should be noted that Dr. Blakemore in his 1976 Reith Lectures operated within this mechanistic framework.

<u>27.2.2. Soft Determinism.</u> This also assumes that all events are determined but conceives freedom as self-determination and not the absence of determinism. It therefore concludes that the freedom of man and the determination of events are compatible. Individual acts may be determined by motives which are in turn determined by earlier events, but this does not lead back to hard determinism for motives may devolve from physical forces, or more loosely as basic tendencies to act in certain ways, or simply as "dispositions and attitudes existing antecedent to and independent of acts." (Barbour 1968/b, p.307.)

Classical mechanics is only a branch of inquiry dealing with a limited set of properties and relations. Thus, assuming that it is deterministic, it is only such with respect to certain mechanical properties of physical systems, or more precisely with respect to the mechanical states of systems. It follows that Laplace was guilty of serious error in declaring that 'nothing would be uncertain' as this omnipotence would only be warranted if he could know <u>all</u> the properties and analyze all the physical traits. Further: mechanics does not give a summary account of sequential order for real events, rather it deals with limiting and ideal instances, and consequently any resultant determinism is with respect to the theoretical system of thought whose state variables are instantaneous positions and moments, and not with concrete reality. However it may fairly be said that a theory is reasonably called determinate if internal analysis indicates that the theoretical state of the system at an instant logically determines a unique state for another instant. In this sense classical mechanics may be called determinate.

There are different ways of defining or characterising a mechanical state description. (i) It may be defined in terms of an infinite, rather than a finite, number of values with respect to a set of state of variables - for example in the field theories of Maxwell's electromagnetic theory which involves the study of continuous media. Nevertheless, the form of classical electromagnetic theory is determinate for given constant boundaries and given all the initial data we can determine future values. (ii) State descriptions may also be defined in terms of variable values at different times, or during some period of time - that is, not instantaneous values. This is obviously applicable in the biological and medical fields which require a history of their subject, but we find this in mechanics itself in areas such as metal fatigue or electric hysteresis where the past history is required. (iii) A state description may be defined with respect to the value of a variable that represents a statistical property of a class, rather than an individual, for example in the aggregate numbers of molecules in gases. Here while the individual molecules do not enter into the prediction the aggregate does constitute, in the theory, a determinate system.

27.2.3. The Principle of Causality. Determinism is tied in the first instance to law and causality and not to predictability (cf. Flew 1971, p.253.). Thus we are driven back to the question: Do events occur in fixed causal orders which science seeks to unfold, or is causality a methodological tool? The question is whether the laws of causality are inherent traits in nature or simply regulative principles of inquiry. Is causality an empirical generalisation from evidence, an *a priori* truth, a concealed definition, or a mere conviction? (Cf. 27.4.2.)

Since Hume (1739, p.141.) many have assumed that 'A is the cause of B' simply means 'B regularly follows from A in accordance with a law or rule.' Kant (1787, pp.412-3.) argued that when we observe an event we assume a foregoing event and therefore the law of causality is reduced to the method of scientific research - causality is an *a priori* necessity. This view still seems valid despite Heisenberg's disclaimer on the grounds of atomic physics and the unpredictability of alpha-particle emission. Whatever the truth may be the principle of causality is not an inductive truth. Conceived as a maxim of inquiry the principle provides a basis whereby we may look for laws and theories that possess no explicit reference to the times and places at which events and processes occur. The principle thus constructed is a general recommendation to construct/find theories to which these may be applied, with no tight restriction upon the detailed form of the theory.

Several features may be noted. (i) The mechanical state does not itself determine all properties within a system. (ii) Causality is a necessity of analytical thought (cf. Popper 1972/b, p.248. Nagel 1974, p.324.). (Heisenberg gets into the peculiar position of trying to provide causal explanations as to why causal explanations are impossible!) (iii) In science the denotation of chance is a technical term which refers to the absence of knowledge of causal connections and not necessarily to intrinsic chance. This is not to be confused with the connotative meaning of chaos, unexpected events, or the intersection of two causal chains. However some, following the Epicurean notion of spontaneous swerving atoms, advocate chance in reality as referring to some absolute rather than relational character of events. (iv) Northrop (1971, p.19.) indicates a twofold usage of causality by Heisenberg where (a) cause is strictly deterministic, and (b) where every determinate system is a causal system but not every causal system is a determinate one. Thus while Heisenberg upholds (b) within quantum theory, (a) cannot be maintained.

27.3. DETERMINISM IS NOT ENOUGH [1]

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1. The following lengthy quotation from Stoker seems to me to help crystallize the position I am aiming at in this chapter. It is taken from an essay I read subsequent to writing this chapter.

"1.2. Some coherential contra-polar distinctions as they (legitimately or not) appear in the history of science....are: a priori/a posteriori; authority/subject; body/soul; cause/purpose; church/world; continuity/discontinuity; eternity/time; existence/essence; general/individual; firm/dynamic; freedom/dependence; freedom/nature; God/cosmos; individual/society; law/subject; man/world; meaning/being; meaning/reality; multiplicity/diversity; nature/culture; nature/grace; necessity/accident; necessity/reality; particular/universal; perception/thought; possibility/actuality; possibility/necessity; principle/fact; quantity/quality; rational/irrational; spirit/soul; spirit/matter; subject/object; time/energy; thought/action; thought/being; truth/reality; unity/multiplicity; value/fact; whole/part etc.etc.

1.3. In our view the following at least may be said to hold good for the coherent contra-polarity of such contrasts:

Two objections to strict determinism can be made - the one logical, the other moral. The logical objection has been advocated by many from Aquinas to C.S.Lewis and notes that if all human acts were the outcome of necessity, then rational deliberation would be impossible. (Cf. O'Connor 1972, p.35f.) On the moral front it is obvious that if man is reduced to some pre-determined biological machine then he is depersonalised and demoralised. It robs man of any dignity as a responsible being, and undercuts the basis of society governed by law, for law assumes individual moral responsibility.

<u>27.3.1. The Reductionistic Determinism of Skinner.</u> One of the crucial areas for this question is psychology - what exactly goes on

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a. They confront us with two distinct poles.
b. No pole is heteroducible (reducible) to the other.
c. The two poles cohere. (They are mutually related, each requiring and referring to the other.)
d. Cohering, they nevertheless do form a contrast.
e. Except for distinctions like God/cosmos, or eternity/time, each coherential contra-polar contrast is particular in character.
f. That particularity must be fully recognized and respected.
g. Therefore no such coherential contra-polar distinction is to be used as a theoretical pair of pliers with the intention of compressing the whole of the cosmos (with its encompassing coherence of radical diversity) within it.
h. By virtue of their irreducibility both poles must remain balanced, both in theory and in practice.
i. Finally, all the various coherential contra-polar contrasts are themselves mutually coherent in various ways and are, therefore, to be recognized and respected as such.

1.3.1. The above being so, it is necessary that we further distinguish between <u>contra- and anti-polar oppositions (contrasts)</u>. In the former the poles are mutually related, coherent; each pole requires the other. In anti-polar oppositions the one pole excludes the other anti-thetically; the poles do not mutually cohere. Thus 'necessary' coheres with 'accidental' in contra-polar fashion and vice versa. When they are absolutized, however, so as to pit 'absolute necessity' over against 'absolute accidentality' (or absolute chance), then they constitute an anti-polar opposition in which each pole counts the other out. (So also where absolute necessity, or chance for that matter, are pitted over against the God of the Scriptures.).....

2.2. ....In the cosmos we meet up with both; <u>the necessary and the accidental (the contingent)</u>. Both are creaturely; neither is self-sufficient; nor may either of them be absolutized.....If and when we say...that God is the Absolute, then absolutising of 'necessity' and 'accidence' amounts to deification of (conferring self-sufficiency to) what is creaturely and dependent....Moreover, determinations like 'absolute accidence' and 'absolute necessity' are intrinsically self-contradictory, since 'accidental' and 'necessary' here delimit the absolute which, as such, can allow no delimitation whatsoever."
(Stoker 1973, pp145,147.)
This quotation should be kept in mind throughout this chapter.

in the brain/mind of man. Much of this area is dominated by deterministic thinking - e.g. Skinner and Blakemore. Skinner epitomises hard determinism and writes that: "If we are to use the methods of science in the field of human affairs, we must assume that behaviour is lawful and determined." (1953, p.6.) He argues that up until recently it had been generally held that there was some sort of ghost in the machine, some autonomous individual ego, mind, or centre of consciousness, that was free to choose. But in his significantly titled 'Beyond Freedom and Dignity' he argues that man is simply a machine governed by environmental controls, by operant conditioning. It is, he claims, a "fact that all control is exerted by the environment." Man has no soul, no mind; he neither initiates, originates or creates. (Cf. 1973, pp.196,180,155.) Immediately we ask if this means that Michelangelo's painting in the Sistene Chapel, the works of Bach, Mozart, Dickens and Tolstoy are the result of environmental conditioning.

Skinner likes to regard man as a dog (cf. ibid p.196.) rather than as a being made in the image of God. He may think this a step forward but the Christian certainly cannot. But his programme fails to answer several crucial objections. Who is going to control the controllers of his utopia? (cf. 1962.) Why, on his basis, does the biological community of mankind have any value in the first place that makes the building of utopia desirable? If man has regarded himself different from all else (animals, plants and things) for thousands of years, not just on the basis of what he would like to consider himself, but on the grounds of empirical differences - how can any observation be trusted if all this was wrong? Are we not led to scepticism with regard to all knowledge and all knowing processes? (Cf. Chomsky 1973, p.117.) Again, there is on his basis no secondary boundary condition to science: that is, added to what man can do, the question of what he should do.

27.3.2. The Oedipus Problem. But even assuming some form of mental determination, does this rule out freedom and responsibility? If all was determined it would appear that any outcome is already fixed - but is it? The problem revolves around the factor that if an event is determined and we know all the initial conditions we should in principle be able to forecast the outcome. But in the process of human action and knowing how do we accommodate the knowledge of the prediction as affecting the outcome? (Cf. Hume 1739, p.45-46.) This is the Oedipus problem, or the impact of the publication of an outcome on a subject of that prediction. In a paper published in 1950, Popper showed that if we make the concept of the predictability of an event explicit, it can be proved that not all of even large-scaled events (classical physics) can be predicted. It followed that the Laplacian view of the universe was in fact incoherent. Thus, arguing from Godel's theorem, he showed that to pass information to a calculator about its own state "is liable to interfere strongly with that state and thereby to destroy the predictive value of the information." [2] So any calculating machine (the brain?) is incapable of predicting certain of its own future states. Popper uses this to argue that determinism is an indefensible theory.

It follows that no completely detailed description of the present or future state of the brain can be equally accurate. The individual belief is irrelevant - for if accurate before belief, then afterwards the brain state is altered so that the former description is out of date. Similarly, if it were adjusted somehow to allow for brain effects of believing, then if you did not believe your brain would still not be in the implied state. (Cf. MacKay 1974, p.79; and 1967, pp.16-17.) Simply because the rigorous determinist asserts that whatever I believe is strictly reflected in the state of my brain, it follows that no complete description of my brain can exist which is equally true whether or not I believe it. Thus even if some super-scientist were to make a detailed prediction on paper concerning me; it has no binding force with respect to my action or thought, it has no inevitable claim to my concurrence. (Cf. MacKay 1966, p.434.)

This is the same point as Popper's: that even a determinate machine cannot produce a convergence on to a specification of its own future states simple in that to embody such information in its own system makes that system out of date. It is the problem of a photograph of a photograph ad infinitum within itself. The super-scientist faces the dilemma where:

> "In a very strict sense (sc. the description on the paper) is incredible - not only because you do not feel like believing it, but because any attempt on your part to believe it would make it out of date. We therefore have the logical paradox that a prediction based on what the man has written on the paper, although it may be valid for him as long as he keeps it to himself, is not 'the real truth' in any universally

2. Popper, 'The British Journal for the Philosophy of Science' - 1950, 1, p.189.

binding and exclusive sense, because 'the real truth' is something that anyone would be right to believe and wrong to disbelieve; but here is something which you would be wrong to believe - and which he knows you would be wrong to believe. If you believed it, you would make it out of date, and would then be wrong to believe it too." (MacKay 1965, p.63.)

Thus without holding either determinism or indeterminism we can show what does not follow from a determinate viewpoint - namely that man can have no freedom. Even if there is some form of determinism it would not thereby rule out individual responsibility. MacKay, in fact, uses this argument to undercut the Calvinist-Arminian impassé with respect to predestination, suggesting that even God's determined Sovereignty does not nullify our valid belief that we are free from some fatalistic outcome. (1974, p.82.)

27.4. WHAT IS INDETERMINISM?

It is popularly believed that, while classical physics is deterministic, modern quantum mechanics is indeterministic. It would appear that the former is mechanical and deterministic while the latter is mechanical and indeterministic. Classical mechanics has a deterministic structure. Generally speaking mechanics is a set of equations that formulate the interrelationships of specific traits of bodies on other physical properties - for example the equations of motion. At this level, however, quantum mechanics is also causal since it too formulates causal relationships. But classical mechanics is clearly distinguished as deterministic in that given the force-function for a physical system, the mechanical state at any time of that system is completely and uniquely determined by the mechanical state of the system at an arbitrary initial time. (Cf. Nagel 1974, p.279.) However it would be wrong to conclude that some system of bodies is determined - rather it must be that the <u>theory</u> concerning these bodies postulates a deterministic relationship. There is a discontinuity between reality and a theory about reality.

Quantum mechanics, unlike classical statistical mechanics, is not a theory of wholes or aggregates, but concerns individual basic particles and probabilistic theory.[3] In the former aspect it has an

3. More specifically the difference between quantum mechanics and classical mechanics may be expressed as follows: in the classical tradition, the state of any isolated mechanical system at a given moment in time is given precisely when only numbers specifying the position and momentum of each mass in the system are empirically determined at that moment in time; no numbers referring to

objective sense and in the latter a subjective sense. However Einstein did not concur with this general view, contending that statistical theories, though important, were neither fundamental nor objective but subjectivistic theories introduced because of the fragmentary nature of our knowledge. Thus he held that quantum theory was not a fundamental theory, it was not complete. The objective reality, or completed theory would be deterministic and not probabilistic. Popper (1976/a p.154.) tried to counter the subjectivism of both Einstein and his opponents by introducing a propensity interpretation of probability. (Cf.8.3.)

It is perhaps significant that when Popper visited Princeton in 1950 he read a paper on 'Indeterminism in Quantum Physics and in Classical Physics' before an audience that included Bohr and Einstein. Subsequently he had a long conversation with Einstein which revolved around this basic problem - is our world deterministic or indeterministic? During these discussions Popper tried to get Einstein to give up his deterministic viewpoint. They also spent time discussing Bohr's principle of complementarity which Einstein contended he could not understand despite his greatest effort (ibid p.131.).

But the basic feature of quantum mechanics that precipitated the discussion on determinism-indeterminism was the set of formula logically derivable from the assumptions of the theory and known as the Heisenberg Uncertainty Relations. While these seem to emphasise the measuring process uncertainty is not, in fact, derived from experimental evidence. It is a consequence of the uncertainty relations.

Quantum mechanics is not to be considered indeterminate merely because of the uncertainty relations.[4] The whole uncertainty

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probability are present. In quantum theory, however, the interpretation of an observation of a system is more complicated and involves incompleteness and no overall accuracy. Position, if known, means velocity imprecisely known and vice versa. Nevertheless, the conservation laws hold in both sets of theory, the classical form still applying in quantum theory where the revised form, derived by Einstein, is used for relativistic energies. Similarly, the classical laws of thermodynamics apply to a classical gas of molecules and a quantum gas of electrons.

4. Note that the words position, velocity, etc. have different senses in quantum theory from that of classical mechanics.

relationship is based on an assumption of instantaneous values for each particle within a system. Given this assumption, all would be quite reasonable, but in point of fact quantum mechanics does not define the state of a system in this way. So we must grant that while quantum mechanics is not determinate with respect to a state description defined in terms of instantaneous positions and momenta as the state variables, nevertheless it does not follow that the theory is not determinate with respect to some other defined framework. (Cf. Nagel 1974, p.306.) In classical mechanics the variables of state are associated with properties of the individuals postulated by the theory; but in quantum theory the state variable is associated with a statistical property of the postulated element. So while classical discrepancies are attributed to lack of precise knowledge concerning the initial state of the system; in quantum mechanics such discrepancy is also seen as a condition by noting that the assumptions and rules which coordinate the theoretical state of a system with experimental data contain uneliminable (apparently?) statistical components. Therefore we find that physicists can maintain that quantum theory is, in the nature of the case, indeterministic.

Many have extrapolated from quantum phenomena to the macroscopic world and claimed it is statistical in character. But is the whole merely the aggregate of the parts? Nagel writes that:

> "It is....a non sequitur to conclude that, because quantum mechanics is the foundation for all other parts of physics but is a statistical theory, all physical laws deducible from quantum mechanics must also be statistical." (ibid p.315.)

In the final analysis we can ask what evidence in the macroscopic realm displays indeterminism in character, and the answer is that there is no concrete experimental evidence for macro-indeterminism.

It is sometimes maintained that quantum indeterminism has restored to man the freedom and responsibility that he lost in the strict Newtonian determinism. But indeterminism is based, not on freedom, but chance. [5] While little is yet known about the influence of individual atoms at critical neural junctions within the brain it would seem that individual atoms have little impact. As MacKay

5. Charles Pierce posited chance variations in physical causality to account for the apparent spontaneity of the mind. Similarly William James talked of a 'looseness' or 'disconnectedness' in the universe to allow for man's experience and moral responsibility.

points out, after we reach a certain age, cells are dying off at a large rate each day but appear to make little difference to our daily lives. Indeterminism is not equivalent to freedom. Do we after all wish to argue that Haydn composed his symphonies freely, or under the dictates of chance? It is reductionistic to seek human responsibility in the microscopic world of the atom (it infringes sphere sovereignty). Likewise determinism is just as bad - can we reconcile a determinate prediction of a symphony before it was conceived?

<u>27.4.1. The Uncertainty Relations</u>. We need to distinguish between the unpredictability of a system and the indeterminancy of a system. We can conceive an unpredictable but determinate system as one where no complete future specification is possible to us, but where replicas released from identical initial conditions would later be found to be in the same state. On the other hand, an indeterminate system is one where, even if we had an ensemble of identical replicas, they would not be found in the same later state. Thus turning to our universe; is it (after Heisenberg) essentially indeterminate or merely unpredictable?

Now, while it is commonly held that Heisenberg's formula refer to measurements, Popper contends that: "The Heisenberg formula <u>do not refer to measurements</u>; which implies that the whole of current 'quantum theory of measurement' is packed with misinterpretations." (1976/a, p.95.) It is also erroneous to claim that quantum theory rules out exact measurements, although it is still correct to say that the formula which are peculiar to it (statistically interpreted) give no precise singular predictions. But we can obtain precise frequency predictions. (Cf. Popper 1972/b, p.229.) The statistically interpreted theory obviously rules out the possibility of exact measurements, but some form of precise testability is necessary or the whole theory would be quite untestable and thus wholly metaphysical! Under Heisenberg's uncertainty relations it apparently becomes impossible in principle to predict the path of a particle. But the uncertainty relations apply only to magnitudes belonging to the particle after the measurement has been made. Position and momentum up to the instant of measuring can be ascertained in principle with unlimited precision.

The starting premise of Heisenberg's schema of thought is interesting. It is an epistemological programme to rid physical theory of unobservables (cf.10.3.4.) - that is, what was not accessible to experimental observations was to be regarded as metaphysical. This led him to reject the concept which enabled the precise path of a particle to be found by claiming that whether we should attach physical reality to a calculated past history was merely a matter of taste. The end result of this may well be thought to be to attribute no reality to quantum theory but a brand of subjectivism/idealism of certain instrumental value. Against this, there have always been those who maintain the realistic view of science; who, while accepting for the moment the idea of 'wavicles' see no reason to abandon the classical realistic concept that sub-atomic particles are in fact particles possessing locality and momentum.

Popper, for example, reacts against any subjective interpretation and proposes that an objective, statistical interpretation of the uncertainty formulae should be seen as the fundamental reality. One of Popper's section headings in his 'Logic of Scientific Discovery' is revealing - 'An Attempt to Eliminate Metaphysical Elements by Inverting Heisenberg's Programme; with Applications.' (ibid p.228.) Thus he too adopts the same epistemological programme - to rid science of metaphysics. When we interpret uncertainty relations in a solely subjective way, then the concept of physics as an objective science is undermined. Popper responds by arguing that the uncertainty relations are formally singular probability statements and that this allows an untangling of their subjective and objective interpretations. He gives the following illustration: imagine a mirror which is semi-translucent, letting part of light through and reflecting part. The formally singular probability that a given photon passes through the mirror may be taken to equal the probability that it will be reflected. The estimated probability is defined by objective statistical probabilities, that is, it is equivalent to the hypothesis that one half of a given class alpha of light quanta will pass through the mirror and the other half reflected. Now let photon k fall on the mirror, and let it be found that experimentally this has been reflected - then the probabilities seem to suddenly change (discontinuously). Before they equalled 1/2, while after the reflection they became 0 and 1. (ibid p.235.)

<u>27.4.1.1. Uncertainty As Indeterminacy In Nature.</u> Heisenberg contended that the uncertainty relations point to, or represent, indeterminism as a fundamental objective feature of nature. Thus indeterminism is an <u>ontic</u> reality. Margeneau writes that "the

uncertainty does not reside in the imperfection in our measurements, nor in man's ability to know; it has its cause in nature herself." (1954, p.6f.) But Heisenberg does not totally wipe out the idea of some form of weak causality. Thus the future is not decided, but on the other hand it is not toally open. In fact he endeavours to restore the concept of potentiality (in a combination of Aristotelian and Newtonian views) as objective and not merely subjective. Yet he holds that subatomic phenomena are significant in man and: "To this extent, at least, the causality governing him is of the weaker type, and he embodies both mechanical fate and potentiality." (Northrop 1971, p.25.) Here the Principle of Complementarity and an acceptance of the 'common-sense' concept of body-mind stand and fall together, but it may be that both ideas are but stepladders which may one day be thrown away.

<u>27.4.1.2. Uncertainty as Experimental/Conceptual Limitations.</u> It has also been held that uncertainty is an experimental limitation with respect to measuring. But while this holds up in many situations it does not account for the relevance of the uncertainty relations where nothing is done to disturb the system. However this led on to the idea that the uncertainty resided in a fundamental limitation of the knowledge man could have. The uncertainty was conceptual and not experimental. This gives an agnostic position concerning atomic determinism or indeterminism, and ontic questions are ignored or dismissed as irrelevant. Probability functions are useful calculating tools for coordinating observations, but are not representations of the real world. Thus Frank asserts: "We invite trouble if we ask the question, what are the 'real' physical objects." (1962, p.244.) This is a powerful source of instrumentalism and complementarity.

<u>27.4.1.3. Uncertainty As Temporary Ignorance.</u> Many great names stand here such as Einstein, Planck, de Broglie and Bohm, all contending that the problem of uncertainty is epistemological and not ontical, believing that the sub-atomic realm is in all probability causally determined and that it is only our present ignorance that hides this. Einstein firmly believed that one day we would get beyond our present lack of knowledge and see that all was fully determined. (1973, pp.316-318.) This of course raises serious problems as to the choice and responsibility that man may be said to possess, for this was not simply a belief concerning quantum mechanics but the whole of reality (cf. 18.5.3.).

27.4.2. Towards A Cosmonomic View of Indeterminism. Christian interest in this question gives no clearcut prominence to any one of the above alternatives. The Roman Catholic historian of science, Van Melson (1952), chooses for determinism; while the physicist-theologian, Pollard (1958) sees in chance the working of God's providence (which seems to tend to a god-of-the-gaps-idea). In the tradition of the Cosmonomic Idea the physicist Stafleu (1976) sees the first interpretation as an illustration of the fundamental individuality of all things as created.

It seems to me that the first two aspects can be combined to give a forceful argument that uncertainty is here to stay at this level and that strict determinism is undercut.[6] As Stafleu sees it: it seems to fit neatly into the idea of sphere sovereignty and kernel irreducibility that there is in created nature a basic level of indefinability - which has been exposed in quantum theory. At the same time the human mind is limited and finite and therefore uncertainty enters as a condition of conceptual limitation. We can never have exhaustive truth of nature, even though we may have true truth. But what man knows at any given time is (outside of revelation) provisional, temporal and relative, not ultimate, eternal and absolute.

27.5. INDETERMINISM IS NOT ENOUGH [7]

27.5.1. The Mind and Indeterminism (after MacKay). Despite the limitations concerning quantum theory, some thinkers have extrapolated from it to metaphysical generalisations - a result of its epistemic programme! Thus Eccles argues that the will of man influences neural circuits without negating the physical laws, in that the energy levels involved are within the limits of the uncertainty relations. But MacKay has countered this: (a) by pointing out that there are about ten thousand million nerve cells in the brain and the chances are greater that any one will be disturbed by a physical (macroscopic) event. The uncertainty relations become increasingly determinate the bigger the object we are studying, and a nerve cell, while by our standards small, is massive compared to an electron. (b) The brain is not to be compared to a wireless set where the failure of a valve upsets the whole performance. Nerve cells seems more akin to a rope where the individual strands work in teamwork. (c) The random

6. Cf. footnote 1 - my reference to Stoker.
7. Cf. footnote 1.

variations that may be allowed for in the uncertainty principle are small compared to physical variations such as temperature, blood fluctuation and external stimulii. In the event MacKay thinks that the introduction of randomness in the chain of individual control tends to excuse a person from responsibility rather than crediting him with it - which is what proponents of this view, in the main, are arguing.

27.5.2. Chance and Necessity (Monod). Jacques Monod is the apostle of unadulterated chance. He writes:

> "...chance alone is at the source of every innovation, of all creation in the biosphere. Pure chance, absolutely free but blind, at the very root of the stupendous edifice of evolution: this central concept of modern biology is no longer among other possible or even conceivable hypotheses. It is today the sole conceivable hypothesis, the only one compatible with observed and tested fact. And nothing warrants the supposition (or the hope) that conceptions about this should, or ever could, be revised." (1974, p.110.)

Note the total dogmatic (religious) claim being made here - this is the closed mind par excellance. Monod goes on, depicting man as alone in an alien universe and concludes his book 'Chance and Necessity' with these words:

> "The ancient covenant is in pieces; man at last knows that he is alone in the unfeeling immensity of the universe, out of which he emerged only by chance. Neither his destiny nor his duty have been written down. The kingdom above or the darkness below: it is for him to choose." (ibid p.167.)

Man is simply the product of chance, a random product of the roulette wheel (cf. ibid p.137.). But in this it is inevitable that his values are subjective, his ethic solipsistic. The problem is that on his own basis he has no basis for values or judgements.

27.5.3. Worlds 1,2 and 3 - Popper.[8] A much more consistent philosophical system involving a general worldview, science and ethics, is given by Karl Popper who advocates an indeterministic world but also suggests that indeterminism per se is not enough to establish human responsibility. While the mainline British philosophers such as Russell, Moore and the analytics had investigated knowledge with a Cartesian subjectivistic presupposition about what knowledge was, namely the mental state of particular individuals; Popper has consistently contended for an indeterministic but realist and

8. Cf. Popper (1975, chs.3,4.); (1973/a); and (1976/a, chs.18,38,39.)

rationalist concept of objective truth.

He posits the necessity of holding to a world 1, 2 and 3. World 1 is the physical world of rocks, trees, people, physical force fields etc.; world 2 is the psychological world of men's hopes and fears etc.; and world 3 holds the products of the mind (world 2), such as works of art, ethical values, social institutions etc.. Thus books are at one and the same time members of worlds 1 and 3. Two copies of the same book are individually physical members of world 1; but in world 3 represent the same mental content. It is crucial to Popper that the reality of all three worlds be held to, and that it is realised that each has the ability to 'kick back' if its rules are infringed. He points out that until recently world 2 was the fashion, that is a monistic immaterialism/phenomenalism; but that today world 1 has reasserted itself, that is a monistic materialism/psychicalism. But he would suggest that toothache was real!

To distinguish worlds 2 and 3 is crucial, and the difference largely lies in that to think a thought involves world 2, but to formulate and produce it into the external world involves world 3 - that is, the difference between thought processes and thought content. He indicates the relative autonomy of world 3 with the following example. Assuming (and this is an assumption) that man has invented the sequence of natural numbers - 1,2,3,4,....n - it might be held that this was simply an artifact of world 2. But what of the sequence of odd or even numbers, or primes, or the existence of perfect and amicable numbers - can it be held that man also invented them? Goldbach, for example, has given a theorem that every even number is the sum of two primes, and while this has been demonstrated as true for all known numbers, no proof has so far been discovered - it is an empirical discovery antecedent on the postulation of the natural numbers.

Classical determinism is equivalent to world 1 determinism and was clearly formulated by Laplace. His view being that given the precise masses, positions and velocities of all material at some point in time, then in principle we can calculate all that has and will happen. This view leaves no room for human freedom, and more seriously from a logical point of view, the required calculator would need to exceed the universe. However, with the failure of Maxwell to explain electricity and magnetism on the basis of Newtonian mechanics, the Laplacian world 1 became open to a new dimension - field forces, though still in world

1. Many physicists still believe that world 1 has no openness to world 2.

Indeterminism seemed to break this circle of closedness and Popper suggests that even classical determinate Newtonian mechanics is in principle indeterminate! That there is indeterminism at all suggests, he claims, world 1 may be open to world 2 and not determined and closed. But such openness does not establish freedom in man. Popper argues indeterminism is a necessary, but not a sufficient, condition of freedom.

Strict determinism implies that the poetry of Homer, the philosophy of Plato, the music of Bach and the science of Heisenberg are preordained, merely products of world 1. This is absurd. The opposite extreme of sheer chance is equally absurd as an explanation of such events. Thus Popper concludes:

> "All this means that world 3 can act upon the world 2 of our minds. But if so, there is no doubt that, when a mathematician writes down his world 3 results on (physical) paper, his mind - his world 2 - acts upon the physical world 1. Thus world 1 is open towards world 2, just as world 2 is open towards world 3." (1973/a, p.25.)

Therefore he envisages that our universe is partly causal, partly probabilistic, and partly open. "Man is certainly part of nature, but, in creating world 3, he has transcended himself and nature, as it existed before him." (ibid p.26.)

Remembering the argument of MacKay for the openness of determinism (cf. 27.3.2.), note that Popper is in effect using a similar idea to present the case for indeterminism. His idea of the three worlds is however imprecise - appearing to be a hybrid of Platonic forms and more concrete ideas, such as books, libraries etc.. However, I feel that the thrust of his argument is a sound corrective against world 1 determinism, for he suggests there is no scientific reason why mental and physical states should not interact. (Cf. 1972/a p.298.)

Popper presents his basic aim as follows: the first conceptual revolution saw God replaced by Nature leaving all else unchanged - theological determinism simply became natural determinism; the second revolution by Hegel and Marx replaced Nature by History, and Popper asserts that his role is to combat this deification of History and reinstate Nature in its full supremecy. Perhaps the Christian should be endeavouring to go one step more and combat both the deification of history and nature. It is God who has given to man the ability to transcend himself and nature, to create and formulate his ideas in world 3. Tentatively it might be suggested that world 3 also embodies the will of God for His creation as well as the content of man's thoughts - or should a world 4 be posited?

27.6. ATTEMPTED RESOLUTIONS

27.6.1. The Illusion Theory of Hume. This has, of course, had much popularity in British empiricism. (Cf. Korner 1969, p.233.)

27.6.2. The Dual-World Theory. Vitalism suggested that non-living matter was under a different set of laws from living matter. There is the more basic dual-stuff theory of someone like Descartes who, holding to a mechanistic view of the material universe, wished to safeguard responsible action from the realm of natural necessity. So he distinguished two distinct realms of mind and body, with the natural laws applying only to the latter. (Cf. Pears 1972, p.235.) Kant also advocated a double-world theory, making a radical distinction between the phenomenal world and the world as it really is (noumenal). Also there was his clear separation between the world of physical necessity and that of the moral imperative. (Cf. Korner 1969, p.235 - Appendix E.) Such views are still very much with us and in a recent work de Ropp claims that there is a qualitative difference between the mind of man and animals, it is more complex and operates in an entirely different dimension (cf. 1972, p.203 - cf. Heisenberg 1952, p.107.)

27.6.3. The Dual-Language Theory (cf. 16.5.2.2.). This theory tends to follow Hume (in seeking a resolution by linguistic clarification) and Kant (in regarding neither predetermination or freedom as illusory). Here a choice is free in the realm of actor language, but determined when viewed in spectator language. Despite the obvious tensions it is claimed both are needed to qualify human experience. Thus freedom and determinism are shut up within different linguistic aspects of reality.

27.6.4. Existentialism. This rests on the point that any concept of determinism resides on an abstractive analysis of some form, whereas freedom is a property of the act of the total person. So we are to trust the impression of freedom that we all experience from day to day above any metaphysical or scientific assumptions. Man's existence, as

Kierkegaard reiterated time and again, cannot be captured in the categories of Hegelian logic. But experience can be wrong and misleading! Once it was thought there were no atoms; once it was thought the earth was the centre of the universe.

27.7. GOD AND MAN IN THE PERSPECTIVE OF PROVIDENCE

It is impossible to escape from the biblical perspective that God creates and preserves, controls and directs the destiny of His creation. Nevertheless the theological term 'providence' is not in fact a Scriptural term, being formulated as a doctrine in the early church against Epicurean chance and Stoic fatalism. Augustine, Aquinas, Luther and Calvin all testify to their belief in this doctrine. Modern theology has departed in general from such views for a variety of reasons: by conceding to science, in the tradition of British empiricism, with respect to the acquisition of knowledge; by confusing scientific uniformity with respect to all types and sequences of events, thus ruling out revelation _per se_; and by failing to work out the relation of God to the cosmos. Liberal theology largely eliminated revelation by shutting up all things to the empiricalistic and rationalistic arena of humanist thinking. Existential theology effectively shut God off from all realms except the personal where the encounter between man and God was maintained. Conservatives also shut God up to the realm of the personal encounter and denied the validity of the cosmos. All these tend to create, perhaps unwillingly, a God-of-the-gaps mentality, or at least operate within that mentality while ironically condemning past ages for the self-same fault. But if it is thought that scientific uniformity can be a barrier to miracle or prayer, if science is made autonomous from its religious foundations in the heart of man - then we have entered into a mentality where a God-of-the-gaps is not only possible, but inevitable.

Providence is obscured if connected solely to special acts of God. It is the whole upholding (cohering) in being of reality that is involved. The great Reformation statements firmly asserted the total rule and providence of God over His creation, and I firmly believe they are of particular value coming at a point when modern science was under way, but before the dissociation of God from the laws of nature.[9] The Bible presents a creation with rational order but not determined

9. Cf. Confessio Belgica Art.13; Heidelberg Catechism Q.27.

necessitarian character; it presents no inherent natural law autonomous from the will of God, but conceives of this order as the sign of God's loving care. The order of nature is not our perceived or logical order but that which is willed by God. Thus both natural order and extra-ordinary event are equally from God.

Providence, then, may be conceived as the continued operation of the divine power through which God as Creator preserves all things, is involved in all processes of becoming in the world, and directs all things to their end. This is not to limit providence to the foreordination of God, nor conceive some mechanically determined providence where what will be will be.

It seems to me that we are needing to recapture something of the emphasis of Calvin here, not only in that providence gives a rational and reasonable worldview vis a vis the created order, but also gives comfort and assurance. It is a doctrine that frees from anxiety because it is our Father who is in control of all things. In this sense the doctrine of providence presents a primary existential calling which must not be dissected into bits and pieces of logic for there is a mystery, an undisclosedness of God involved. We are asked to believe and to understand, but while belief is total commit ment, knowledge is ever finite and limited.

The providence of God involves His preservation, that is His continuous work by which He maintains His whole creation in being, including all its properties and powers; it involves His divine government, that continued activity of ruling all things so as to secure the end of His divine will; and it must be seen in the light of co-operation or concurrence by man and nature with God. Nature may appear to act autonomously, but God is mediately operative in all things. Interestingly Aquinas, like Calvin and Luther, rejected unbridled free will in man, and advocated the doctrine of predestination, reprobation and election. (Cf. Hookyaas 1973, p.107. and Flew 1971, p.233.) Now while Calvin would agree with this thrust, he nevertheless contended that "the eternal decrees of God by no means prevent us from proceeding under his will, to provide for ourselves, and arrange all our affairs." (1560, p.103.) God is ultimate; but man is still a responsible rational being. The problem is undoubtedly that of trying to reduce God and His ways to finite human categories (cf. footnote 1.). We must face up to the reality that the biblical picture of man, time and again, is that of men faced with choices to be obedient or disobedient, believing or disbelieving - all of which is non-sense apart from the moral responsibility of man.

I support neither an absolute determinism nor man as autonomous from His creator. The Scriptures consistently present the divine sovereignty and the responsibility of man in juxtaposition. Think of Luke 15 - the parable of the lost sheep, coin and son. In the first two aspects it is God who alone seeks out that which is lost; the coin and the sheep are passive. But in the third episode it is the son who wakens to the realisation of his lostness and returns (actively) to the father. Another example is John 6;39 and 40 where the middle portions of these two verses (parts 'a' and 'c' being parallel) clearly indicate the balance between God's side and man's side.

27.8. TOWARDS CONCLUSIONS

C.S.Lewis suggests somewhere that reason has to but nod at its post and the patrols of naturalism will swiftly move in and take over our mentality; that the minute we stop consciously directing our existential being to the total providence and sustaining power of God, then imagination, mental habit, temperament and the spirit of the age infiltrate our defences. We know that the revelation of God demands a certain attitude, a certain world and life stance, but our minds are often overcome by the insidious spirit of the age which assumes at root a self-contained universe which is closed and has no God.

God alone gives us a valid expectation of uniformity in the world, a uniformity without which science is impossible. But we are not given that this uniformity is an intrinsic property of an autonomous order; rather we are given it as an expectation, as a work-a-day conviction which will be fulfilled by and large, and not as a statement about exhaustive reality and experience. For when it assumes this latter role it excludes God. To misappropriate the principle of uniformity is to limit the free operation of the transcendent in human experience.

In non-theistic scientific approaches uniformity is married to either irrational chance or rationalised determinism. But if the whole universe is the result, not of the plan and power of God, but of irrational causes and reality nothing but matter in random motion, how can this theory stand on its own (Cf Barclay 1974, p.105.) Deterministic uniformity is no better for if nature's order is totally uniform then God's relation to the universe will need to be thought of as distanced. He may be the original creator who gave some potentiality to all things to unfold themselves, but He is not involved in the affairs of the universe, least of all its physical aspects. This is the failing of all who would do their science and then turn round and say 'On to God.' Determinism leads to laws <u>of</u> nature, while theism points to nature controlled by the law of God.

Despite Heisenberg prediction remains good with respect to the boiling of kettles, the accuracy of clocks, and the putting of man on the moon. Fundamental irrationality and science are incompatible, for all research assumes uniformity somewhere along the line with respect to the methods used. So the Theist does not reject the fact that past events and the environment condition the activities of people; yet he will always maintain that we can react in more than one way to any given situation.

Causality cannot be reduced to a mode or aspect of being. It is not sufficient to explain it away merely on the terms of temporal and spatial relationships. Without denying the existence and necessity of spatial concomitants and temporal precedents as causal, it must be asserted that to rely solely on such conditions as providing a sufficient explanation of causality is unsatisfactory. We recognise causality in observation; we do not derive it from observation - and this ability is a gift given by God to further our mastery and dominion of the universe. We need the category of cause and effect to do all other rationalising. In effect causality is a God-given intuitive realisation. To turn the whole question round: do not the facts of experience give an insoluble problem to theoretical determinism?

This discussion should have highlighted the dangers attendant on the equation of scientific theory with theistic belief in insoluble bonding. While indeterminism is still debated in physics it would seem presumptuous for theology, which is after all another abstractive discipline, to step in and tell science what it should believe.[10] It

10. It is worth noting that in May 1977 an International Conference on Space-Time Absoluteness was to be held by those scientists who reject the Einsteinian solution. Cf. New Scientist 23 Sept., 1976, p.662.

seems to me that theology should never irrevocably tie the revelation of God (special) to some fleeting scientific theory - for to do so is to overestimate science. It can only say that some particular theory is apparently consistent with Christian belief, or is not. While the 'yes' must be conditional, certain negations seem feasible. It seems to me that the Theist can confidently reject any theory which involves either absolutistic chance or determinism which precludes the wholeness of being and the responsibility of man.

I conclude that Theism does not capitalise to any great extent on the new physics, because as Mascall (1956, p.147.) has indicated, any such capitalisation is based on a crude equivalence of the physical and metaphysical. We must beware of confusing the metaphysical wonder of the biblical revelation and attitude towards God with the quite different physical puzzlement of the exploring scientist. As C.S.Lewis notes somewhere: in science we are, as it were, reading the notes to a poem, in Christianity we find the poem itself.

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POSTSCRIPT TO PART IV

Coming to this final postscript I feel that I have barely scratched the surface of an immense subject of vital importance. However I hope I have succeeded in indicating something of the religious and theological foundations of science and technology. I have tried to indicate the religious foundations lying in a governing worldview which is tied to some religious motive (cf. 3.5; 11.6; 12.5; 16.2; 18.1.1; Part IV; and Appendix A.) This is tied to questions of a philosophical nature as well as theological: to the ontological foundation of existence of self and reality as creatures within God's creation; to the epistemological reality that our knowledge of self and reality (and hence of science) can only proceed when it is grounded in a true and living knowledge of God[1]; and to the axiological end which can be construed only eschatologically from God and in no way as a messianic Marxism.

In understanding these foundations I believe the Christian has a relevant answer to many of today's problems; an answer to the apparently divergent choice between counter-culture, Marxism and status quo. All of these are finally closed worldviews, and even where transcendence is appealed to (e.g. Roszak) it is an immanent transcendence. But there is a God. And we live in the world He has created, and in the history He controls.

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1. While individuals may contribute to development, man is essentially a corporate being and we must look at the fruits of an age. In this connection it is worth remembering the remark of Oppenheimer that modern science could not have given birth to itself as we know it today because it has no foundation in our day. Cf. Encounter Oct. 1962.

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APPENDIX A

F.A.SCHAEFFER'S ANALYSIS OF THE DICHOTOMY IN MAN'S THOUGHT [1]

A.1. In the Scholastic period 'nature' meant the world in which man lived and in which his mind possessed a relative autonomy. 'Grace' on the other hand was the realm of the church, revelation and heaven. But in this dualism, grace was ascendant and life was governed by the divine and supernatural. 'Grace' was over 'nature', and the church dominated every town and village both architecturally and socially. The world was seen as full of spirits and 'nature' was not to be tampered with by man, resulting in a loss of any true scientific activity. Aquinas marked the end of this period, maintaining the view of philosophy as ancillary to theology and at the same time holding to the Greek concept of the autonomy of reason. Therefore the way was opened to the independence of 'nature' from 'grace' (cf. Macquarrie 1971, p.279.); no longer was it nature and grace, but nature versus grace. 'Nature' had been liberated from the constraints of 'grace'. But though Aquinas made no hard and fast distinction here, what he did was open the door to the possibility of total separation. When he separated theology from art and science an irreversible step had been taken. It prepared the road for these other disciplines to come into prominence in their own right, but also to assert an autonomous existence and eventually take over the role of master and lord that Aquinas assigned to theology. The crux of the matter was not so much the separation of disciplines as the independent autonomy that was granted to the human intellect. The crucial feature in Aquinas, argues Schaeffer, is that he had an incomplete view of the Fall, for while he agreed that man was fallen and that the will was corrupt, he did not extend this to include the mind, the reason of man. This meant that reason, man's ability to work out from his own rationalism, became the basic starting point for his search for truth. (Cf. Ross & McLaughlin 1972, pp.29,30.)

This shift, this liberation of nature, can be seen in many ways. Up to this point art had been essentially symbolical, but with the new climate of humanistic optimism this ceased to be so. Nature having been set free from the constraints of grace could now be appreciated in itself; thus nature could be painted as nature without

1. Cf. Schaeffer (1968/a; 1968/b; 1971; 1972.)

any religious theme underlying it. The first man to do this was probably Albrecht Altdorfer, and Gombrich writes of him: "Many of his water colours and etchings, and at least one of his oil-paintings, tell no story and contain no human being. This is quite a momentous change. Even the Greeks with all their love of nature had painted landscapes only as settings for their pastoral scenes." (1972, p.273.) Here we also find the first recorded instance of a man climbing a mountain simply to conquer the challenge it presented. As this shift develops the natural always tends to push out the supernatural, or in Schaeffer's phrase 'nature eats up grace'. But the problem was, and is, that not only does nature tend to become more important than grace and finally replace it altogether, but nature thus liberated becomes by itself destructive. This is illustrated by Schaeffer from the world of art.

> "In France, Fouquet (c. 1416-1480) painted, about 1450, the king's mistress, Agnes Sorel, as Mary. Everybody knowing the court who saw it knew that this was the king's mistress. Fouquet painted her with one breast exposed. Whereas before it would have been Mary feeding the baby Jesus, now it was the king's mistress with one breast exposed - and grace is dead." (1968/a, p.16.)

Before Aquinas, then, there was little interest in nature (from Christianity) and his bringing it to the fore was a welcome move. But the problem was the tension created between nature and grace which led to the setting up of autonomous reason as the frame of reference for interpreting and constructing a worldview. Re-established nature was good in terms of understanding the details and particulars that go to make up the world we live in; but because of the underlying dualism it led to chaos in failing to provide an integrating reference point whereby the universals, or absolutes, of our universe could be based. This was the first chink in the hope of a unified field of knowledge and it led to a loss of absolutes in the area of morals and knowledge.

<u>A.2.</u> Following Aquinas:

> "The Thomistic synthesis of nature and grace was replaced by a sharp antithesis. Any point of connection between the natural and the supernatural was denied. This was the introduction to the shifting of primacy to the nature motive." (Dooyeweerd 1972, p.45.)

This general trend in the destruction of grace by nature gathers increasing momentum until it reached its climax in the Enlightenment.

Here the supernatural, the sphere of grace, was removed in totality from the arena of rational thought. There could be no room for it in the new physical sciences which were beginning to dominate.

> "By the seventeenth century nature had totally devoured grace, and what was left in its place was man's striving for freedom. However men soon found that their freedom was being threatened by the deterministic and mechanistic image of the world which their natural science was creating. The fight to retain freedom was carried on by the Romantic movement, beginning with Rousseau and Kant." (E.L.H.Taylor 1970, p.viif.)

This brings us to the next of Schaeffer's pivotal points which deals with the influence of Kant and Rousseau. By this time rationalism had become so well developed as a system there was no room left for any talk of grace within the field of the rational. All that existed was the deterministic views that had come down from the followers of Newton, and men like Laplace could assert that they had no need of God in their hypotheses. Grace was gone; eaten up by nature. 'Nature *and* grace' had become 'nature *versus* grace'; and now with grace gone it became '*nature and freedom*'.

This new formulation of the dualism in terms of nature and freedom had however a greater lack of cohesion. From the outset it was virtually nature *versus* freedom. While for Aquinas nature was under grace and in a sense flowed out of it, in Kant's dualism there was little in common between the concepts of nature and freedom. On the one hand there was determinism, the autonomous machine that was the world in which all could be explained in terms of the sciences; and on the other hand there was a certain quality of freedom that had its roots, not in the rational, but as an idea posited by ethics.

The autonomous had become fully developed, leaving no room for an area of revelation or grace. This took place, in Schaeffer's terms, 'upstairs'. Schaeffer sees all these dualisms in terms of 'upstairs' and 'downstairs'; in the former there is grace, soul, freedom, mysticism or whatever form men happen to give it; while the latter is the realm of nature, rationality, science and determinism. Only in the biblical view of creation, fall and redemption is a dichotomy avoided. It is Schaeffer's contention that all other systems fail in that they fall into a dualism. (Cf. ch.27, footnote 1.)

Up to this point all humanistic thought had followed an essentially threefold character: (i) it was rationalistic, starting from man and centred in him; (ii) it was rational, that is it operated on a basis of antithesis; and (iii) it held out the hope of a unified view of knowledge, that is any belief system could hopefully contain all knowledge, or at least had the possibility to do so. This is not to claim to have exhaustive knowledge but to know truly in all areas of knowledge. But by the time of Kant a point was reached when something had to give way. (Cf. Schaeffer 1968/a, p.40.) In an endeavour to hang on to his rationalism, his self-centredness, of making himself the sole reference point for all his thinking, man abandoned rationality and the hope of a unified field of knowledge.

Men gave up trying to be rational. Hegel introduced the concept of synthesis instead of anti-thesis; now there was thesis and anti-thesis and by stirring them up in the melting point of rationalism we arrived at a middle way of synthesis. Thus truth and error became blurred as did morality. Man also abandoned any hope of a unified knowledge and no longer was any hope held out of combining the two storeys - a complete dichotomy was accepted and led to the structuring of the various disciplines into watertight compartments.

__A.3.__ This brings us to Schaeffer's third step in the progress of the dualism of man's thought. The hope of a rational unified view was abandoned and in its place was put a split field of knowledge. Knowledge could now be on two levels between which there were no connecting links. The original dualism was virtually in the form of a continuum and that of freedom and nature (while having a basic opposition) was contained within a rational framework. But the dualism that now emerged was that of rationality and non-rationality. This is the modern dichotomy of faith and reason. Now the division between the two spheres had become absolute for there was no possibility of anything in common between the rational and the irrational. It was of the essence of Kierkegaard that faith lay in the area of the irrational and could not be explained or rationalised. His faith was not the biblical concept of faith which was that of putting trust in God and Christ, and doing so on the basis of certain revelations, promises and acts of God. For Kierkegaard there was no basis for faith, no promises or acts to believe in - it was a leap in the dark.

The dilemma for man was that in the area of rationality no meaning or values had been left. "Thus by the beginning of the nineteenth century autonomous freedom and autonomous science stood facing each other in deadly combat." (E.L.H.Taylor 1970, p.viii.) But: "On the basis of rationality, logic and scientific determinism man's life no longer has any meaning to it." (ibid p.ix.) Hence the modern scene is dominated by two opposing views - that of positivism (in some, probably attenuated, form) and existentialism.

Existentialism stands apparently in direct tension with the world of science which is supposed to contain a body of hard positivistic truth (still the popular myth). But it is worth noting that in our age many familiar with the world of science are moving increasingly to an irrational world that is beginning to take the form of existentialism. By and large however modern science tends towards a positivistic view of reality - except among frontline researchers and some philosophers. Only that which is capable of proof or reducible to terms of a formula or mathematics is accepted as part of the rational structure of reality. The watchword: What use is it?

A.4. This is not to say that the founders of science held this view. (Cf. Schaeffer 1968/a, p.32.) However the position that has developed is a firm belief in the uniformity of natural causes in a closed system. God is excluded and man trapped in the system. This means a view of the natural that is materialistic, and the development of a system of thought that allows only for the material. But this leaves the scientist with a problem. When he leaves his laboratory at night and goes home to his wife, he cannot say 'I love you' with any rational meaning. What to him was rational was left behind in his laboratory and he is caught in the dichotomy between the science-ideal and the personality-ideal. Thus to talk of love and beauty he has to transcend his deterministic view of material reality. He cannot live within the confines of his own worldview because he has been made by God in a way that demands love, beauty and morals. To exercise his true humanity, his 'mannishness' as Schaeffer calls it, he has to take a leap into the upper storey. It must be understood that this upper storey is disengaged from the world of determined rationality on his own terms.

Thus we have arrived at the modern representations of the nature grace dualism. No longer is it seen in these terms but this is still the basic split that underlies the modern dilemma. The lower storey of nature has passed into the sphere of the rational (on the basis of rationalism), the world of the machine, of a closed sequence of determined causality. (Cf. ch.27.) It is a world of facts, of formula, where man carefully pursues his sciences and defines his terms. The end result being the death of man *qua* man.

God is dead to modern man having been long since removed from the life of this world. God has no part to play in mathematics, physics, chemistry or biology and is pushed off to the misty regions upstairs where nothing is defined and all is possible because nothing is rational. But in a sense the tragedy is that man is dead. By reducing all to the level of the machine the uniqueness of man is lost. No longer is he seen as a special creation at the apex of creation. Today man is but a mechanical apparatus evolution is believed to have flung up, a collection of atoms that obey the dictates of environmental and biological conditioning. There is no difference between men and animals, and men have lost the meaning and purpose that gave significance to life.

Downstairs all that is left in the sphere of rationality is mathematics and physics, the social sciences and psychology; while upstairs God, love, morals, freedom and significance have become but symbols for mystic manipulation. Upstairs are connotation words that can be tossed about in various ways because they lack definition. So grace has become agnosticism and mysticism. In the area of rationality man is forced into an ultimate wall of agnosticism because, starting from himself and working outward in a closed system of determined reality, he cannot arrive at true truth. Thus the dualism ends up in an irretrievable dilemma; ends in despair of ever knowing anything truly; ends in the death of man as well as God. On the other hand man is unboundingly optimistic and this is only possible by a leap upstairs, to the area 'beyond' science.

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This is, of course, a mere sketch of what Schaeffer takes several books to work out in detail. His own work should be seen in the light of Dooyeweerd's analysis (1969, vol.I.) of the same theme - indeed it has been suggested that Schaeffer is essentially an Anglicized, popularised version of the former's work. While some of Schaeffer's dates and pivotal figures may give rise to debate, such controversy should not detract from the overall thrust he is making - namely of the progressive separation of the two aspects of the ground motive in the mind of humanistic man.

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APPENDIX B

A NOTE ON THE SECOND LAW OF THERMODYNAMICS

Boltzmann contended that the entropy of a gas increased with time by associating entropy with disorder and showing that disordered states of a gas in a box are more probable than ordered states. From this he concluded a general mechanical law which stated that closed systems tend to become more and more disordered the older they get. Thus his H-theorem was taken to prove a one-directional increase of disorder with time. But it was pointed out that Poincaré had already postulated a proof that every closed system returns after a finite time to the neighbourhood of the state in which it was previously. Thus we have cyclic processes. Hence there could be no preferred direction of time associated with increasing entropy. Boltzmann had to rethink, and Popper contends that he gave up his central argument, namely an objective arrow of time and increasing entropy with this. However in a second reply Boltzmann endeavoured to fix the future direction of time:

> "We have the choice of two kinds of picture. Either we assume that the whole universe is at the present moment in a very improbable state. Or else we assume that the aeons during which this improbable state lasts, and the distance from here to Sirius, are <u>minute</u> if compared with the age and size of the whole universe. In such a universe, which is in thermal equilibrium as a whole and therefore dead, relatively small regions of the size of our galaxy will be found here and there; regions (which we may call 'worlds') which deviate significantly from thermal equilibrium for relatively short stretches of these 'aeons' of time. Among these worlds the probabilities of their state (i.e. the entropy) will increase as often as they decrease. In the universe as a whole the two directions of time are indistinguishable, just as in space there is no up or down. However, just as at a certain place on the earth's surface we can call 'down' the direction towards the centre of the earth, so a living organism that finds itself in such a world at a certain period of time can define the 'direction' of time as going from the less probable state to the more probable one (the former will be the 'past' and the latter the 'future'), and by virtue of this definition (sic) he will find that his own small region, isolated from the rest of the universe, is 'initially' always in an improbable state. It seems to me that this way of looking at things is the only one which allows us to understand the validity of the second law, and the heat death of each individual world, without invoking a unidirectional change of the entire universe from a definite initial state to a final state." (Boltzmann: quoted and translated by Popper 1976/a, p.160.)

Unfortunately this tends to a subjective idea of time, to philosophical idealism where the real becomes illusory. This is implicit in his identification of unidirectional change as an illusion. Thus Popper argues that his H-theorem falls to the ground in that for his objective concept of time, entropy decreases as often as it increases; while for his subjective concept, entropy increases by definition or illusion. (Popper ibid pp.156-167.)

Now, the first law of thermodynamics is that of energy conservation; while the second concerns the reduction of energy available for work, that is entropy. A standard 1975 physics text-book gives a general formulation of this as follows:

> "An isolated system, free of external influence, will, if it is initially in a state of relative order, always pass to states of relative disorder until it eventually reaches the state of maximum disorder." (Weidner & Sells 1975, p.291.)

This account goes on to review that while on the microscopic scale all processes/collisions are ideally reversible, this is not so of the macroscopic scale, or the scale of the real world as we experience it.

> "By a microscopic state is meant a state corresponding to a specific position and momentum for each and every molecule of a gas. There are available so many more microscopic states representing disorder or near disorder than representing order that the most probable macroscopic state is that of maximum disorder; indeed, it is near certainty." (ibid p.293.)

Thus while individual collisions between particles are reversible in time such that we cannot tell whether a moving-picture film portraying an intermolecular collision is being run forward or backward, this does not hold when we deal with large numbers of particles. It only holds for the isolated instance and my contention would be that the isolated instance is either an ideal conception or an artificial construct of the laboratory; rarely is it representative of the macroscopic world. We can tell when a film of an exploding bomb is run backwards.

> "Thus, the second law of thermodynamics implies directionality of time. At the macroscopic level, time's arrow points to the future. Order turns to disorder; ordered energy is degraded into disordered or thermal energy." (ibid p.295.)

I note, however, the objection, for instance by Adolf Grunbaum, that there is a logical hiatus as we progress from the microscopic reversible process to the macroscopic irreversible process. It is from this basis that it has been argued that since the probability that a molecule has a given velocity is independent of the sign of that velocity, separation could occur as readily as mixing. There is also a reversibility objection to the effect that for any behaviour of a system which resulted in an increase of entropy with time, it would also be possible to have entropic decrease. (This is similar to the periodicity objection of Poincaré.) Grunbaum goes on, after reviewing these objections to contend that:

> "Boltzmann's H-theorem can thus be upheld in the face of the reversibility and periodicity objections, but only if coupled with a very important proviso: the affirmation of a high probability of a future entropy increase must not be construed to assert a high probability that present low entropy values were preceded by still lower entropies in the past. For the relative probability that a low entropy state was preceded by a state of higher entropy is just as great as the relative probability that a low state will be followed by a higher state..." (1968, p.409.)

Popper cites the instance of irreversible processes which do not involve entropy increase. Consider a large surface of water initially at rest into which a stone is dropped - producing an outgoing concentric wave of decreasing amplitude. He argues that the irreversibility of this process is attributable to the physical impossibility of the uncoordinated concatenation on all points of a circle of the initial conditions required for the opposite effect. However, he admits in a closed system there is an entropy increase as a result of viscous losses - but Popper strengthens the argument by taking a thin gas in an infinite universe. (Cf. Grunbaum 1968, p.415f.)

Stephen Toulmin has an interesting essay on this topic. He acknowledges the run-down theory that the one-way-system of the second law implies, and concedes that this law has "won for itself a supreme position." (1970, p.24.) But then he asks if it is universally applicable. Does a universal law necessarily imply a statement about the universe? Arguing from the fact that the second law refers to a closed system and that the universe is boundless (cf. Einstein's boundless but finite universe), therefore the second law cannot apply to the whole even if it universally applies to the parts. So while the fact of the cooling down of the earth may be a fact of physics, the contention that the universe is decaying away is merely metaphysical speculation. Hence Toulmin endeavours to argue that universal laws are not laws of nature. He develops his argument by comparing the law to a map projection.

But it seems to me that his argument depends on even more tenuous assumptions than the ones he is attacking. The extension from mapping tools to scientific laws, though consistent within his instrumental position, has already been seen as inadequate (cf. ch. 11.). As he draws to a conclusion he writes:

> "All this is not to say that philosophical attitudes to the universe-as-a-whole are unjustifiable, and cannot be argued about. Perhaps we should be stoical about the ultimate fate of all things, or carefree, or other-worldly; and no doubt reasons of some sort can be given in favour of adopting one of these attitudes or another. All we are entitled to say is, that physics does not oblige us to adopt one, or indeed any, of these attitudes. The running-down universe is a myth, and we shall discover about the Apocalypse from physics only what we read into the subject." (ibid p.33.)

But surely his whole argument is constructed on a premise that only allows him to remain silent? How, apart from a purely metaphysical jump (on his terms) does he get from the second last to the last sentence in the above quotation? Surely on his own premise he can not say that the earth is running-down or not? If universal laws apply to the universe then obviously he must answer in the affirmative; but if they do not, he still has no mandate for a rejection of this possibility - all he can do is to espouse silence.

It seems to me that his whole object is to avoid the logical implications of what he acknowledges to be a law supreme in the scientific world. As S.R.Montgomery points out all real processes are irreversible because of friction which reduces the available potential; because of heat transfer across finite temperature differences (though heat transfer is not itself irreversible); and because of unrestrained expansions. Reversible processes or cycles are representative of the unattainable limit for real processes. (S.R. Montgomery 1966, p.30.) In any real, irreversible process the change in entropy is related to the heat transfer by the equation $dS > Q_I/T$ - where 'S' refers to entropy, 'Q' to heat transfer interaction, 'I' to irreversibility, and 'T' to absolute temperature. (This is a direct consequence of the Clausius inequality.) As a particular consequence of this relation it follows that during any irreversible adiabatic[1] process the entropy must increase. That is, the entropy of an isolated system can only increase or, in the limit,

1. An adiabatic process is one in which there is a change in the pressure and volume of the contents of an enclosure without exchange of heat between the enclosure and its surroundings - presumably there can be no heat transfer outwith the universe.

remain constant. Thus Montgomery writes:

> "Since a system and its environment together constitute an isolated system, any decrease in the entropy of that system during an irreversible process must be accompanied by a greater increase in the entropy of the environment. This can be demonstrated very simply for heat transfer between bodies across a finite temperature difference." (ibid p.55.)

In the light of this it seems evasive to reject the second law in terms of the universe. Undoubtedly it is the fear of some rationalists that the acceptance of such conclusions leads inevitably to God. (Cf. R.E.D.Clark 1961, p.55.) Eddington rightly complained that critics of the heat-death of the universe who claim that it is unsafe to extrapolate from our experience and knowledge to this conclusion are exactly the same critics, who in refereeing a paper on, for example, the origin of cosmic rays in galaxies beyond telescopic range, would look right away to see if the paper was consistent with the second law - and advise its rejection if it did not conform.

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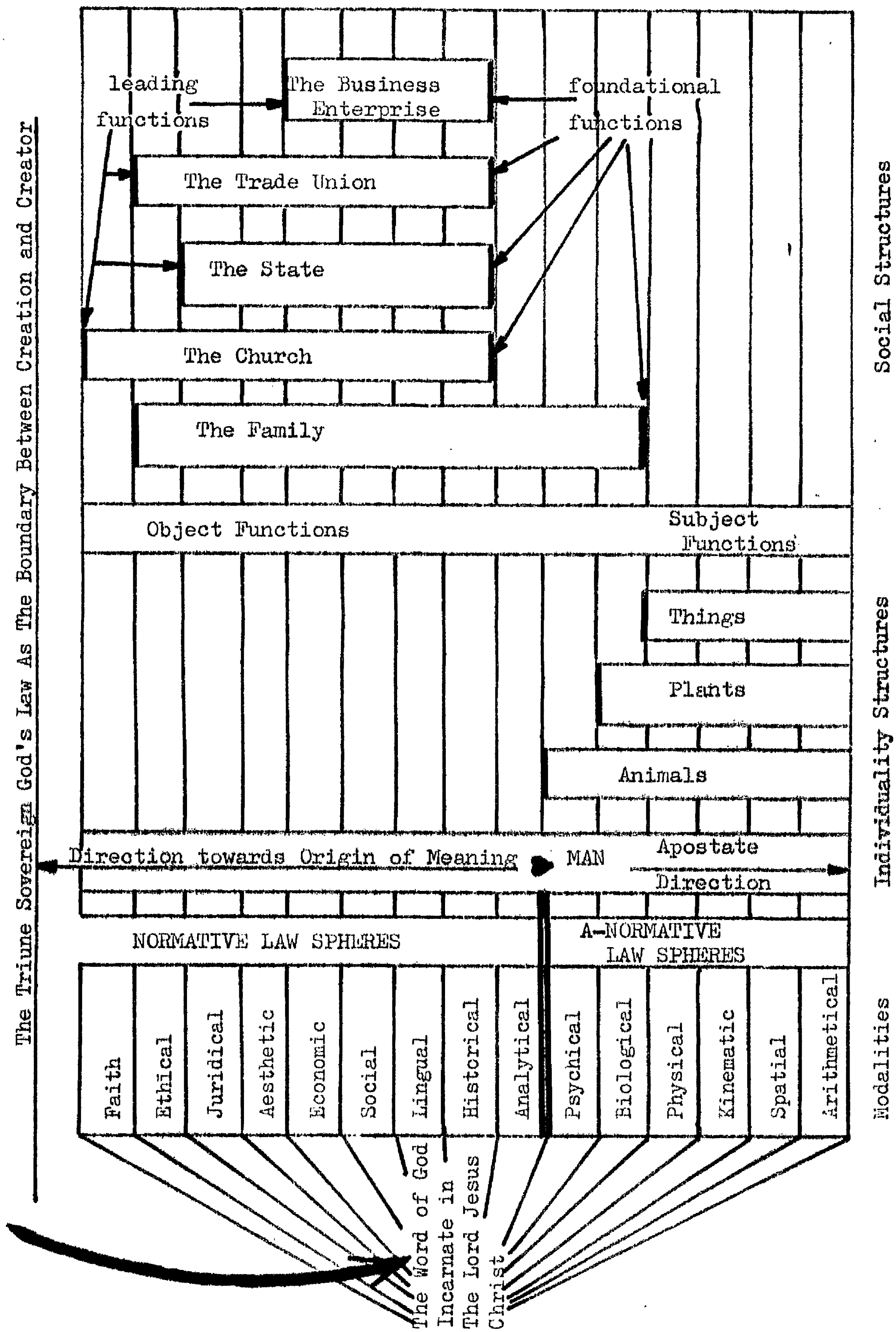
APPENDIX C

DOOYEWEERD'S LAW SPHERES (E.L.H.Taylor 1970, p.626.)



APPENDIX D

SCHEME OF DOOYEWEERD'S COSMOLOGY (Cf. Taylor, E.L.H. 1967, p.53.)

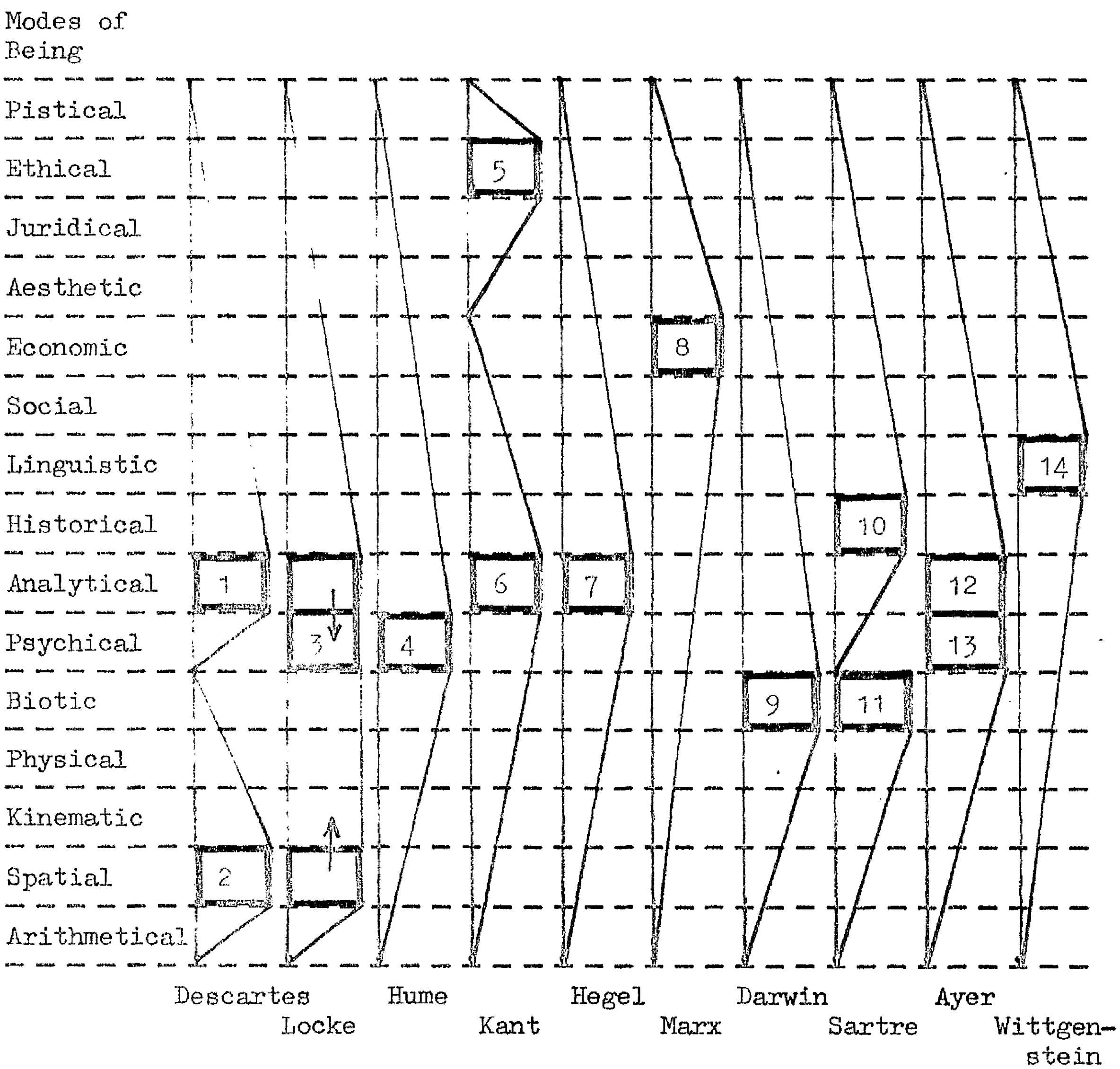
Succession of Spheres		Modal Moment	Order of Time	Scientia
1.	Arithmetical	Discrete quantity	Succession and relation of numbers	Mathematics
2.	Spatial	Extension	Spatial simultaneity	Mathematics
3/4.	Kinematical & Physical	Movement	Measured time according to the movement of the earth around its axis	Physics and Chemistry
5.	Biological	Organic Life	Organic development	Biology, Physiology, Morphology
6.	Psychical	Feeling & Sensation	Succession of feelings	Psychology
7.	Analytical	Theoretical distinction	Logical prior and posterior	Logic
8.	Historical	The cultural process of development of human society	Historical development in the sense of periodicy	History
9.	Linguistical	Symbolic signification	Pauses, tenses, etc.	Philology, Semantics
10.	Social	Social intercourse	Social status and convention	Sociology
11.	Economic	Economy	Calculation of interest, investments etc.	Economics
12.	Aesthetic	Harmony	Unity of time, aesthetic duration	Aesthetics
13.	Juridical	Retribution	The course of retribution, expiring contracts etc.	Jurisprudence
14.	Ethical	Love of neighbour	Prudence	Ethics
15.	Pistical	Transcendent certainty regarding the origin	The reference to eternity	Theology

Dooyeweerd, of course, does not consider this scheme as final as further research may reveal more modal spheres or cause some change in the order of the spheres.

APPENDIX E

DIAGRAM SHOWING THE HUMANISTIC ABSOLUTIZATION OF THE RELATIVE

The diagram shows the development of Western Humanism, in which the ground motive of 'nature' and 'freedom' progressively involves itself in 'dialectical tensions' and the reduction of the fulness of created reality to one or two of its modes. (This diagram is adapted from R.Russell and J.Pierce - 1969, between pp.5 and 6.)



Key: 1. = Mind; 2. = Matter; 3. = Ideas; 4. = Impressions;
5. = Noumenal; 6. = Phenomenal; 7. = Absolute Spirit;
8. = Economic Determinism; 9. = Evolution; 10. = Free Self;
11. = World; 12. = Logic; 13. = Sense Data;
14. = Language Games.

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GLOSSARY OF TERMS

This glossary is included to give a summary of those terms or expressions which may be considered to be unusual, or common but given a specific content, or stem from the philosophy of Dooyeweerd. Most of the references that pertain to Dooyeweerd are drawn from the glossary by M. Wolters in Kalsbeek (1975, pp.346-354.) Wolters' summaries are marked - *; though I have adapted them.

*Anticipation : A 'meaning-moment' within one Modality referring to a higher modality. An example is efficiency, a meaning-moment which is found within the technical-historical modality, but which points forward to the higher economic modality. Contrast - Retrocipation.

*Antimony : Literally 'conflict of laws'. A logical contradiction arising out of a failure to distinguish the different kinds of law valid in different modalities. Since ontic laws do not conflict an antimony is always a logical sign of ontological Reductionism. Example: Zeno's Paradoxes.

*Antithesis : Used by Dooyeweerd (following Kuyper) in a specifically religious sense to refer to the fundamental spiritual opposition between the Kingdom of God and the kingdom of darkness. Since this is an opposition between regimes, not realms, it runs through every department of human life and culture, including philosophy and the academic enterprise as a whole, and through the heart of every believer as he struggles to live a life of undivided allegiance to God.

Arche : God has revealed Himself as the only and absolute Origin of all things. As such this is to be sharply distinguished from the Archimedian Point.

*Archimedian Point : A sure place to stand; a vantage point from which everything can in principle be seen in true perspective. For Dooyeweerd this is the position 'in Christ' of the believer.

*Common Grace : God's goodness to all men in maintaining the creation and its structures. By virtue of this common (or conserving) grace there is much that is good, true and beautiful in the lives of unbelievers, including their philosophizing.

*Cosmonomic Idea : Dooyeweerd's own English rendering of WETSIDEE.

Occasional equivalents are 'transcendental ground idea', and 'transcendental basic idea.'

*Dialectic : In Dooyeweerd's usage: an unresolvable tension, within a system or line of thought, between two logically irreconcilable polar positions. Such a dialectical tension is characteristic of each of the three non-christian Ground Motives which Dooyeweerd sees as having dominated Western thought.

*Enkapsis (enkaptical) : A neologism borrowed by Dooyeweerd from the Swiss biologist Heidenhain, and derived from the Greek enkaptein, 'to swallow up.' The term refers to the structural interlacements which can exist between things, plants, animals, and societal structures which have their own internal structural principle and independent qualifying function. As such, enkapsis is to be clearly distinguished from the part-whole relation in which there is a common internal structure and qualifying function.

*Foundational Function : The lower of the two modalities which characterize certain types of structural wholes. The other is called the 'function of destination' or 'leading function.' For example, the founding function of the family is the biotic modality.

*Function of Destination : Refers to the function which primarily characterizes a structural whole. Also called qualifying function. The state, for example, has as function of destination the juridical, while its founding function is the historical.

*Gegenstend : A German word for 'object', used by Dooyeweerd as a technical term for a modality when abstracted from the coherence of time and opposed to the analytical function in the Theoretical attitude of thought, thereby establishing the 'gegenstend relation.' 'Gegenstend' is therefore the technically precise word for the object of science, while 'object' itself is reserved for the objects of naive experience (pre-abstractive thought).

*Ground Motive : Dutch grondmotief, used by Dooyeweerd in the sense of fundamental motivation, driving force. He distinguished four basic ground motives: that of Form and Matter, which dominated pagan Greek philosophy; that of Nature and Grace, which underlay medieval Christian synthesis thought; that of Nature and Freedom, which has shaped the philosophies of modern times; and finally the biblical ground motive of creation, fall and redemption, which lies at the root of a radical and integrally Scriptural philosophy.

*<u>Guiding Function</u> : The highest subject function of a structural whole (e.g. stone, animal, business enterprise, state.) Except in the case of man, this function is also said to qualify the structural whole. It is called the <u>guiding</u> function because it 'guides' or 'leads' its substrate functions. For example, the guiding function of a plant is the biotic. The physical function of a plant (as studied, e.g. by biochemistry) is different from physical functioning elsewhere, because of its being 'guided' by the biotic.

*<u>Heart</u> : The concentration point of man's existence, the supratemporal focus of all man's temporal functions, the religious root unity of man. Dooyeweerd says that it was his rediscovery of the biblical concept of the heart as the central religious depth dimension of man's multifaceted life which enabled him to wrestle free from Neo-Kantianism and Phenomenology. The Scriptures speak of this focal point also as 'soul', 'spirit', and 'inner man'. Philosophical equivalents are Ego, I, I-ness, and Selfhood. It is the heart in this sense which survives death, and it is by the religious redirection of the heart in regeneration that all man's temporal functions are renewed.

*<u>Individuality Structure</u> : The general name for the characteristic lawful order of concrete things, as given by virtue of creation. There is an individuality structure for the state, for marriage, for works of art, for mosquitoes, for sodium chloride, etc.. It must be distinguished from Modal Structure. A theoretical analysis of the latter is the indispensible precondition for an analysis of individuality structure. (Cf. Zigterman 1977.)

*<u>Law</u> : The notion of creational law is central to Dooyeweerd's philosophy. Everything in creation is subject to God's law for it, and accordingly law is the boundary between God and creation. Scriptural synonyms for law are 'ordinances', 'decrees', 'commandments', 'word', etc..

*<u>Law-Side</u> : The created cosmos, for Dooyeweerd, has two correlative 'sides': a law-side and a subject-side. The former is simply the aggregate of God's laws or ordinances for creation, the latter the totality of created reality, which is subject to those laws. It is important to note that the law-side is unaffected by sin, and is always <u>universally</u> valid.

Law-Sphere : An early equivalent for Modality - used by Dooyeweerd to stress the fact that each modal aspect answers to its own peculiar laws.

Meaning : Dooyeweerd uses the word meaning in an unusual sense. He means by it the referential, in-self-sufficient character of created reality in that it points beyond itself to God as Origin. He stresses that reality is meaning in this sense and that therefore it does not have meaning. 'Meaning' is the Christian alternative of the metaphysical Substance of immanence philosophy. 'Meaning' becomes almost a synonym for 'reality'.

Modal Irreducibility : Incapability of theoretical reduction - this is the negative way of referring to the unique distinctiveness of things which we find everywhere in creation and which theoretical thought must respect. Insofar as everything has its own peculiar created nature and character, it cannot be understood in terms of categories foreign to itself.

Modality : One of the fifteen fundamental ways of being distinguished by Dooyeweerd. As modes of being, they are sharply distinguished from the concrete things to which they belong.

Presupposita : Those initial assumptions necessary for rational thought. If man is to think rationally he must assume these.

Presuppositions : Those assumptions that a man has to make a choice over. A belief or theory which is assumed before the next step in logic is developed. Such a prior postulate can be held consciously or unconsciously.

Pre-Theoretical Thought (or naive thought) : This is human experience insofar as it is not 'theoretical' in Dooyeweerd's precise sense. 'Naive' does not mean unsophisticated. Dooyeweerd is at pains to emphasize that theory is embedded in this everyday experience and must not violate it.

Religion (Religious) : For Dooyeweerd, religion is not an area or sphere of life, but the whole of it. It is service of God (or an idol) in every domain of human endeavour. As such it is to be sharply distinguished from religious faith, which is but one of the many acts and attitudes of human existence. Religion is an affair of the heart, and so directs all man's functions.

*<u>Retrocipation</u> : A feature in one modality which refers to, is reminiscent of, an earlier one, yet retaining the modal qualification of the aspect in which it is found. The 'extension' of a concept, for example, is a kind of logical space: it is a strictly logical affair, and yet it harks back to the spatial in its original sense.

<u>Science</u> : I have restricted my usage of this term to the popular connotative meaning - that is, to the natural sciences.

<u>Scientia</u> : While realising this is the formal equivalent of 'science' in its denotation, I have used this in the distinguished sense of referring to not only the natural sciences but also to the social sciences and humanities (including philosophy and theology). Scientia is always, strictly speaking, a matter of modal abstraction and as such is distinguished from pre-theoretical thought/experience. Thus the term is used in a more restricted, and also a wider, sense than the popular usage of science.

*<u>Sphere Sovereignty</u> : A translation of Kuyper's phrase <u>soevereiniteit in eigen kring</u>, by which he meant that the various distinct spheres of human authority, such as family, school and church, each have their own responsibility and decision making power, which may not be usurped by those in authority in another sphere, for example the state. Dooyeweerd retains this usage, but extends the usage of the phrase to mean also the irreducibility of the modal aspects. This is the ontological principle on which the sociological principle is based, since each of the societal 'spheres' mentioned is qualified by a different irreducible modality.

*<u>Sphere Universality</u> : The counterpart of modal sphere sovereignty. It is the principle that all the modalities are intimately connected with each other in an unbroken coherence. Just as sphere sovereignty stresses the unique distinctiveness and irreducibility of the modal aspects, so sphere universality emphasizes that every one depends for its meaning on all the others, especially as evidenced by the analogies in the modal structure of each (that is the collective anticipations and retrocipations.)

*<u>Subject</u> : Used in two senses by Dooyeweerd: (i) as distinguished from object (something qualified by an object function); and (ii)

as distinguished from Law. The former sense is roughly equivalent to common usage, the latter is unusual and confusing. Since all things are 'subject' to Law, objects are also subjects in the second sense.

*Subject-Side : The correlate of Law-Side. Since sin is disobedience to the Law, we find sin only on the subject-side of the cosmos. Another feature of the subject-side is that it is only here that individuality is found.

Technic : (Cf. techne, technique.) Associated with man's technology it is a wider concept covering the attempt by man to actively dominate his environment.

Technology : This is conceived as the practice, description, and terminology of any, or all of, the applied sciences which have practical value and/or industrial use.

Theoretical Thought : Thought that is abstractive and bears the character of being systematic, intentional and methodical, and operates in a verificatory realm. Contrast Pre-Theoretical.

*Transcendental : A technical term from the philosophy of Kant denoting the a priori structural conditions which make human experience (specifically human knowledge and theoretical thought) possible. As such it is to be sharply distinguished from the term 'transcendent'.

*Wetsidee : The Dutch original of 'Cosmonomic Idea', literally 'law-idea'. Dooyeweerd's philosophy is known in Holland as the Wijsbegeerte der wetsidee (philosophy of the law-idea). The name derives from the central place of creational law in his thought.

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BIBLIOGRAPHY

1. INTRODUCTION

In the text of this study books and articles are identified by the name of the author and a date (which is followed by volume number and page number.) This corresponds to the name and date in brackets in the bibliography. It should be noticed that this date is not necessarily the date of publication referred to, but may in fact be that of the original date of writing (or as close as may be estimated.) This helps to locate some of the historical material. The date of the publication referred to, where different from the date in the text and the date in brackets in the bibliography (which is the same), will be given at the end of the publication details.

1.1. Abreviations. The following abbreviations are used in the bibliography.

AACS : Association for the Advancement of Christian Scholarship (until 1969 - the Association for Reformed Scientific Studies), the sponsor of the Institute for Christian Studies, Toronto, Canada.

CGK : Criticism and the Growth of Knowledge - eds. I.Lakatos and A.Musgrave, CUP, London, 1976.

CSU : The Christian Studies Unit - directed by R.Russell, 33 South Street, Derby. A source of useful unpublished material.

CUP : Cambridge University Press.

ICS : The postgraduate research Institute for Christian Studies, Toronto, Canada.

Idea : The Idea of Christian Philosophy: Essays in Honour of D.H.T. Vollenhoven - Wedge, Toronto, 1973.

IRB : International Reformed Bulletin.

JA : Jerusalem and Athens: Critical Discussions on the Philosophy and Apologetics of Cornelius Van Til - ed. E.R.Geehan, PRPC, Nutley, N.J., 1971.

OUP : Oxford University Press

PRPC : The Presbyterian and Reformed Publishing Co..

UP : University Press.

1.2. Periodicals. A complete list of periodicals consulted is unnecessary as articles will be referred to in the main list of books and articles. However the lesser known periodicals consulted are listed below.

Anticipation : Church and Society, World Council of Churches, 150 Route de Ferney - 1211 Geneva.

C.J.L. Foundation Newsletter : Committee for Justice and Liberty Christian Action Foundation, 229 College St., Toronto, Canada.

International Reformed Bulletin : Quarterly of the International Association for Reformed Faith and Action, Grand Rapids, Michigan - up to No. 68, thereafter 3 Ottawa Place, Chapel Allerton, Leeds, England.

Perspective : Newsletter of the AACS, 229 College St., Toronto, Canada.

The Guide : Monthly organ of the Christian Labour Association of Canada, 1036 Weston Rd., Toronto, Canada.

Third Way : Fortnightly published by the Thirty Press, 19 Draycott Place, London - from Jan. 1977.

Vanguard : An independent (bi)monthly periodical published since Nov. 1970 by Wedge Publishing Foundation, Toronto, Canada.

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