ETHICS IN EXTRATERRESTRIAL HUMANITY

NINA KOJIMA

MA Philosophy (Ljubljana)
MA Sociology (Ljubljana)
MA Film Directing (West London)

Ph.D in Philosophy (Research)

School of Humanities, College of Arts
University of Glasgow

Original submission: 27 March 2025
Revised final submission: 17 July 2025

ABSTRACT

With the launch of the first satellite into Earth's orbit, we turned the Archimedean point from our home planet towards the heart of the Universe. By the end of this decade, humans will live and work permanently on the Moon and, at the beginning of the next one, on Mars. Life outside our home planet, in lethal and challenging environments, will propel our civilisation into the extraterrestrial, to embark on an even greater – interstellar – civilisation.

Some predict that there will be new generations of humans born and evolved into extraterrestrial gravities that will eventually lead to a 'new' human race. Extraterrestrial humans will no longer consider the Earth to be their home, but rather Mars. For creatures and humans who evolved on Earth to live on objects of our solar system and beyond it will only be possible with the support of technology and nanotechnology. This life will no longer be comparable with life as we know it now, and one of the major challenges we will face will be the ethical implications of that.

There are many questions to be answered. The core one for this research is: are we going to conquer solar system objects as good citizens or as cosmic vandals? What kind of relationship will we establish with these planets we are not made of, in the case that these planets contain life? Are we allowed to contaminate planets we are not made of, even if they do not present any indication of possible life forms? Also – an important question – life as we know it on Earth is based on carbon, but could other objects in the universe evolve life forms based on silicon? Knowing our practices on Earth, how we assess all situations from an anthropocentric point of view, is it at all possible to acknowledge and even give priority to living creatures – if there are any – outside our home planet?

This thesis will lead to more questions than answers, and the conclusions will be suggestions based on assumptions of how we could reach the best outcome when we start living our extraterrestrial life. The thesis has two parts. The first part introduces ethical questions and concerns related to the argument that we ought to leave our home planet; the second part will try to predict the possibility of ethics in our extraterrestrial human life, based on the heavy support of technology and nanotechnology and implementation of that on other objects, planets and moons in our solar system. This is a huge scale, so I will concentrate on human extraterrestrial life on Mars for two main reasons: Mars will be the first example of a planet where humans will live and work; and this will happen in the next 10 to 15 years.

TABLE OF CONTENTS

INTRODUCTION

We are living in exciting times; those people born from the 1970s onwards will witness Homo sapiens' most giant leap – living and working in permanent bases on the Moon and Mars, empowering our human race to go extraterrestrial. These challenging steps will be possible only because of our technological and nanotechnological achievements. Seeking new resources of energy and minerals around our solar system might not be considered as a necessity to some; others believe it is our duty to look for new opportunities and spread our human life beyond Earth. The most commonly accepted theory is that our ancestors started this journey approximately 300,000 years ago, when they left the Kenyan Rift Valley. New technologies and worlds bring new challenges, and new ethical questions: how will we practice our virtues and how will we be able to live a life worth living? How will we survive in lethal environments? Extraterrestrial humanity is at the brink of a new techno-nanotechnological and AI era; how will our virtues play out? This thesis is an assessment of already existing ethical questions regarding our relationship with the Universe, and a prediction of the role they will play in the future. Chapter by chapter, I look into the most notable ethical questions, assuming virtue ethics will play the most important part in this journey.

Part I.

Chapter 1: Introduction to the Ethics in Extraterrestrial Humanity

This chapter introduces our relationship and moral responsibility towards our horizon that is the closest to us, the Lower Earth Orbit (LEO). Here, ethical questions are closely related to our environmental duties, and the techno era plays an important part, challenging our ethical views. Satellites already enable us to live a better life, helping to prevent disastrous incidents with their weather predictions. But on the other hand, they create an enormous amount of space junk, which could lead to a large-scale disaster. This chapter introduces us to the core of this thesis: how difficult it is to assess whether we are ‘right’ or ‘wrong’ when introducing new technologies. It also indicates that our virtues will play the most important part when thinking about extraterrestrial humanity

Chapter 2: Do We Have an Ethical Responsibility Towards a Truly Alien Form of Life?

This chapter showcases our anthropocentric relationship towards non-human animals and opens an important question on how we are going to define the alien life, if we can at all establish a relationship with alien life. Most of the temporal mainstream ethical views are theologically based, non-human animals were never created by God, nor given dominion status by God. This position is extremely problematic for detecting and confirming extraterrestrial life, hence creating an ethical responsibility towards it. I offer the assessment on non-human life from utilitarian, deontological and virtue ethical perspectives and I argue that because of the so far unknown and undiscovered existence of alien life, virtue ethics should be the most appropriate when we (if we ever) meet alien life. In this chapter I also trigger a philosophical question: “what is life?”, and how a determination of life plays out differently. The definition of life is important for our determination to conclude the ethical relationship towards non-human life. Regardless of metabolic and Darwinian theory, I am proposing: when assessing our moral responsibility towards extraterrestrial life we should determine what we believe that extraterrestrial life is, we must classify it as “alive”, then we can responsibly implement our ethical relationship regarding this life. We must loosen our anthropocentric and Earth-centric view regarding extraterrestrial life, which is so far embroidered into deontological and utilitarian ethical practices. My assumption on which I will present the arguments during my research in this thesis is that our extraterrestrial life is part of our social evolution.

Chapter 3: How Does a Virtue Ethicist Approach Questions in Applied Ethics?

The previous chapter focused on the problematic ethical relationship to extraterrestrial life, and the suggestion of this research is to give priority to a virtue-ethical perspective that requires further explanation. Further chapters fulcrum on extraterrestrial humanity itself and the ethical norms that will potentially be required when living an extraterrestrial life. Some ethical theories are more coherent with the rule or frame of moral practice; deontology emphasises duties and rules, and consequentialism emphasises the consequences of action. Virtue ethicists emphasise the importance of cultivating virtuous character traits such as honesty, courage, compassion, wisdom and integrity. When faced with an ethical dilemma,

they consider which virtues are relevant to the situation and how those virtues can guide ethical decision-making. This chapter explains the core evolution of virtues based on the Aristotelian ethical view and also in a relation to the technologies. Throughout human evolution, technology has played a very important part. Our technical achievements and creativity have made our human family into a progressive civilisation that is capable of reaching far beyond our horizons. During human evolution, we have created moral choices and possibilities that were not necessary for us in previous times. Technology is not value-neutral; new tools bring new significance and new morals. (Vallor 2016)

Chapter 4: Ethical Dilemmas of Extraterrestrial Human Life on Mars

After assessment on virtue ethical theory where I express my believe in why the virtue ethical perspective will play a core part in humanity living extraterrestrial life heavily depending on technologies including nanotechnology, this chapter offers an assessment to the most obvious dilemmas which arise when we proceed with living on a barren planet. Here I focus on Mars for the obvious reason; it will be the first planet in our solar system where humans will, according to the plan we have now, permanently live and work on. My question regards the most obvious ethical concerns: contamination of the Martian environment, terraforming the Red Planet, who are the colonisers of Mars and what is their agenda?. My ethical concern is also regarding more political questions on the system of the "Humartian[1]" society. I also open a question of moral responsibilities if the mission to Mars will be led by an institution or by private benefactors. I consider other ethical questions related to our life in western societies where we are exercising nouns which give us meaning to our life and which had throughout our social evolution played out different. The way we understand autonomy, bodily autonomy, liberty now and the way we exercise them will be different and, in many ways, limited for those living and working in a lethal extraterrestrial environment. Some people think that exceeding our human race to other objects in our solar system is not driven by our scientific excitement

[1] I am creating a new noun which has already been in use by a community of the Mars Society but also others who are considering human permanently living and working on Mars. Human, who will still look like us, but won't be part of life on Earth anymore or human who will be born on Mars, but won't be able to travel back to Earth, since their evolvement to the low Martian gravity will make this journey impossible. When landing on Earth their bones and organs will crack, implode. These individuals who are genetically related to human on Earth but can't live on Earth anymore, on the other hand they are not related to Martian life, if any life forms exist there at all. Humartian is a name for such individuals, hence this name is so far only in use and accepted by the small community.

and the fact that we must source energy, minerals from other planets to continue living on our own one, is a form of new religion and I question that. Related to the religious view is also a question on euthanasia; my question is in the circumstance of being far away and unable to fly to the hospital, will euthanasia as a prospect be exercised on a compassion ground in space?

Chapter 5: Proposal for Panopticon on Mars, (Conclusion to Part One)

Considering all ethical challenges from the previous chapters, I created a proposal for the Panopticon on Mars. It is a habitat which could potentially work out in a challenging circumstance as the best possible solution concerning the potential volitation on autonomy, bodily autonomy, liberty, freedom of movement and potential tyranny. Panopticon on Mars is a concept which would enable that normal human, schoolteacher, librarian, nurse, people who do not have $250,000 for a return ticket to Mars, could fly to work and live there. With the strong media appearance and "live streaming" from the red planet, their mission to Mars would be 100% sponsored from the audience from Earth[2]. The habitat as shown on pictures would accommodate also safe scientific research, layers of transparent globe around would enable artificial production of ozone to protect human from cosmic radiation. Streaming would be used as surveillance, similar as the concept of Bentham's design of a prison cell or Foucault's assessment of the society and specific environments. My proposal of live streaming also serves as a prevention for tyranny or other forms of misjustice which can lead to extremely unethical concepts of extraterrestrial human life.

Part II.

Chapter 6: Human Condition

Chapter 6 is trying to explain why we as Arendt said turn our live away from Earth, as she considers humanity in the aftermath of the scientific age. She defines the 'modern age' as the rise of science and the political and industrial revolutions of the 17th, 18th and 19th centuries; her 'modern world' includes the two World Wars, the first atomic bomb and the rise of totalitarianism. Also in this modern world, the first

[2] Live streaming from Mars to Earth is actually not live, because of a vast distance between the planets and a signal travel the live streaming would trigger around 20 minutes to reach Earth.

satellite (Sputnik) started orbiting in the Low Earth Orbit, and automatism was developed to replace labour. One of her comparisons with the non-human animal life is that in contrast to other workers (bees and birds) we have an idea first and then we work towards the creation of something new. As she says action is the highest form of human activity, representing political engagement, discourse and the ability to create something new. This chapter also raises a question of posthumanism, when technologies like it or not will take over, like it or not, our work, thinking and someday perhaps even decision making.

Chapter 7: Nanotechnology and Extraterrestrial Human Life

In Chapter 7, I touch the points concepted in the Feynman's essay in which he predicts technology as we known by now. I also debate on a difference between scientific finding and technological achievement. Like Popper discerns that the scientific finding is about something which already exists, black holes exist as we know for the past decades, hence we haven't got the equation for them yet; scientists usually work in small groups or independently. In comparison, technological achievement requires large groups of collaborators: scientists, engineers, and other support groups. Technological achievement is good only if it works. This acknowledgment is important to understand Drexler's proposal for the radical abundance, when nanotechnology takes over most of our physical work and set human to a completely new level. His positive assessment towards nanotechnology also protects Earth and ecosystems from suffering, brings down climate change and creates better living standards, quite the opposite view of philosophers in the seventh chapter. This chapter concludes with an important question on why we are going extraterrestrial, because it is part of our natural evolution this time as technological advancement or because we are out to colonise.

Chapter 8: Ethics in Nanotechnology and Technology

Can we define nanotechnology as a completely new or is it actually just another branch of technologies? Does nanotechnology apply completely new ethical norms? (Bacchini). Should we set tests or limitations on what is a real discipline and claim that only a true discipline can raise ethical issues? Allhoff and Lin suggest leaving the argument of whether nanotechnology is a true discipline because it doesn't really

break new ground, and rather understanding nanotechnology as a new height in our understanding about the world. In a sense it is like architecture, and can be regarded as a convergence of aesthetic design and engineering. In this chapter I am leaning towards assumption that nanotechnology will develop faster and to a greater extent in extraterrestrial environments, where there will be fewer restrictions and considerations of whether certain nanotechnological products are ethically questionable or not. Nanotechnology is also expected to accelerate work in artificial intelligence and other innovations such as increased processing speed, increased memory, quantum computing, happy hormones and genetic adjustments. If nanotechnology is something new, I believe there will be new ethics, all accompanied by the virtue-ethical norms.

Chapter 9: AI in Extraterrestrial Environments

Nanotechnology and AI already work together in several fields but also in space. In this chapter I consider Vallor's assessment that AI is nothing more than a mirror of our intelligence back to us; sometimes it results in bad outcomes. As we can see from media reports, books, analysis and TED-style talks, we are in a serious situation and there is evidence that these systems are transforming our economic and social order, even destroying it. Hence the mirror does not tell who we really are. Important question to answer is does the AI mirror serve a virtue, and if so which virtue, hence the answer is far from straightforward. As much as Vallor doesn't think there is much virtue in AI, Bostrom shows a more positive view. He predicts a machine superintelligence which can lift the best of humanity. Bostrom's suggestion is in developing a sophisticated AI, which can entirely change, take over and replace our organic human life. Based on this assumption, it is that "cosmic superintelligence" that can decide whether we organically vulnerable creators have moral status. Can superintelligence adopt our moral views and acts with the virtue ethical approach? In any case, living in an extraterrestrial environment pushes the necessity of using AI.

Chapter 10: To Live Forever

It is the most common thought when discussing the extraterrestrial human life, the possibility of longevity. The ethical questions related to living forever are also a

concern for society, hence I present the assessment based on theoretical physics that extraterrestrial societies might benefit from it. Even though only possible in theory, I am thinking about the next step, the possibility of trespassing galaxies, time and perhaps other Universes. The good outcome with expansion of humanity by moving to other planets, moons in our solar system and beyond is achievable only with a longer life than we have now.

ACKNOWLEDGEMENT

I would like to express my sincere gratitude to my main supervisor, Professor Mona Simion, for guiding me throughout my research. She helped me make the decision on the best ethical theory to use for this research, which was particularly challenging as the whole idea lies in the near future and no one knows how events may play out. I am especially grateful to her for accepting me and helping me with my application in the first place. I would also like to express my utmost gratitude to my second supervisor, Professor Christoph Kelp, for his consistent support and his reviews, suggestions and valuable questions regarding my research. I also thank my third supervisor, Professor Glen Pettigrove, for helping me understand virtue ethical theory in depth, shaping my view on technologies and virtues. Professor Ben Colburn helped me with the idea of autonomy, and I thank him too. I am deeply thankful to these respectful professors who have helped me, not just on my academic path, but also that they were there for me in my lowest moments. I am also extremely thankful to my friend of many decades, the late Professor Cvetka Hedžet Tóth, who encouraged me to pursue my PhD research and always believed in me.

Last but not least, special thanks go to my husband, Tosh Kojima, for supporting me, inspiring me, debating the universe and astrophysics with me for endless hours, and sharing this journey.

PART I

1. Introduction to the Ethics in Extraterrestrial Humanity

The Universe has been observed by humans in civilisations long before ours. Fundamental questions of modern and ancient philosophy about our being, creation, ethics and science are directly and indirectly related to the Universe. Questions about its existence and exploration are yet to be fully explored.

With the launch of the Sputnik satellite into Low Earth Orbit (LEO), humanity reached for the first time into a realm that was previously unknown yet long visible to all civilisations. This chapter examines the tensions inherent in our use of space technologies: while satellites are designed to improve human life – reflecting what might be described as techno-moral virtues (a concept I will engage with in detail through Shannon Vallor's philosophy in later chapters) – their proliferation has also produced significant environmental challenges, notably the pollution of LEO. The chapter aims to highlight this ethical paradox, considering not only the environmental impact of space debris but also controversies such as the ability of individual companies to transform the appearance of the night sky. In doing so, it raises critical questions about how we determine what is right or wrong in our stewardship of a domain that, within the span of a single human lifetime, has shifted from untouched beauty to a contested and increasingly exploited space.

In the modern era of technology and artificial intelligence, we are still looking for answers, including mathematical predictions of the formation and age of the Universe, our solar system, and the planets and galaxies around it.

The philosophical perspective on the Universe is changing, and in the past 70 years we have progressed substantially in our understanding. The future of humanity is set upon the stars, in a real way. Humanity landed on the Moon and the sound we produced is reaching solar systems far beyond ours. Perhaps in a billion years it will reach distant galaxies, coming close to stars with exo-planets.

We developed systems – the Hubble telescope (Webb Space Telescope, ground telescopes in Chile, Tenerife, Australia) can reach galaxies far away – but mathematical formulas sadly prove that we are far from being able to reach nearby solar systems in our lifetime. Philosophy has always played an important role in

discovering the truth about the Universe, and philosophy is needed like never before to set the right, ethical configuration of the relationship between humanity and the Universe, our solar system and beyond.

The ethics of space exploration is a relatively new branch, but a much needed one. While most humans are still only able to observe the Universe in the night sky, either with bare eyes or a telescope, there are a few people who are developing advanced space programmes. These tycoons and billionaires, whose carefully manoeuvred tax manipulations help them create so much wealth that they can afford expensive space programmes which the vast majority of the world's states cannot, are racing to build human colonies on the Moon and Mars and develop space tourism.

Some countries that are among the greatest violators of human rights are also developing advanced space programmes. They have the money and resources, but do they have the right to do so? This is one of the fundamental philosophical questions, equally important as the question of whether human exploration of our solar system and the Universe is ethical. Can human exploration of our solar system, and life in human colonies on the Moon and Mars, be ethical? Can we make it ethical before we put our footprints on another object in our solar system?

We need an account of the ethics of space exploration. The argument about the unethical exploration of our solar system starts not far from the Earth's surface, at its low orbit. Starlink is a satellite internet constellation constructed by SpaceX. It is consisting of mass-produced small satellites providing satellite internet access, working in combination with ground transceivers. Some of these satellites are sold for scientific, exploratory and army purposes. As of September 2024, SpaceX has deployed 6,426 Starlink satellites to Lower Earth Orbit, with 6,371 of them operational. In October 2015, the US Federal Communications Commission (FCC) submitted filings to the International Telecommunication Union (ITU) on behalf of SpaceX to arrange a spectrum for 30,000 additional Starlink satellites to supplement the 12,000 Starlink satellites already approved by the FCC.

Astronomers have raised concerns about the constellation's effect on ground-based astronomy. For the foreseeable future most astronomical observations are still from the Earth, from ground-based telescopes. Vast numbers of satellites orbiting Earth are causing destruction, and from some of the observatories it is almost impossible

to see the night sky. Furthermore, the Starlink satellites will add substantially to the already jammed orbital environment.

Another ethical question is how can a single company unilaterally change the night sky's appearance? And who will clean the waste once the satellites are no longer in use and the company that launched them into orbit no longer exists?

Is it ethical to base a 'Space Law'[3] on, for example, the laws for international waters? Could this law be commonly accepted for the habitat in our orbit and in any space settlement beyond?

Humanity is acknowledging that carbon dioxide emissions are the primary driver of global climate change. Human activities such as polluting oceans and storing nuclear reactor waste in deserts, caves and deep oceans are causing substantial damage for future generations.

Developed nations are investing in technology driven by consumption of green energy and recycling products. Scandinavian countries admit that this is a new era of human society, but would they call it ecological socialism? This politically driven noun might not be acceptable in North America, but many scientists advocate that the only way to survive and slow the exhaustion of the Earth is to swing to a very new direction, using green energy and resources based on sustainability. At least the results of this will show dramatically in our lifetime.

Satellites are one of the most important inventions of modern society. Life without them is impossible to imagine. They are in everyday use for both ethical and unethical purposes and missions. Their orbits around Earth substantially help predict the weather, monitor climate change, make observations, aid navigation and telecommunication – and perhaps even aid spying and killing.

In August 2005, satellites spotted category 5 Hurricane Katrina approaching the Bahamas, the US states of Florida and New Orleans, and the eastern side of Mexico. Katrina caused 1,800 deaths, made millions of people homeless, and the material damage was an estimated $125 billion. The early capture of Katrina from

[3] The first concept of space law, 'Magna Carta of Space' (1966) by William A. Hyman, was signed by most countries, but not all. Later, the United Nations formed a special committee for space affairs (which has changed its name over the years), and now most of the world nations agree that space disputes should be mediated according to the Law of the Sea Convention (International Waters).

satellites saved lives and allowed many to protect their properties and find rescue shelters. No one can argue that a satellite's captured image of a growing hurricane was unethical. Instead, it is quite the opposite; the use of weather satellites serves humanity and in this example is ethically justifiable.

The argument of many astronomers that Starlink is not ethical is a paradox. Starlink will provide observatory monocles so that observations of space will not be disrupted by the weather conditions on Earth. Furthermore, telecommunication systems will provide better and safer travel in the oceans, on the ground, and in the desert and mountains, where satellite signals did not reach until recently.

The life expectancy of satellites launched in the 1990s was 12 years; for those launched at the millennium it was 15 years. Starlink's life expectancy is between three to four years before they will deorbit. Arguably, satellite waste causes pollution in two ways. It prevents astronomy observation from the ground, and it creates extra rubbish in the low Earth orbit (LEO), but it also creates the hazard of not burning out when falling into the atmosphere. Space shuttles and space crafts, such as those from the Apollo missions, all entered our atmosphere from a specific angle so they couldn't burn out and were able to land safely. The same could happen with an overdue satellite[4]. Eventually it could fall into an ocean, desert or town, causing pollution or even a catastrophe that could lead to the loss of lives. In the case of Starlink's full constellation of 11,000 satellites, it only takes simple maths to calculate that three to four satellites will have to be replaced every day. Where are the old ones going to go?

Civilisations long before ours built a unique relationship with space. Ground astronomy observations were at the heart of science even before our civilisation; for instance, the Ancient Egyptians' lives depended on the rising of the Sirius star in the sky to predict the annual flooding of the Nile. That way, the Egyptians knew when to plant seeds and when to harvest. In the Southern Hemisphere, another ancient

[4] A 22-tonne Chinese rocket was out of control as it fell to Earth on 8-9 May 2021. It took many hours before Chinese authorities confirmed that most of the rocket would burn off before debris crashed into the ocean. The European Space Agency predicted a risk zone that encompassed a portion of Earth's surface between 41.5°N and 41.5°S latitude, which included virtually all of America south of New York, all of Africa and Australia, parts of Asia south of Japan and Europe's Spain, Portugal, Italy and Greece. This was not the first time this had happened. In 2001, the Russian space station Mir deorbited and plummeted into the Pacific Ocean according to navigated procedure.

civilisation depended on Sirius – for Polynesians, it was a signal for winter, and they used it to help them navigate around the Pacific Ocean.

Meanwhile the Moon helped many early civilisations mark the year, and it has been admired by poets and writers throughout the ages. But now some countries consider storing waste from power stations' nuclear reactors on the Moon, as an alternative to polluting the Earth (this is too expensive for now and the technology is not fully developed).

As the Moon is a dead rock, some scientists suggest that it will serve well to dispose of our nuclear waste in the future. Pollution on our planet is getting worse, and even with advanced technologies we will not be able to stop it, though perhaps we can slow it. Waste from nuclear reactors is currently disposed deep in our oceans and caves, and in some cases deep under the desert sand. Why not dispose of this on the Moon if and when technology permits it?

Milligan (2015) sees a paradox. If we protect the Egyptian pyramids, the Great Wall of China, the Petra Valley in Jordan and Machu Picchu in Peru, which are without doubt treasures left by civilisations before ours, then we have to protect the Moon. Likewise we should protect the night sky and we should consider ethical norms when assessing the situation in the LEO.

In 2009, an inactive Russian communication satellite, Cosmos 2251, collided with an active commercial communication satellite operated by US-based Iridium Satellite LLC. The collision occurred approximately 800 km (497 miles) above Siberia. It was the first time that a hypervelocity collision occurred between two satellites, rather than between satellites and space debris. NASA estimated that the collision led to the creation of at least 1,000 pieces of space junk.

The international legal framework governing such collisions is primarily derived from the 1967 Outer Space Treaty and the 1972 Liability Convention. These treaties assign liability for damages caused by space objects to the 'launching state'. Under this definition, Russia is deemed liable for Cosmos 2251. However, the determination of the launching state for Iridium 33 is less clear. The satellite was not registered with the United Nations as required under the 1974 Registration Convention, leaving ambiguity over whether the launching state was Russia, the United States or Kazakhstan.

Notably, no warnings were issued about the impending collision between Cosmos 2251 and Iridium 33. However, both US and Russian military agencies possessed precise tracking data on the satellites prior to the incident. Proper analysis of this data could have predicted the high likelihood of a close encounter. Because the ownership of the Iridium was unclear, none of the countries who owned the satellites were accountable. In 2011, a large amount of space debris from Cosmos 2251 passed the International Space Station (ISS) but, luckily, none of the pieces hit it.

Regulations, treaties and maritime law governing space activities are often loosely defined, with ethical considerations frequently overlooked. Several incidents in recent history underscore the dangers posed by humanity's incomplete and sometimes negligent approach to space stewardship.

In 1997, Lottie Williams, a resident of Oklahoma in the United States, was struck by debris from a satellite rocket launched the previous year. Fortunately, she suffered no serious injuries. A more significant incident occurred back in 1978, when the Soviet Union’s nuclear-powered satellite Cosmos 954 crashed in Canada’s Northern Territories. This event caused widespread environmental devastation, with radioactive contamination killing wildlife and rendering vast areas uninhabitable. Decades later, reports from environmentalists indicated severe ecological impacts, including animals born with deformities such as missing limbs or multiple heads, and extensive ‘dead zones’.

In July 1979, NASA's first space station, Skylab, re-entered Earth's atmosphere and narrowly missed a village in southwestern Australia, crashing mere meters away. While these incidents resulted in no human fatalities, they serve as stark reminders of the potential dangers posed by uncontrolled re-entries and space debris.

The risks are magnified when considering scenarios such as a recurrence of the Carrington Event, recorded in 1859, the most intense geomagnetic solar storm in history. The solar flares were so powerful that they disrupted Earth's magnetic field, creating spectacular auroras visible even in the Southern Hemisphere. Witnesses in Japan, Brazil and Florida USA, documented the extraordinary displays, which were featured in newspapers around the world and described as an awe-inspiring celestial phenomenon.

However, the event had devastating consequences for technology at the time. Telegraph systems, the pinnacle of 19th-century communication technology, were severely affected. Many operators were electrocuted or burned as the intense geomagnetic currents surged through the lines, igniting fires and rendering equipment inoperable.

If an event of similar magnitude were to occur today, the impact could be catastrophic. Modern technology and infrastructure, deeply reliant on satellites and electrical systems, would face unprecedented disruption. Beyond technological failures, the debris from space junk in Earth's orbit could rain down, not just into oceans but onto streets, cities and villages, posing a dire threat to human safety. This potential scenario highlights the urgent need for better management of orbital debris and preparation for solar storms of this magnitude.

All these events illustrate the importance of ethical reviews as the basis of new space treaties and space laws. Our current behaviour is unethical and could lead us into more dangerous situations.

Most defunct satellites remain in low Earth orbit (LEO), contributing to the growing issue of space junk. Collisions between these satellites generate even more debris, creating a cascading problem. On its website, NASA has expressed concern about this issue, estimating that millions of pieces of space debris are currently orbiting Earth. These range from small fragments, some as tiny as tennis balls, to larger objects over a metre in length. Travelling mostly at speeds of up to 18,000 miles per hour – seven times faster than a bullet – even a small object can be extremely powerful.[5] So this debris poses a significant threat to astronauts aboard the ISS and China’s Tiangong space station.

According to a December 2022 NASA report, the ISS has had to adjust its orbit 32 times since 1999 to avoid collisions with satellites and trackable debris. However, not all space debris can be tracked. In May 2021, a piece of space junk struck the ISS’s robotic arm, used for external observations. While the arm sustained damage, a direct hit to the main station could have resulted in catastrophic consequences.

[5] NASA estimates that space junk in Low Earth Orbit (LEO*)* travels at approximately 17,500 miles per hour (28,160 km/h). This extreme speed means that even small debris, like a paint chip, can cause significant damage to satellites, spacecraft, and even the International Space Station (ISS) upon impact. [1]

In November 2021, seven astronauts aboard the ISS were forced to take shelter in their transport spacecraft as a precaution when a large convoy of space debris approached the station, triggering alarms. Such incidents highlight the growing danger posed by space debris and the urgent need for effective mitigation strategies.

These are just a few of the ethical concerns that begin close to Earth. As we venture deeper into space, these concerns grow more complex. Human missions to planets like Mars involve significant risks, when you consider the seven-month, one-way journey where countless things could go wrong. Once there, astronauts would face the challenges of living in a hostile environment, lacking breathable oxygen and enduring cosmic radiation capable of destroying human cells within minutes.

But the questions extend beyond the risks to human lives. What is our ethical responsibility toward other planets and objects in our solar system? What does this monumental leap into space truly signify? Should we consider the possibility that intelligent life is unique to Earth and, if so, does that uniqueness grant us dominion over the Universe? Such a perspective is not only profoundly arrogant but also shuts down opportunities for ethical reflection and meaningful debate.

This research seeks to open such a debate, exploring all known possibilities while advocating for a virtue ethics approach. As we stand on the threshold of becoming an extraterrestrial civilisation, it challenges us to ask: what will humanity look like when we finally leave Earth behind? How can we ensure our actions reflect a respect for life, the cosmos, and our place within it?

2. Do We Have an Ethical Responsibility Towards a Truly Alien Form of Life?

Can we apply predominantly human-centred ethical theories of morality to alien organisms, and can we establish a suitable path now, so that in our extraterrestrial future we will be ready to act as moral beings from Earth?

This chapter continues the exploration of ethical controversy and paradox introduced previously, shifting focus to humanity's problematic relationship with non-human life. Drawing on both historical and contemporary cases, it demonstrates that we are ill-prepared to develop or sustain an ethical framework for engaging with alien life – should we ever discover such life within our solar system. The chapter

also highlights the conceptual difficulties in defining life itself, underscoring that both theories and criteria for recognising life remain far from universal. By examining these issues, the chapter aims to illuminate the ethical complexities that arise when considering our responsibilities beyond Earth.

As one of our greatest science fiction authors, Arthur C. Clarke, wrote: “Two possibilities exist: either we are alone in the Universe or we are not. Both are equally terrifying.”

Where does our anthropocentric ethical behaviour stand, if life based on organic forms is not unique to Earth? That life may be related to Earth, meaning that at some time in the past it spread around the solar system, or it might exist based on other compositions like silicon, boron or something else. What would be the reaction from astrobiologists if NASA or a similar space agency suddenly confirmed that life exists on Mars? Reaching to an answer, we should first consider several facts of our morally questionable behaviour on Earth. But before that, I must indicate a difficult question that is the basis of this debate, and which is not straight-forward to answer: what is the definition of life?

Most moral theories, particularly those based on the philosophy of Immanuel Kant, also known as deontological ethics, distinguish moral agents from moral patients (the subject of the moral agent’s concern)[6]. The moral agent must have the ability to reason and have self-concern. Moral agents are intelligent, self-conscious, and capable of self-assessment, which can lead to an understanding of what is right and wrong. They make choices and take actions that can harm or benefit others, so they can be hold responsible for their moral behaviour. Non-living entities can harm, destroy and even kill (a rock from a landslide or volcano, water from a typhoon or wind from a tornado), but they have no moral obligation, since they lack the ability to reason, and they are unaware of what they do. Life (at least for now) is a precondition for moral agency.

Yet non-living things can possess intrinsic moral status. Our moon has a beauty that has been admired by civilisations long before ours; and the robots and avatars we

[6] Theories that distinguish between moral agents and moral patients do so based on different criteria: rationality (Kantian ethics), sentience (utilitarianism), virtue (Aristotle), care (care ethics), and contract (contractualism). The ethical implications of this distinction affect how we treat animals, infants, and individuals with diminished capacities, influencing debates on moral responsibility and justice.

create can also trigger an emotional attachment. In science fiction films, these robots also have a moral status; they fight alongside with us against enemies from outer space and even though they are just machines we give them admiration, care and an ethical response, we feel sorrow and pain when they ‘die’ or stop working. Not long ago, the only living entities to be worthy of moral consideration were human beings, and sometimes not even all of them (depending on sex, age, race, ethnic minority and mental faculties).

In the past few decades there has been a debate on whether to include non-human beings in ethical consideration. When it comes to animals, this debate gets heated, with some of the biggest advocates for animal ethics being Tom Regan, Tony Milligan and Peter Singer.

Milligan takes a position that we mustn’t go to Mars for other environmental and ecological reasons, which we will analyse in further chapters. For Milligan, to find life on another planet, even in a primitive form, would lead scientists to the conclusion that life is spread in the Universe and that we must completely reset our understanding on what we want to do with this discovery. This leads him to another conclusion that in this case we are not the only live beings in the Universe, so the Universe does not strictly belong to us. Therefore, we must not take an action or decision on what to do with it. He is an advocate of preserving life and not landing on planets or solar objects we are not made of, not to contaminate planets and not to interfere with their ecosystem, even if they are very basic, small or primitive. His biggest opponent is Robert Zubrin (2019,2021), founder and president of the Mars Society, whose views are also anthropocentric but from a very different perspective to Milligan. He thinks that if life does exist on Mars, even in a primitive form, this life had plenty of time to develop in something bigger and greater and it didn’t because it can’t. We are halfway through the life of our sun and as nature takes its course we will have to find other planets, objects in our solar system and far beyond. Included in this anthropocentric view, Zubrin also indicates also a very theological view: that to protect a human life is our duty, that we are superior creatures.

Milligan and Zubrin’s arguments lead us to another very important question about whether our approach to alien life should be ethically concerned, and this is: “What is the definition of life?”.

On Earth in recent decades, we have started having more sympathy with animals that can deliver similar cognitive functions as us. We started acknowledging that chimpanzees, orangutans and gorillas can laugh, be angry, be sad… that they can participate in games and watch shows. They understand tricks, they are social and sometimes brutally aggressive. There are familiarities with our characters. We have also changed our perception that it is right to imprison chimpanzees and perform experiments on their bodies to serve some good outcome for humanity. But it wasn't always like that, not even on a human scale. There is the very sad example of Ota Benga, a Mbuti (Congo pygmy) man who was kept in a cage at the Bronx Zoo in 1906 to be exhibited. Even more recently, in 1958, Brussels World's Fair displayed large numbers of Congolese families. The question is, what changed this perception? I will argue in further chapters that it is a change in our virtue ethical practices.

Referring to the essay "Towards the Ethics of Astrobiology" (Carol E. Cleland, Elspeth M. Wilson), the claim is that the question of ethics and moral status is deeply rooted in the concept of life. Since we do not have a compelling answer to the question 'What is life?', we cannot have an adequate position to understand our ethical responsibilities towards forms of life that differ significantly from our own. The core argument in this essay is that the current human concept of a moral status is anthropocentric and Earth-centric.

Examples for that are many, so I will focus only on few, where non-human animals are scrapped of being moral subjects and our moral relationship with them is based on the laws we create as virtuous people.

One of the most compelling cases is that of the chimpanzee Tommy in New York. This non-human animal, which is one of our closest relatives (having 48 chromosomes, so only two more than a human), was born and lived in solitary confinement in a wire cage for 26 years, serving his owner as a circus animal.

After a fire broke out, killing most of the apes at his owner's house, Tommy's case became a legal battle between the charity Nonhuman Rights Project and the New York courts. The charity's founder, Steven M. Wise, presented a case arguing that Tommy deserved to live out his life in a sanctuary in Florida with other chimpanzees. He directly referred to the landmark 1772 case Somerset vs Stewart. Somerset

came to England as an American slave owned by Stewart, who wanted to send "his" slave to Jamaica for sale. The judge decided that Somerset was a free man because there was no state of slavery in England.[7] Slavery had never been authorised by statue by England and Wales, therefore in England slavery could not be supported by the common law.

Sadly, the case of chimpanzee Tommy didn't go Wise's way. The New York courts decided that if an animal did something wrong, the behaviour cannot be taken as an act of a reasonable person, and for that reason a chimpanzee cannot be prosecuted, meaning a chimpanzee cannot gain the status of a person. Singer's (2016) argument when assessing this case is based on scientific facts analysed by Jane Goodall (1986,2000) and Dian Fossey who have no difficulty in recognising the value of great apes. Throughout her research, Goodall realised that chimpanzees have what we consider as "human" actions. They can feel sadness and joy, they are capable of rational thoughts as well as emotions. They are also capable of behaviours such as kisses, hugs, pats, and tickling, and learn these practises from being family members and living in a community.

The essay "Towards the Ethics of Astrobiology" also looks into other cases where we have no moral relationship with non-human animals on this planet. One of the examples in the essay are prairie dogs. As we know now, they live in their own society, and they even have a language with which they communicate if danger is coming. They kiss and vocally interact when they meet. With their "language", they can also reveal emotions and happy feelings. Likewise, studies of whales have shown that they also have a language and communicate with each other; like elephants, they can express sadness and joy, they live in society. Octopuses on the other hand are not known as a social animal, but the latest studies show them to be one of the most intelligent animals on Earth. The octopus has nine brains and can solve mazes and complete tricky tasks to get food rewards. As well as having a very sophisticated mind, octopuses also have a genetic quirk that is seen in humans. Scientists now believe that the octopus has self-awareness, rudimentary manifestations of which include awareness of a physical boundary that demarcates

[7] Lord Mansfield (1772): "The state of slavery is of such a nature that it is incapable of being introduced on any reasons, moral or political, but only by positive law, which preserves its force long after the reasons, occasions, and time itself from whence it was created, is erased from memory. It is so odious, that nothing can be suffered to support it, but positive law. Whatever inconveniences, therefore, may follow from the decision, I cannot say this case is allowed or approved by the law of England; and therefore, the black must be discharged."

them from the external world and the capacity to distinguish between themselves and another organism. (Merker 2005, Godfrey-Smith 2013).

In our relationships and interaction with all the animals mentioned above, we demonstrate a severe lack of moral judgment, hence moral sensitivity. Octopuses are quite often tortured before eaten, as they wait in aquariums in the middle of the restaurants in dirty water. Laboratories have tested drugs and medical equipment on chimpanzees who are kept in small cages. We kill elephants for their tusks, and we do not care at all about prairie dogs; we have also hunted whales in the past and they are still commonly accidentally killed in the process of fishing.

One of the great mathematicians and philosophers of his time, Descartes, had no scientific proof, data or evidence about animal pain, but thought that animals had no soul; that all their suffering was not really pain but just a machine-mechanism. When he dissected living horses and dogs without anaesthesia, he dismissed their screams of agony as broken mechanical devices without a soul. We can completely dismiss his assertions about nonhuman animals now, but he thought that animals didn't even rise to the level of irrelevance. Seemingly the Cartesian position was that nonhuman animals are soulless automata or merely "things".

There is, of course, a difference between Western theological traditions whose theological theories about moral status are much more anthropocentric – their dogma is based on the spiritual relationship between humanity and divinity and Eastern philosophies.

Most of the temporal mainstream ethical views are theologically based. In the Judeo-Christian-Muslim tradition, having a "rational soul" or "divine spark" often plays a central role in determining moral status. Even the most famous theologist would never grant moral status to our closest animal relatives – chimpanzees, gorillas and orangutans – because, to their doctrines, they do not possess a "rational soul". Unlike Adam and Eve, they were never created by God, nor given dominion status by God. This position is extremely problematic for detecting and confirming extraterrestrial life, hence creating an ethical responsibility towards it.

The question remains: are theologists making any progress towards changing the anthropocentric view, if in the next decade or so the James Webb[8] Telescope detects signs or finds proof of existing intelligent life outside our solar system?[9]

The essay "Towards the Ethics of Astrobiology" offers two valuable arguments. The first argument is that secular approaches have a significant advantage over theological ones when theorising about the moral status of nonhuman organisms. The appeal of secular ethics is also broader than theological thinking because it includes the ethical approach of non-religious people. Most likely the first human who reaches another world and potentially meets extraterrestrial life will be a scientist, hence it is highly unlikely that this person will consider life as religious and be a believer of the Adam and Eve dogma.

I will support this argument with Jayme S. J. Schwartz's analysis in her book "The Value of Science in Space Exploration" (2020), where she refers to very interesting data related to space and extraterrestrial life. Those who identify as Jewish, Hindu and Buddhist have a greater than average interest in space, but Evangelicals who are more likely than other religions to attend religious groups and services at least once a week are far more pessimistic about space, because they have a more literal understanding of their scripture.

Schwartz finds it interesting how few surveys have attempted to measure the public's interest in astrobiology in the USA[10] (until the book was published, only four surveys). She refers to the Pettinico telephone survey that spoke to 1,000 random US adults as the largest survey of its kind. To the question 'Do you believe that there is life in other planets in the Universe besides Earth?', 60% of those surveyed said yes and 32% said no (8% were undecided). As Schwartz concludes, belief in extraterrestrial life correlated negativity with the frequency of religious service attendance: the survey showed that only 45% of those who attended a religious service at least once a week believed in life on other planets, whereas 70% of those

[8] Recent reports that the James Webb Telescope (JWST) detected signs of life on a distant planet outside the solar system, are, unfortunately, premature, scientists at the University of California Riverside (UCR) concluded.

[9] Astrophysicist Avi Loeb has publicly proposed a theory that has sparked significant debate within the scientific community, asserting that our solar system has been visited by advanced extraterrestrial technology. He advocates for novel approaches in the search for extraterrestrial intelligence, emphasizing the deployment of advanced technological instruments, including deep-space probes, to enhance the detection of potential alien artifacts in our night sky.

[10] The four surveys were Swami (2009), Pettinico (2011), Oreiro and Solbes (2017), and Parson, Capova, and Li (2019)

rarely or never attending services believed in life on other planets. Of the 32% of people who are not open to extraterrestrial life, 56% citied religion as a main reason. As the USA is a secular society, this survey indicates other aspects of space exploration, including how many people actually support the public sector of NASA and its space exploration programmes, which were not so long ago dominant in the world's race for exploring space.

Considering religious pluralism – and avoiding major disruptions in the style of "Star Wars" – a secular approach would deliver and preserve more truthful outcomes when settling on Mars. The appeal of secular ethics is broader than that of theology. Despite this argument, secular moral theory as it stands at the present can still not hold the proper arguments, as it suffers excessively from a human-centred concept of moral status.

The most highly citied and perhaps most influential contemporary examples of secular approaches to the issue of moral status in Western philosophy are utilitarian and deontology-duty ethics.

The second argument is that none of these would serve the right purpose, as while they differ in methodological orientation, both focus on distinctly human characteristics when describing moral status.

According to Kant, a person is a rational being; people are "moral agents", having the capacity to determine moral imperatives and consciously will their own ends. All other animals are 'nonpersons' – he labels them mere things.

The authors of the essay find Kant's explanations interesting for two reasons: because human beings are presented as a prototype for moral agency (personhood), and because Kant explicitly excludes nonhuman animals on Earth from the category of persons by denying that they share our capacity for rationality. But by associating personhood broadly with the capacity of rationality, Kant leaves open the possibility of an alien (exhibiting human-like rationality) qualifying as a "person".[11]

[11] The closest exoplanet to Earth which could hold an intelligent life is Prima Centauri b, planet which is 4,24 light years away

Probably the first writer who included nonhuman animals in the moral radar was the father of utilitarian ethics, Jeremy Bentham. The passage (1781) where he indicates that animals can feel pain as much as humans, is relevant here.[12] Bentham focuses exclusively on the fact that animals have a human ability to suffer. His utilitarian logic appears to be that if animals are *similar* to us in this one crucial respect, then they might also warrant moral consideration. Bentham's view was extremely progressive in the 18th century. In contrast, John Stuart Mill's (1863) utilitarian view is that it is the ratio that matters and not the feelings; his famous statement is:" It is better to be an unsatisfied human than a satisfied pig."

In the present time, humans are more open-minded about moral theories that advocate for animal rights. With a utilitarian approach to this, Peter Singer (2016) champions animal liberation and Tom Regan (1984,1985,2004) gives a deontological defence of animal rights. Tony Milligan (2015) went further – his view on alien life remains anthropocentric, but from a very different perspective. His conclusion is that if there is life on Mars, even just in a primitive form of a molecule, we must not dare to interfere with it. Our interaction with an ecosystem that we did not evolve from, and with a planet that is not our own, could severely change or even destroy life on Mars. This would be massively wrong, because this life could well develop into something greater and bigger, perhaps one day into life like the one our own planet holds.

Singer, a utilitarian philosopher, advocates that we must not exclude nonhuman animals from moral consideration, because they have the ability to suffer. In his book "Ethics in the Real World" (2016), he asserts that fish can suffer as well. Taking fish out of water and watching how they gasp for breath is evidence of suffering and not evidence of mechanical reaction, as once claimed by Descartes. Just because fish don't scream and don't have vocal organs it doesn't lead to the conclusion that they are not suffering. Despite the fact the that fish do not strictly qualify as highly

[12] Other animals, which, on account of their interests having been neglected by the insensibility of the ancient jurists, stand degraded into the class of things. [original emphasis] ... The day has been, I grieve it to say in many places it is not yet past, in which the greater part of the species, under the denomination of slaves, have been treated ... upon the same footing as... animals are still. The day may come, when the rest of the animal creation may acquire those rights which never could have been withholden from them but by the hand of tyranny. The French have already discovered that the blackness of skin is no reason why a human being should be abandoned without redress to the caprice of a tormentor. It may come one day to be recognised, that the number of legs, the villosity of the skin, or the termination of the sacrum, are reasons equally insufficient for abandoning a sensitive being to the same fate. What else is it that should trace the insuperable line? Is it the faculty of reason, or perhaps, the faculty for discourse?...the question is not, Can they reason? nor, Can they talk? but, Can they suffer? (Bentham, 1781, Ch. 17 footnote)

developed animals, and may or may not have self-awareness, fish still can suffer. As Singer concludes, all animals that are conscious of pleasure and pain and can suffer must be accorded moral status. He provocatively goes even further, arguing that giving a moral preference to our own species represents a morally reproachable type of "speciesism". Singer draws an important distinction between species with a high self-awareness and those that don't have a strong sense of themselves as independent entities with a past and a future; but they all can suffer.

Singer moves beyond traditional human-centred ethical approaches in Western philosophy; his unit of analysis is pleasure and pain and he acknowledges that nonhuman animals suffer in their own nonhuman way. Sentience is the ability to express feelings and sensations, but it may not necessarily imply higher cognitive functions such as awareness, reasoning or complex thought processes[13].

Singer focuses on "self-awareness" related to sentience, and organisms that are higher- and lower-developed when assessing practical concerns in the realm of applied ethics.

I have deliberately introduced the two cases of humans from Africa in exhibitions from very recent history. These have parallels with social revolution in countries with colonial and slave history. According to the historical facts, we can claim that in parallel to the abolition of acts of slavery and post anti-slavery revolutions, things were also changing in our moral relationship with animals. The case of Somerset vs Stewart and the landmark decision by the judge in 1772 is in parallel with Bentham's pioneering approach towards animal ethics in 1780. In 1833, the British Parliament abolished slavery in the colonies. The first organised movement for woman's suffrage was at Langham Place Circle in the 1850s. In the USA, slavery was abolished by the 13th Amendment, which was passed by Congress in 1865. In 1848, the first woman's rights convention, the Seneca Falls Convention, was held in the USA, followed by the National Women's Rights Convention in 1850.

In 1835, Britain passed its first Cruelty to Animals Act, a couple of years after the official anti-slavery act was passed. This serves as a parable of Western societies,

[13] To Singer (2016), fish caught in a shoal suffocating for hours outside the water before being sold as fresh catch is a morally questionable method. Recently consumers have moved towards Singer's utilitarian approach – some customers from the supermarket Marks & Spencer prefer buying fish from salmon farms where they slaughter the fish immediately with a special vacuum cleaner method and needle into the brain, rather than buying wild fish caught by fishermen, which end up slowly dying in a net on the boat.

but Eastern philosophies were more open-minded regarding animal protection, with Jain and Hindu laws from 450AD onwards preventing animal cruelty and, in Japan, Emperor Tenmu prohibited eating meat and killing animals for eating in 675AD.

Regan in his moral theory (2004) defends the moral status of animals based on duty ethics with the rights-based method. He said animals are subject to life, and have rights. This is an inherent value. The term 'subject to a life' only applies to self-aware, sentient organisms capable of having beliefs and desires, consciously experiencing emotions, maintaining a psychophysical identity over time, acting deliberately to achieve ends, and conceiving future goals. Animals have rights because they are subject to a life. A year-old mammal has a self-awareness, which stays all its life or until it gets seriously ill. Regan puts the argument between utility and a rights-based view directly to the case of animals in science, and this argument will be used many times in this research. Most astrobiologists and scientists do not think that searching for extraterrestrial life in our solar system will actually bring us to a discovery of sophisticated, human-like life. For the time being, searching for alien life will be constricted to our home solar system, knowing that technology can take us only so far and knowing the biochemical components – after all, in our solar system we might only be dealing only with life in microbial ecosystems. This does not mean that we will be leaving our animals behind on our home planet, and here we must consider Regan's ethical view. This will be properly discussed in a separate chapter of this thesis.

What is important for the time being is the rights-based view versus utilitarianism. In Regan's assessment, the utilitarian will consider the use of animals for scientific purposes depending on the outcome (2004, 392). The harm done to animals for scientific purposes is aggregated in consequences for all those affected by the outcome. If the outcome that results in harming animals can produce the biggest aggregate balance of good over evil, then this harmful experience for the utilitarian is justifiable and obligatory. If the outcome will be at least as good as other outcomes, then the harmful experimentation is permissible. Only if the harmful experimentation would produce less than the largest consequences would it be wrong.

Regan sees the utilitarian principle at this point based on many assessments: who will be harmed, who will benefit, how much, and so on. As he points out, there are

also the interests of those who test animals, conduct the research, manage research groups, the wholesalers of cages, animal breeders… the accumulation of these many people is taken into account and counted equitably. To utilitarians, this accountability is important, but Regan finds it problematic because their interests must be considered, to be sure, but not any more than anybody else's.

Regan concludes that utilitarians fail to give us the most important thing, the facts to determine whether the use of animals in science is justified; instead, they give us all sorts of reasons from other sectors and individuals performing scientific research on animals. Also, the argument where a utilitarian claims that experimenting on less advanced, less intelligent, less developed and less self-aware animals would lead to a better result than experimenting on human beings is a faulty and unjustifiable claim.

Regan's rights-based view takes a very different stand. "No one, whether human or animal, is ever to be treated as if she were a mere receptacle, or as if her value were reducible to her possible utility for others" (2004,393). Regan opposes the practice that for the sake of satisfying outcomes of experiments, one can harm any individual, and says that the harm done to animals in pursuit of scientific purposes is wrong. Any gains of this are ill-gotten, they are secured unjustly. Regan challenges those who do science for advanced knowledge and general welfare, but don't allow that this violates the rights of an individual. He campaigns for the abolition of harming animals for the purpose of science, education and other utilitarian practices.

Regan's moral theory is problematic when searching for extraterrestrial life because of his core claim that all that are subject to life have rights and that we have a moral duty to protect that. He does not specify what life is, and with the data we have so far in relation to Mars, we might only find molecular forms.

Only time will tell if we are able to change our moral relationship and duty towards animals. By exercising our virtue ethical approach, we are advancing our moral duties, which I will argue in the second part of this thesis when introducing a debate regarding ethics and nanotechnology.

As per the most accepted theory, we all evolved from a Kenyan valley, and now – with no fur and thin skin – we live in places such as the South Pole, Earth's orbit and

very soon on an object in our solar system, Moon or Mars. Our biological evolution was in parallel with our social evolution and our acclaim is in virtue ethics. As humans, we seek many needs that are related to our biological composition; we need water, food, shelter and we need to flourish, to live a life that is worth living. Throughout our social development and evolution, we created countries, courts, universities, and religious and philosophical institutions to help us achieve a good life, to help us be better, happier. One of the reasons that drives us to strive into the extraterrestrial is to flourish in science and technology, but the question remains: can we do it with our anthropocentric and Earth-centric perspective, and can virtue ethics navigate us to a better extraterrestrial human civilisation?

This research argues that we could possibly achieve this by exercising our virtues. But this practice could destroy our perception of extraterrestrial life for two reasons. If we find nothing more than small molecules and uncomplex organisms, we might well say this life is not worthy and adopt Zubrin's view. If we find more complex organisms in forms of creatures, then we should not take either a deontological or utilitarian ethical practice but advance our virtue ethical perspective for both humans and nonhumans. Finally, if there are human-like individuals near our solar system then we must ask ourselves first why they wouldn't' like to meet us, before we decide to meet them.

2.1. What is the Definition of Life?

To determinate what extraterrestrial life is, a definition is crucial, hence we must answer the question:" what is life?". We ought to first answer this question about what life on Earth is.

The answer to this question is philosophical[14], involving molecular science, biology, the theory of evolution and other expertise: it requires interdisciplinary assessment.

In recent years, molecular biologists have tried to synthesise life in laboratories and define the moment when two molecules form a simple cell 'a life'. The stage at which the synthesis of two non-living molecules becomes a simple form of life is not clear.

[14] One of the first philosophers who tried to answer the question 'what is life?' was Aristotle. (Aristotle, De Anima, Bk II, 412a13-416b30)

Astrobiologists consider complex questions about extraterrestrial life, among them a crucial one: how to detect alien life if it is very different from ours. For some time, scientists have been aware that extraterrestrial life could be based on silicon and possibly even boron, and not carbon that evolves the organic forms of molecules. Life as we know it so far originates from this planet and is of organic material.

The theory that life is spread in our solar system, and that bacteria and microcells were always in circulation, travelling with asteroids between the objects in our solar system, is not widely accepted but some scientists prefer it.

It would be much more difficult to assume that “alien” life is similar and related to us. At this point I must open another debate. If life is spread in our solar system and possibly around the Universe, some astrobiologists are advocates of the so-called “panspermia” theory. This is the consideration that life is most likely carbon-based, which means life is spread around the Universe by meteors and comets in the aftermath of a massive impact on planets. In that case, the Universe does not belong strictly to us, we must share it, and this requires complex ethical considerations. A greater focus on this will be in a future chapter on contamination.

There have been scientific reports that we contaminated Mars with bacteria from Earth when landing robotic missions on its surface. There are some bacteria that can survive long space travel and exposure to cosmic radiation. We have also found rocks from Mars on Earth. They were most likely excavated from the Martian atmosphere to space after a tremendous impact, possibly hit by a meteor, moon, or even a dwarf planet. Some scientists believe that life in the Universe is spread in the concept of panspermia[15].

The question “what is life?” certainly needs a definition of “life” but, so far, every definition of life cannot stand its core argument and is swiftly attacked by a counter claim.

In the last century, metabolic definitions of life were popular. In NASA’s first search for microbial life on Mars, they designed robotic mechanisms in the Viking programs, which could potentially detect life. Although the Viking robots were well-equipped,

[15] Panspermia is one of the mainstream theories that life may have originated elsewhere in the Universe and reached Earth through space travel. This theory doesn’t have broad support because it does not answer where life originates, if the space travel of microbial organisms was assisted by advanced extraterrestrial beings, or if there was a primary-first creation of that life.

the counter argument to their finding life were strong as well, particularly in the core argument: what if life on Mars was scientifically different? The Viking robotic examinations could only detect life that was determined on the premise: "consumption of energy from the environment, changing its shape and releasing it back to the environment", which is a metabolic definition, hence carbon-based life. We can't say that a candle is a living thing, although it does have all the criteria for life from the previous sentence, taking energy from the environment, changing shape and releasing energy and finally dying. The majority of scientists concluded that the Viking missions failed to detect life on Martian soil. In short, as the article "Towards the Ethics of Astrobiology" claims, metabolic definitions of life are invariably either too broad (encompassing some non-living organisms in addition to living ones) or overly narrow (excluding possible alien organisms differing from familiar life on Earth) and attempts to find a middle ground continue to be unsuccessful.

There are other theories also mentioned in this article that try to prove life; one of the most adaptable is Darwin's theory of evolution, which has in recent years supplanted metabolic definitions in popularity among astrobiologists and biologists. The quote from the paper is "a self-sustained chemical system capable of undergoing Darwinian evolution" (e.g., Joyce, 1994).

Scientists also propose other definitions: thermodynamic, biochemical, cybernetic, and autopoietic definitions, all of which face serious counterexamples. Do these reach the right answer to determine what life is? No. As per life on Earth, we need to know a great deal of chemistry and biology[16].

There is another obstacle to determining what life is on our planet. We have discovered nanotechnology, particles that can act like-life, from the same principle that our DNA works, except nanotechnology is completely manmade. Its particles

[16] Life on Earth is based upon an exceedingly complex cooperative arrangement between two types of large, organic (carbon containing) molecules, i.e. proteins and nucleic acids. Proteins supply the bulk of the structural material for building organismal bodies as well as the catalytic (enzymatic) material for powering and maintaining them. Nucleic acids store the hereditary information required for reproduction and for synthesising the enormous quantity and variety of protein required by an organism during its life span. The crucial process of coordinating these functions – of translating the hereditary material stored in nucleic acids into proteins for use in growth, maintenance, and repair – is handled by ribosomes, minuscule but intricately structured molecular devices found in large numbers in the cells of all known organisms on Earth. The similarities go even deeper, however. Proteins consist of long chains (polymers) of smaller organic molecules known as amino acids. Although over a hundred amino acids are found in nature, all life on Earth (e.g. bacteria, jellyfish, mushrooms, redwood trees, sharks, crows, and humans) constructs its proteins from the same approximately 20 amino acids.

are self-sustained, self-replicable, they can exist and support their “life” in more challenging circumstances than carbon-based molecules. Nanotechnology will play the core part in our extraterrestrial future, where our lives in lethal environments will not be possible without its support. I will argue more about the complexity regarding our ethical relationship with nanotechnology in part two of this research.

In conclusion to this chapter, when assessing our moral responsibility towards extraterrestrial life we should determine what we believe that extraterrestrial life is, we must classify it as “alive”, then we can responsibly implement our ethical relationship regarding this life. To help us set the right terms we must loosen our anthropocentric and Earth-centric view regarding extraterrestrial life, which is so far embroidered into deontological and utilitarian ethical practice. My assumption on which I will present the arguments during my research in this thesis is that our extraterrestrial life is part of our social evolution. Our civilisation is driven by science and technology; science has no one definition of life, and philosophy must serve as a support when finding extraterrestrial life.

As mentioned earlier, deontological and utilitarian ethical approaches cannot properly support our ethical relationship to alien life, nor can they detect it. As the US research data concluded, people with religious views don’t care that much about extraterrestrial activity and life. Both ethical theories, deontological and utilitarian, fail in practice to protect nonhuman life on our home planet, and lack an argument of what life is. In the next chapter and in the second part of the thesis, which is related to extraterrestrial nanotechnology, I will try to answer some relevant ethical questions with regards to our extraterrestrial life, taking a virtue-ethical perspective.

Humanity is driven by science and technology and the current civilisation is at the brink of turning humanity extraterrestrial. It was once thought that humans lived between Earth and Heaven, but our lives will soon be spread around the Universe.[17]

Equally important is the question of whether we can act with our anthropocentric behaviour as moral agents, and can alien microbial life be considered as patients?

[17] Avi Loeb (2023), one of the most prominent astrophysicists of our time, asserts that we are witnessing a period of significant cosmological transformation. He contends that, amid the growing body of evidence, humanity is on the verge of confirming that we are not alone in the universe. Furthermore, he suggests that this era presents an unprecedented opportunity to initiate interactions with the broader cosmos and any potential extraterrestrial entities that may exist beyond our Solar System.

Milligan sees our anthropocentric behaviour as unreasonable in the sense that only a few years ago in the pandemic we were washing our hands to get rid of the deadly virus and bacteria, but to find this type of microorganism (a virus is not considered alive by scientists) would bring us to one of the greatest discoveries ever – it would mean that we are not alone in the solar system and consequentially the Universe does not belong to us. At this point, Milligan sees them as creatures with greater ethical consideration. With this conclusion, that the Universe does not belong to us, Milligan takes off from the anthropocentric moral view. If we are not alone in the Universe and we must share it, even though it is only with small and primitive organisms, we must not go and contaminate their habitats.

Considering all modern theories focused on our moral relationship and duty towards animals, we ought to consider higher moral standards towards animals that are closest to us by behaviour and social skills; those that can feel pain, sadness, happiness, use cognitive functions similar to ours, and can think and solve problems. But is this really the case? I argue that we have very little or no moral relationship to some of the animals that show intelligent functions. An octopus is capable of solving a maze, of opening and closing a jar of food, even climbing to the next aquarium to harvest fish at night. But its life expanse is short, it is not a social animal, and it has no relationship with generations of its family. Insects are also a good example; although they have great social skills and can produce amazing structures, look after each other and work together in harmony, our moral relationship towards most insects in practice is vague or none.

What is life is more of a philosophical question than it has ever been, even though in modern times, molecular and cognitive sciences are at the core of many branches of biology. And lately we have created robot-machines and implemented them into our everyday life, where we see them showing impressive human-like functions. They can answer rational questions; their cognitive functions can sometimes be like humans. They don’t eat or sleep. From the outside they look alive, but the question is, are they conscious? The declaration of life is very problematic, but one of the things we can claim is does life require a consciousness.

The search for extraterrestrial life is as much about basic biology, geology, chemistry and astrobiology as it is about seeking to understand our place in the Universe and continue with the philosophical debate of who we are and what is our

relationship and moral consideration with the rest of the Universe. What is our moral duty to life outside our planet if we ever discover it?

Science agrees that it will be very difficult to find and prove an alien life if it is completely different and not related to ours, and it will be much easier to find if it is carbon-based, the outcome of panspermia.

Further chapters are an ethical assessment of other forms of our behaviour in extraterrestrial environments: questions about liberty, freedom of movement, violation of bodily autonomy and tyranny.

What would be our moral practice when we conquer an object in our solar system and, equally importantly, do we have right to take animals from our planet and forcefully start putting them elsewhere in the Universe, even on a long-distance spaceship?[18]

3. How Does a Virtue Ethicist Approach Questions in Applied Ethics?

The previous two chapters introduced the ethical controversies and paradoxes inherent in our decision-making, particularly our difficulties in undertaking robust ethical assessments. While those chapters prompted us to consider which ethical theories might be suitable for evaluating our relationship with alien life or the problem of polluting Low Earth Orbit (LEO), they also revealed the challenge of identifying any truly “universal” ethical framework. The previous chapter focused on the problematic ethical relationship to extraterrestrial life, and the suggestion of this research is to give priority to a virtue-ethical perspective that requires further explanation.

If the earlier chapters served as a necessary preparation for understanding this complexity, this chapter represents the core theoretical foundation upon which the entire thesis will build.

[18] I wish to open another debate, but this would be a subject for different research. With the consideration that we ought to be good to flourish and to live a good life, are we morally dysfunctional or is morality an exercise of reaching higher standards and goals? Thinking about the current geopolitical situation: the wars in Ukraine and the Middle East, conflicts in Yemen and Burma, where the weakest members of our civilisation, children, are collateral damage, dying before reaching adulthood. If there are intelligent and sophisticated creatures or life elsewhere in the Universe and if they have the technology to watch us now, they must have an ethical imperative and they probably would not want to have anything to do with us.

Here, the focus shifts to the ethical questions surrounding extraterrestrial human life, approached through the lens of virtue ethics. This chapter will offer a detailed argument – grounded in both factual and foreseeable circumstances – explaining why it is reasonable to assume that ethics in extraterrestrial settings will (and should) follow virtue-ethical principles. From this point forward, the thesis will draw its main conclusions from virtue ethics, primarily because human life beyond Earth will depend on technological achievements designed to help us flourish and live well – what might be termed techno-moral virtues.

Crucially, virtue ethics is uniquely adaptable, always leaving space for ethical practices to be refined and improved. This openness is essential for extraterrestrial contexts, where communities will need to innovate ethically in order to survive and thrive. To support this claim, the chapter will also examine virtue ethics in relation to other moral theories – particularly utilitarianism, which typically emphasises rule-based frameworks imposed by institutions to secure the greatest good and minimise harm. Unlike terrestrial societies, which benefit from established institutions enforcing rules (sometimes in a quasi-military manner), early space communities on lethal and barren planets will lack such structures. In these settings, ethical outcomes will depend fundamentally on the character and virtues of individual actors who must cooperate to build and sustain life in an unforgiving environment.

Further chapters will focus on extraterrestrial humanity itself and the ethical norms that will potentially be required when living an extraterrestrial life.

This research is based on the prediction of extraterrestrial human life, focusing on life on Mars or long-term space travel while living in a relatively small space vessel. What will be the moral norms and practices of humans living in lethal environments far away from Earth? I am assuming that in a small social environment that is not supported by institutions[19] and where no one can voluntarily or forcedly implement ethical norms or views, actors will have a bigger choice to assess ethical situations. Extraterrestrial humans will potentially create new ethical standards and norms or

[19] For quite some time, there will be no courts, police stations, armies, schools or cultural centres on Mars. Life will be complex in its way of using technology and nanotechnology and not fully supported by laws on Earth, even for breathing, but quite simple at the same time. Everyone will have to live in a small and simple compartment, under restrictions on controlling food supply, oxygen use and pressure adjustments.

take the virtues that they already know and exercise on Earth and transfer them to ‘new worlds’.

Virtue ethics is one of the oldest and most enduring ethical theories, emphasising the development of virtuous character traits as the key to leading a morally good life. Through this exploration, we aim to understand the significance of virtues in shaping ethical conduct and the cultivation of moral excellence.

Extraterrestrial humans will face many extraordinarily challenging situations, where they will need to react quickly. Practising virtue and wisdom will be at the core of daily routines, habits and missions. One of the biggest questions is what happens when one’s life changes into the mission of many people, where everyone plays an important part and staying in harmony with others is crucial. A mission is accomplished by following a process and expecting success at the end; it is usually accompanied by rules and training practices that are important for the survival of the mission itself and its agents.

Suppose that a flight to Mars takes seven months and hibernation is necessary for the crew members. The moral theorist will argue that deep REM means using less energy and food, which makes travel lighter, easier and more controlled, hence avoiding the psychological trauma of being further and further away from Earth. Moral theorists might say that hibernation is the best way to follow the rules and code of conduct of the mission[20], and that only the few who are not hibernating can break those rules, in order to successfully land on a new planet. This is on the presumption of human nature: sometimes we do break rules. If the rules are broken by two crew members and not by all 100, it is possibly less controversial and dangerous, as long as the rule they break is not one that leads to a substantial problem.

The virtue-ethical perspective would question whether hibernation is the best way to achieve a good life on a seven-month journey towards Mars. Are the crew members brave and charitable enough to risk their lives for the higher goals of

[20] Implementing a code of conduct is not limited to large organisations and workplaces; it is vitally important in small organisations like space vessels and space settlements as well. Astronauts and other members of extraterrestrial communities must adhere to all practices and procedures meticulously to ensure their own safety and the success of their mission. Astronauts receive thorough training on the code of conduct. Any breaches in this code can cause severe disturbances, particularly in confined environments. The code of conduct is typically reinforced by strict rules and regulations to maintain order and safety.

humanity – landing on another planet and therefore turning humanity extraterrestrial?

Although Aristotle has always been recognised in the ethical tradition, for the last three centuries or so, deontology and a bit later utilitarianism were also the mainstream ethical traditions, so concepts such as motives and moral character, moral education, moral wisdom, the concept of deep happiness, the path to flourish via friendship and family relationships, the meaning of a good life, emotions in our moral life, and how to distinguish between virtue and vice were taken out of the ethical tradition and practice. Fundamentally important questions of what sort of person we should be and how we should live were replaced by guidance towards good and appropriate ethical norms and their opposites. The virtue practice, which opens the path of constant progress where one is capable of enriching and flourishing, was either ignored or replaced.

The foundational concepts of virtue ethics are, in Western philosophy, mostly based on the conceptual ethical theories of Plato and Aristotle, followed later by Aquinas. In the East, the key thinkers were Mencius and Confucius.

Aristotle proposed that moral virtues are habits acquired through practice and developed within the context of community and social interaction. For him, virtues are the mean between two vices, representing a balance or harmony in character. This notion of virtue as a mean is central to his ethical framework, wherein virtues such as courage, temperance and justice are cultivated through rational deliberation and habitual action. Aristotle distinguishes virtues as moral and intellectual. Intellectual virtues (e.g. practical wisdom) are states or traits of character of the reasoning part of the soul. They are habits of thinking, like understanding the nature of things, judging the truth of matters, reasoning from the truth known to the truth that is unknown. By contrast, moral virtues or virtues of character (e.g. temperance) are states or traits of the part characterised by desire and emotion. Moral virtues are dispositions or habits of living that deal with the whole person. For example, prudence, justice, fortitude and temperance are moral virtues.

In Book 2 of ‘Nicomachean Ethics’, Aristotle proposes that our moral virtues have a grounding in our biology. Aristotle calls human beings a social animal, a moral animal; as he says, it is in our nature to develop a rich set of character virtues that

serve as a basis of our moral institutions. In Book 5, he claims that right and wrong depend on laws and social norms. Morality exists between fellow citizens; this is a key thought from other Greek humanists, both before and after Aristotle. Right and wrong is codified by the community of equals, who articulate and decide on ethical norms and the acceptance of rights and wrongs.

Virtue ethical moral theory has been revitalised in the Western philosophy of the past few decades. Virtue ethics is, in all its meanings, directly related to the good life – living the life of a good person who is capable of exhibiting virtue and reaching the highest standards of positive virtue practice.

In the Aristotelian meaning, this whole-life practice is connected with the word ‘eudaemonia’, most often translated as happiness, flourishing and wellbeing. It is the best, most positive state of the spirit that one aims to achieve. Rosalind Hursthouse (1999), a modern Aristotelian ethicist, says a virtue is a character trait that a human being needs for eudaemonia – to flourish or live well.

As emphasised by Aristotle, the exercising of virtue does not enable an agent to flourish; also, the trait does not have to characteristically benefit the agent.

In a very normal circumstances, we understand that the virtuous character is better as an adult than as an adolescent, hence the importance of practising virtue as a whole-life process. Most of us would agree that as we gain years of experience, learning and upgrading our ēthos, we act differently on the basis of our previous experiences, so we reach a better outcome, which is in eudaemonia, flourishing, and to live a life that is worth living. This assessment changes in circumstances if people are increasingly hardened and violent, hence in this circumstances adolescence might start to look quite virtuous.

3.1. Virtue

In Book 2 of ‘Nicomachean Ethics’, Aristotle talks about two kinds of virtue: intellectual virtue (that, for the most part, is created and developed through teaching) and virtue of character (that comes about through our habit, hence this part needs time and experience) – this is a whole-life process, an exercise of getting better. Aristotle proposes a word ‘ēthos’, which stands for character, and the same word with a slight variation can mean habit. Our moral virtues don’t develop in us naturally.

Aristotle says that everything aims to something good, every action and choice, every systematic method that delivers art and technical skill. He proposes that good is what all things strive for. There are two different goals we aim for, he says, some of these are activities and some are products.

Aristoteles's principal concern in ethics is human wellbeing. Central to the well-lived life are virtues. Like Plato, he regards the ethical virtues (justice, courage, temperance, etc) as complex rational, emotional and social skills. On the other hand, he disagrees with Plato that to be completely virtuous one must acquire virtues through training in science, mathematics and philosophy, to understand what goodness is.

One can live well when appreciating the way in which such goods as friendship, pleasure, virtue, honour and wealth fit together as a whole. In order to apply that general understanding to particular cases, we must acquire through proper upbringing and habits the ability to see, on each occasion, which course of action is best supported by reason. If we slowly learn about the general rules, then we cannot acquire practical wisdom as is conceived by Aristotle.

For Aristotle, as for Plato and Socrates, the virtues are central to a well-lived life.

"Virtues are all about actions and emotions and in each action and emotion is a feeling of pleasure and pain, thinking of being a good person is all about action and pain. Our nature primes us to receive them, and then we are perfected by our habits." (2020, 28)

We acquire virtues because we must exercise them first, and Aristotle's examples for this are the builder and lyre player[21]. They both need skill and training, and practice makes them better and more skilled. As Aristotle would say: "People become builders by building things…people become guitar-players by playing the guitar." ('Nicomachean Ethics', 29, II03b).

[21] In the 2020 edition of 'Nicomachean Ethics' by Penguin Classics translator Adam Beresford, he uses as an example a guitar and not a lyre, which Aristotle's original example. The modern guitar as we know it did not exist, but ancient stringed instruments like the lyre, kithara, and barbiton were commonly played in Ancient Greece. Revised with historical accuracy; As Aristotle would say: "People become builders by building things…people become kithara-players by playing the kithara." ('Nicomachean Ethics', 29, II03b).

When we are dealing with other people, some of us become honest and fair and some of us become the opposite – dishonest and unfair. The crucial point is when we are dealing with a specific situation. Aristotle's example is a frightening situation: some of us are afraid and become cowards, and some of us become brave.

So, our disposition and character traits are created by the activities that correspond to them. We become moderate people by refraining from pleasure, and this we can achieve by constant practice.

A good person regularly gets the targets of their choices right. There are three classes of things that are targets of our choices: things that are honourable, things that are in our interest, and things that are pleasurable. The opposite of those are things that are shameful, things that are harmful, and things that are painful.

Where people regularly make mistakes is mostly with respect to pleasure. One can be a good or a bad person depending on whether he or she can feel pleasure or pain the right or the wrong way.

Virtues are not capacities; we are not praised for being good or bad because we are capable of feeling certain emotions, hence virtues are not emotions nor capacities, they are dispositions.

Capacities (dunameis) refer to the basic abilities or potentialities that a person possesses by nature. Everyone is born with the capacity to experience emotions such as anger, fear, or compassion. Capacities are not yet formed – they are like raw material. The ability to feel fear, for example, is a capacity.

Dispositions (hexeis), on the other hand, are stable traits or tendencies developed over time through habit and practice. A disposition shapes how a person typically responds – not merely that they can feel something, but how they feel or act. In ethics, virtues and vices are considered dispositions. Courage, for instance, is a disposition – a cultivated tendency to confront fear appropriately, at the right time, and for the right reasons.

Aristotle places emphasis on dispositions because, for him, ethics is about the development of virtues through practice – not simply having the potential to feel or act, but doing so well and consistently.

Virtue is a disposition to choose certain things. It is, as Aristotle says, a “middle” state, between two ways of being bad (two vices): one caused by going too far and one caused by falling short.

Aristotle charts several examples of falling short, being in the middle and going too far, for instance: coward-brave-reckless; ungenerous-generous-extravagant; unambitious-ambitious (in a good way) -too ambitious. Aristotle calls the middle state being “good-natured”, and a person who possesses this state is good natured or gentle. Looking at two extremes, a person who gets too angry is bad tempered and the vice is “having a bad temper”; someone who falls short is a never-gets-angry kind of a person, and their state is “anger deficiency”. (‘Nicomachean Ethics’, 40, II07b)

When we have three possible dispositions, the one in the middle is virtue and the two vices are opposite each other and opposite to virtue. The strongest contrast is between the two extremes, the two vices, and not between vice and virtue.

Being a good person means finding a midpoint all the time; Aristotle suggests this is like trying to find the midpoint in a circle and that it is a tough task. It takes knowledge, it takes the right person, the right degree, the right time… Not just anyone can do it, hence there are two extremes on each side, and it is hard to get to the middle.

Aristotle also says that when we try to hit the midpoint and get it right, we sometimes lean towards going too far and sometimes lean towards falling short.

A virtue is a trait of character that is excellent. Virtue applies to the whole-life practice, as fulfilled by a complex character. The virtuous person considers the whole aspect of their actions, catalysing through the right mindset and giving the right outcome when acting virtuously.

Virtue is a ‘multi-track disposition ’(Hursthouse, Pettigrove, 2016), where an agent must consider multiple parallels to achieve the right ethical outcome. Pettigrove gives the example of an honest person: he says an honest person is not one who does not cheat, or act according to the right policy, just because she or he is afraid to be caught out being dishonest. This does not make the agent an honest person and is not a character virtue. Honesty is in a valuation of the character, a

manifestation with respect to other actions, and in a situation where an agent is expected to react. The consideration of honesty is more complex, as well as prudence, which is even more complex.

In Adam Beresford's introduction to 'Nicomachean Ethics '(2020 edition), he says that Aristotle's idea on virtues is that they have a non-rational component. We can also acquire virtues by a non-rational process. When we train our emotions, we don't think much about why we like or dislike something, it is just what we do.

While intellect is developed by teaching, for the most part character virtues are developed through habit, and they need experience.

He doesn't say that we don't need any cognitive components at all; to be a fully good person you need wisdom, which is a complexity composed of moral beliefs and common sense. Everyone wants to achieve many goals throughout their life and balance them against one another in the best possible way.

Aristotle also calls his subject "human philosophy". All the questions of right or wrong, good and bad, are tied specifically to the human condition and to human nature; they are human concerns; hence he wants us to do ethics without God.

Yet Beresford is convinced that Aristotle can still speak to us, because there are a number of universal, familiar features of human character that are not a matter of cultural differences between Ancient Greeks. He rejects the translations from Arthur Adkins, Elizabeth Anscombe and others who followed Nietzsche, in supposing that Ancient Greeks did not know the elements of modern thinking about right and wrong. He calls his translation post-Darwinian, which is supposedly more in line with the Aristotelian and Christian view of human character.

Rosalind Hursthouse points out that when we think of virtue in an Aristotelian way, we think of the concept that makes its possessor right, morally good, and an admirable person, whose life-long process is practising virtue. And this habituation is at the highest level of perfection; that's why it is called an art. Hursthouse says: "Aristotle's idea of virtue is not that virtues are just character traits, but excellences of the character." (1999,12).

When referring to the "right level" of virtue, Hursthouse makes a couple of interrelated distinctions: there is a difference between acting from reason, which

humans can do but also animals and small children when they act, and rational wanting or desire, which an adult has, hence it is mere passion and desire that applies to children and animals.

3.2. Flourishing

In the first book of 'Nicomachean Ethics', Aristotle says (2010,12): "To flourish (and prosper) is our ultimate goal. It (means living the life that) meets all our needs. It's the goal of everything we do."

He divides good things in three ways: external goods, goods of the soul (these are goods in the strictest and fullest sense, which also include actions), and goods of the body.

Exercising our goodness depends on us being a good person. The disposition can be there without producing any good effects (for instance if we are asleep, in hibernation – which I will refer again to later – or any other inactive state). Hence when we are exercising our virtues, inactivity is not possible, because we are inevitably doing things and doing them well.

Feeling pleasure is not an external thing, it is in the soul and if you are really devoted then you can exercise that pleasure. Being a good person gives you pleasure, and this can be a constantly repeating practice. As Aristotle says, being a good person is intrinsically enjoyable.

Aristotle admits that a lot of things in our life, important and trivial, happen to us by luck, and if they go badly, they weigh down on and damage our blessedness; they will cause us pain and suffering and negatively impact our activities. In this situation, an honourable behaviour can shine through, not because one is insensitive to pain, but because of one's nobility and sense of pride. Hence with exercising our virtues, the most important thing in our life, nobody who is blessed can ever become a miserable wretch, because this person will never do morally despicable or vile things. Being blessed is humanly possible during one's lifetime; Aristotle has an explanation that this is not when someone is dead, and there is no more chance that all the obstacles of bed luck and trauma which can happen are ruled out, because death is the end. Flourishing is a kind of activity of the soul, a virtue of the soul, expressing complete goodness.

If we step away from what is currently just an announcement of the owner of SpaceX Elon Musk and consider the real possibility of humans going to Mars, travelling for seven months one way in vulnerable and challenging conditions will consist of a complex combination of virtue acts. In addition, there would be a number of possible vices, including disobedience of laws and regulations. The film ‘The Martian’ serves as a good example of how to control emotions when making a rational recognition of certain reasons for action. We could assess this as perfection of character – only people with wisdom can make these decisions. Of course, because it is, after all, a film, the audience sees a successful mission as a happy ending, hence Aristotle's point that virtue is not about rewards. True virtue is about not thinking about or needing rewards for good actions.

To refer to an example from a film, most of the ethical challenges regarding extraterrestrial human life are yet to be conceived. In the 2015 Hollywood blockbuster ‘The Martian’, a space crew travelling back to Earth finds out that one of their colleagues who they thought was dead actually survived a crash and is now living alone on Mars. They provide the only hope to save his life, but this will result in two major vices – disobeying international maritime law, and disobeying orders from Mission Control. The captain consults the crew and briefs them with the fact that every crew member will be facing a hazardous situation if they return to Mars. Turning the spaceship back to Mars to rescue their colleague will cut their chance of survival to 20%, compared to 90% if they continue back to Earth. The success of the rescue mission is also extremely low, as they must get extra food supplies, and will be exposed to cosmic radiation for longer. In these challenging circumstances, the captain concludes that the decision should be made by the whole crew; the majority then agrees to act in prudence. According to Aristotle (Nicomachean Ethics, Book VI), prudence requires:

1. Deliberation about Means (euboulia): The crew carefully weighs their options, considering the dangers of cosmic radiation, the odds of success, and their moral duty to their colleague.
2. Correct Judgment (synesis): They assess the situation wisely, recognizing that their mission is not just about statistical success but about fulfilling their responsibility toward a fellow human being.

3. Right Action (gnome): Despite the dangers, they choose the morally virtuous action – returning to rescue their friend – demonstrating a higher ethical commitment to human life and solidarity.

Prudence does not mean avoiding danger at all costs, nor does it mean acting rashly. If the crew had acted purely on emotion without careful consideration, their decision might have been reckless (thrasos). However, because they balance moral responsibility with rational assessment, their decision aligns with Aristotelian phronesis. Their choice embodies Aristotle's idea that virtue lies in choosing the right action for the right reason at the right time – even when it involves personal risk. The mission may have only a 20% chance of success, but their prudence is demonstrated in recognizing that some moral obligations transcend mere probabilities. Thus, in an Aristotelian sense, their decision exemplifies courage (andreia) guided by prudence, making it a true expression of moral and intellectual virtue rather than mere impulsivity.

Prudence, as understood in Aristotelian philosophy, is a key intellectual virtue called phronesis (practical wisdom). Aristotle describes it as the ability to deliberate well about what is good and beneficial for a person's life, particularly in ethical decision-making. It involves using reason to determine the right course of action in a given situation.

In the context of *The Martian*, when the crew of the Ares III decides to disobey NASA's orders and return to Mars to rescue Mark Watney, their decision can be examined through the lens of Aristotelian prudence.

Prudence (phronesis) in their decision

1. Balancing Moral Duty and Rational Decision-Making

   The crew's choice involves a moral duty toward a fellow human being, despite the risks involved. In Aristotle's view, true phronesis is not just about personal survival but about making ethical choices that reflect virtues like courage, justice, and friendship.

   If they had merely followed NASA's command (prioritizing safety and protocol), it might have been seen as a lack of moral courage, which Aristotle considers a key virtue.

2. Practical Reasoning in Action

   Prudence requires deliberation and action based on reason rather than impulse. The crew does not recklessly decide to return but calculates the risks, devises a plan, and ensures the feasibility of the rescue.

   This aligns with Aristotle's view that prudence is not just about abstract wisdom but about taking practical steps toward a good outcome.

3. Choosing the Highest Good (Eudaemonia)

   Aristotle argues that actions should aim at eudaemonia – human flourishing and well-being. The crew recognizes that leaving Watney behind contradicts their commitment to solidarity, heroism, and the value of life.

   Their decision upholds virtue ethics by showing loyalty, responsibility, and a sense of justice toward their stranded comrade.

Conclusion: Was Their Decision Truly Prudent?

From an Aristotelian standpoint, their choice exhibits practical wisdom because:

- It aligns with ethical virtues (justice, courage, friendship).
- It is not reckless but rational and well-planned.
- It prioritizes the higher moral good over bureaucratic rules.

While NASA's orders prioritize risk aversion and protocol (which could be seen as a form of prudence in a bureaucratic sense), Aristotle's phronesis suggests that the crew made the right decision because they chose the morally superior path through careful deliberation.

In this situation the life practice of prudence is key – so the decision from the captain and crew should not come as a surprise. Astronauts are mostly scientists and explorers (and nowadays frequently tourists too), and their virtue practice of prudence is life-long, even before they set off on extraterrestrial missions.

When discussing the ambition to reach other objects in our solar system and establish extraterrestrial human life, we can see virtue as an ambition. Julia Annas (Pettigrove, Swanton, 2022) says that with any virtue there is the issue of what the person is aiming for; it could be a career, fame, family needs, a change in the

everyday routine. Her example is the case of Lance Armstrong, and she questions if his cheating with doping was virtue or virtuous ambition. Was he doing this to develop virtue – aiming at a career that was in a way guided and constrained by honesty? But she concludes that Armstrong was 'viciously ambitious', and that the trait counts against him.

As Annas clarifies, Aristotle points out the confusions we fall into through lacking distinct terms for virtue and vice. Simple ambition is not itself a developed virtue or vice, but Annas extends this issue and looks at the material a person works on until they have made themselves virtuous or vicious in that respect. There are further references to come about ambition as a virtue.

3.3. Practical Wisdom

Practical wisdom is a phrase that evolves from the Greek word φρόνησῐς and the Latin word phrónēsis – it is a type of wisdom or intelligence relevant to a practical action. It consists of good judgement and an excellent character. As Glen Pettigrove (2003) points out, another way in which one can easily fall short of full virtue is by lacking moral or practical wisdom – phronesis.

To properly understand Aristotle's virtue theory, we must have a firm grasp of his conception of practical wisdom. This is an intellectual virtue with which we develop moral virtue by grasping practical truth and coercing desire. Some philosophers think that practical wisdom concerns the ends of our actions, but the majority think it concerns the means. Practical wisdom has two functions concerned with practical knowledge: an intuitive function, which is a practical intuition concerning the ends of our actions; and a discursive function, which is deliberation concerning the means to our ends.

A virtuous person is morally good, excellent, inspiring, and acts and feels as one should, accordingly to truism (Pettigrove, 2003), which involves all three concepts: arête (excellence or virtue), phronesis (practical or moral wisdom), and eudaemonia (usually translated as happiness and flourishing). These are commonly accepted truisms; but, as Pettigrove says, sometimes virtues like generosity, honesty, compassion and courage can be faults. Someone who possesses these virtues and is morally good can still act wrongly.

Pettigrove's answer is in the dispositions that can often replace the right meaning of the virtues when the virtuous agent is motivated by emotion and not by rational choice. His examples for this are compassion, which is the disposition to be moved by the suffering of others and to act on that emotion. It is what Aristotle calls a 'natural virtue', a proto-version of full virtue awaiting perfection by phronesis or practical wisdom.

There is a comparison to be made between an adult and an adolescent: neither of them can act upon perfection. A virtuous adult is not infallible, and can still fail to do what they intend to due to a lack of knowledge. Hence the difference is that those with practical wisdom will always act upon the right path, even though the outcome could cause stress, negative feelings or challenging situations. Should someone tell the truth even if it hurts?

In general, a good intention is to act well and to do the right thing, nevertheless intentions and actions are different. You can do the right thing by accident, despite a bad intention. Pettigrove demonstrates that children and adolescents are more likely to hurt the ones they intend to benefit, because their understanding of what is beneficial and harmful is mistaken; hence a person with practical wisdom will do the right thing.

There are several forms of contemporary virtue ethics: eudaemonism, agent-based-exemplarist, target-centred, and Platonistic. We will explore these now.

3.4. Eudaemonist Virtue Ethics

Eudaemonia can be translated as a state or condition that relates directly to the good life, welfare, good spirit or flourishing. It is a type of ethics that is directly related to Greek moral philosophy and the Aristotelian tradition. For Aristotle, eudaemonia means living a life in accordance with virtue; it is not a skill to reach eudaemonia, it is itself an expression, something that is possessed as a repeating action of goodness, perfectionism and wellbeing.

It is a whole-life practice, which only certain types of characters can achieve to the highest standards of ethics. At the same time, eudaemonia is also ethical awareness – virtuous people don't just possess eudaemonia, they can exercise it. For that, they

don’t just need the right emotions and understanding, but also rational behaviour and wisdom.

We can understand eudaemonia from the words ‘practice ’and ‘action’. In ancient Greek, as well as in the Western philosophies of the past few decades, virtues and vices are complex dispositions that involve intellectual components, hence the effect of being able to reason well about the right thing to do (phronesis) and also to engage emotions and feelings. For Aristotle, virtue is necessary but not sufficient; there are also other commodities needed that are a matter of luck.

We can also understand eudaemonia as an agent’s tradition. According to Hursthouse, in Aristotelian virtue ethics the emotions have moral significance because virtues and vices come from the same “pathos”. They are dispositions to act, to feel emotions; they are reactions from the action, impulses and extracts emerging at the right time towards the right people or objects, for the right reasons, where “right” means correct.

Hursthouse explains that in virtue ethics the possibility arises when a “good action” is not merely a surrogate for the “right action”, and neither can we replicate it as an “action of the virtuous agent”. A good action is conceptually linked to the “good life” and eudaemonia, hence it is conceptually linked to morally (right) decisions.

Phronesis (prudence) in eudaemonia is a practical virtue or practical wisdom. It is an agent’s acquired trait; when it is possessed, it enables its character to identify the best thing to do in the best given situation. Unlike theoretical wisdom, practical reason results in action or decisions.

Living life with virtue is necessary for eudaemonia.

3.5. Agent-based and Exemplarist Virtue Ethics

Normative qualities are traced back to the qualities of an agent, so the value of eudaemonia is traced back to and ultimately explained in terms of the motivational and dispositional qualities of agents. Agent-based virtue ethics understands rightness in terms of good motivation and wrongness in terms of having bad or insufficiently good motives. Right and wrong actions can be fully understood from the agential character’s traits and motives. Agent-based ethics can occur in a

Nietzschean version of moral sentimentalism. Empathy is a central analytic tool, and it provides the basis for understanding respect for others, social justice, reasons for action and even deontology. It can account for our considered moral judgements much more adequately than utilitarianism can.

3.6. Contemporary Perspectives on Virtue Ethics

In contrast, other ethical theories are more coherent with the rule or frame of moral practice; deontology emphasises duties and rules, and consequentialism emphasises the consequences of action.

Virtue ethicists emphasise the importance of cultivating virtuous character traits such as honesty, courage, compassion, wisdom and integrity. When faced with an ethical dilemma, they consider which virtues are relevant to the situation and how those virtues can guide ethical decision-making. The core is in its character development, which prioritises the development of moral character over simply following rules or maximising outcomes, hence individuals should strive to become virtuous people who habitually act in morally admirable ways. This involves ongoing self-reflection, introspection, and the cultivation of virtuous habits.

Role models, such as historical figures, religious leaders, or individuals within their community, as examples of virtuous behaviour and a case for virtue ethics. These role models serve as inspirations and guides for how to cultivate virtuous character traits and navigate ethical dilemmas.

Central to virtue ethics is the concept of phronesis, or practical wisdom. Virtue ethicists emphasise the importance of developing practical wisdom to discern the morally right course of action in specific situations. This involves considering context, consequences, and the complexities of human relationships.

Considering applied ethics, virtue ethicists may encounter situations where different virtues appear to conflict. For example, the virtue of honesty might conflict with the virtue of compassion in certain situations. In such cases, virtue ethicists seek to find a balance between competing virtues, often guided by practical wisdom and moral discernment.

There is an emphasis on character over actions: unlike some ethical theories that focus primarily on the morality of individual actions, virtue ethics places greater emphasis on the overall character of the moral agent. Most virtue ethicists believe that morally right actions stem from virtuous character traits, and thus, the focus should be on developing a virtuous character rather than merely following a set of rules.

Virtue ethicists often take a long-term perspective on ethical decision-making, considering how actions contribute to the development of moral character over time. They recognise that cultivating a virtuous character is a life-long endeavour that requires ongoing effort and self-reflection.

Hursthouse acknowledges that the biggest criticism directed at virtue ethics is its failing to rank virtues by priority.

She outlines the codifiability thesis, which requires:

- that the rules should require a decision procedure, and
- that the rules should be applicable by the non-virtuous as well as the virtuous, applicable, that is, without any recourse to moral wisdom.

Hursthouse originally outlined the strong codifiability thesis with its requirements as above. Individuals still aspire to a set of rules, based upon which one can decide the right thing to do in every case. She does reject codification when it involves a blanket rejection of any absolute prohibitions, but recognises that there are circumstances when they provide little in the way of general action-guidance and certainly not a code in accordance with which one can live and act well. There are irresolvable situations, with the result that the virtuous character deals with tragic dilemmas.

These rules can be only applied correctly and efficiently by a particular person of a virtuous character who has a certain amount of moral wisdom. Most importantly, these rules are not applied mechanically.

Here Hursthouse acknowledges that virtue ethics compare unfavourably with some envisaged normative ethics.

When cases are unproblematic and clean (she calls them “mother knee rules”), for instance “Don’t lie” or “Keep promises”, understanding and applying these rules are appreciated. The problem is when there are “hard cases”; the application and understanding of these cases becomes more complex, involving judgement and premises that might be broken, so virtue ethics has as much codification as an adequate normative ethics.

There are some dilemmas from which even a good agent, a virtuous agent, cannot emerge having acted well. These tragic, irresolvable dilemmas are at the heart of the conclusion of Hursthouse’s virtue ethics versus applied ethical theory argument (2010, 74). There are some actions a virtuous agent is forced to do in a tragic dilemma, and they fail to be good actions because the doing of them ruins a good life. No matter if these actions are unwillingly or involuntarily done, they are actions not in virtue of wrongdoing, and not in virtue of having done what is right, justifiable or permissible.[22]

So what is the right action to take? Hursthouse recognises that the “must” in this situation is not action-guiding but action conceptual (2010,75).

Within virtue ethics, the ‘good action’ is not merely a surrogate for the ‘right action’, nor is it determined by the action of the virtuous agent. The accounts that virtue ethics holds are not good, bad or indifferent, or – as some people would call them – right, wrong or permissible. Good action is conceptually linked to the morally right decision; as Hursthouse calls it, the “action of the virtuous agent”, which is conceptually linked to “good life and eudaemonia” (2010,74).

But there are some dilemmas from which even a virtuous agent cannot emerge with their life unmarred, and these situations Hursthouse calls “tragic”. An agent is still in a position to take actions, but these actions are not action-guided but action-conceptual. Hursthouse’s example is an actor who is truly compassionate, but

[22] A clear example of such a tragic dilemma is found in Sophie’s Choice, the novel by William Styron. In the story, Sophie, a mother, is forced by a Nazi officer to choose which one of her two children will live and which will die. If she refuses to choose, both will be killed. From an Aristotelian virtue ethics perspective Sophie, as a moral agent, is not lacking in virtue – she deeply loves both children and seeks to preserve their lives. However, no choice is truly virtuous – choosing to save one child means she is complicit in sacrificing the other, but refusing to choose ensures both die. Practical wisdom (phronesis) cannot resolve the situation satisfactorily – there is no option where she emerges morally unscathed. Hursthouse would argue that this tragic dilemma exemplifies how even a virtuous agent cannot always act well, because the circumstances force them into a situation where harm and guilt are inevitable. Sophie's ultimate choice, no matter what it is, leaves her with moral residue – grief, self-reproach, and a sense of inescapable wrongdoing.

cannot live with the knowledge that she didn't save the life of 20 people, and who is courageous, but who cannot kill herself to escape this knowledge.

Hursthouse called a situation from which a virtuous agent cannot emerge unmarred "tragic". In a hypothetical case where astronaut x gives an overdose to a wounded colleague, there are two questions that I will borrow from Hursthouse (2010): one is, should x feel guilty about having done this? Some will say yes, others no. The answers are different whether or not we assess this as a concept of a whole situation. Yet there is another ethical question: should x regret it? Hursthouse also links this to feelings: an emotional reminder will haunt x for the rest of their days. The virtuous agent cannot emerge from this with their life unmarred.

This original specification of the right action does not apply when a dilemma is tragic. If a dilemma is resolvable, there is appropriate action guidance. But when we take it as providing an action assessment, it says the wrong thing: which marks the virtuous agent's life, with the exception of self-sacrifice. When the dilemma is irresolvable, it provides no action guidance, hence it still says the wrong thing if we take it as providing an action assessment.

From the case of the two astronauts in an accident on Mars, we can assess the decision of astronaut x who gave an overdose to the wounded astronaut that his act is the assessment of the whole circumstances. Astronaut x's act is out of charity; it is how a character deals with terrible circumstances. This of course doesn't explain the other assessment: how will x explain his actions once back on Earth, where different rules and guidance apply, which x has signed up for? Throughout this research I will predict and analyse many hypothetical situations and attempt to apply ethical norms from the virtue ethical perspective.

Nevertheless, Hursthouse is known for saying (2010,79): "An action is right if it is what a virtuous agent would characteristically do in the circumstances, except for tragic dilemmas, in which a decision decided upon may be too terrible to be called 'right 'or 'good'."

3.7. Technology and Virtue

Throughout human evolution, technology has played a very important part. Our technical achievements and creativity have made our human family into a

progressive civilisation that is capable of reaching far beyond our horizons. The Moon and Mars might well be just the beginnings of much greater extraterrestrial human life.

Shannon Vallor (2016) understands the challenges of the techno era. In her words, technology cannot be considered in isolation from the social environments in which it operates, and technologies cannot be understood in isolation from their consequences for our moral condition, and it is deeply implicated in both.

Vallor's concept of techno-moral virtues refers to the development and adaptation of moral character traits necessary for ethical living in a technologically mediated world. Grounded in the Aristotelian tradition of virtue ethics, Vallor contends that classical virtues – such as honesty, courage, empathy, and justice – must be critically reinterpreted to address the novel ethical challenges posed by emerging technologies, including artificial intelligence, robotics, and biotechnology. Techno-moral virtues thus provide a framework through which individuals and societies can cultivate the moral capacities required to navigate technological change responsibly, with a view to promoting long-term human flourishing in an increasingly digital and automated age.

Likewise, Vallor argues that we cannot understand modern society independently of the technological practices that shape it, and today you cannot understand morality independently of the technical practices that mediate it. Technology, morality and society are mutually connected in the sense that we can only part them artificially. For her, ethics is a shared human concern for living well with others; it is flourishing as fundamentally social creatures. Human life is an engine of the search for a moral living. A 'good life 'means living a life that we are proud of, that is worth living for ourselves and for our children and generations to come – it is a life we admire and so can others. This requires intellectual and moral tasks. Vallor's observation is that technology is topological: technology was always part of humans and human wellbeing, dating far back to when they invented bows and arrows to help them hunt. Technology is a primary part of human social evolution, but yet to be accomplished is a biological evolution where nanotechnology and biotechnology will eventually start replacing "infertile and mutated" human cells with better ones.

During human evolution, we have created moral choices and possibilities that were not necessary for us in previous times. Technology is not value-neutral; new tools bring new significance and new morals. Technology always reflects and embodies human needs, desires, expectations and judgements; it is developed to help us to live better, to live a 'good life'. Vallor admits that sometimes technologies do fail, but they are engineered to improve human life: they are tools of moral intention. In her view, technology has always worked to improve human life, like ethics, which has developed throughout time, adjusting to new norms, conditions and practices of law. Although ethics cannot be replaced by technology, sometimes new innovations are ethically questionable, for example the atomic bomb.

In the context of colonising Mars, several issues may arise from a virtue-ethical perspective, this prospective will be in focus of the thesis and we ought to consider them prior to our arrival. As we can correctly claim that here on Earth, we get oxygen for free, technically we could survive in a forest or in many other ecosystems, hunting and harvesting what nature provides each season.

But life in extraterrestrial environments is more challenging, and no one can survive in a low-gravity, thin atmosphere that cannot protect human cells from cosmic radiation, with toxic non-organic soil and no oxygen. Human life will not be possible without implementing technology and nanotechnology into society and the whole new world.

Nanotechnology is widely unapproved and non-legalised here on Earth, but it will be necessary to use this advanced "machinery" in extraterrestrial human life. The second part of this research is mainly focused on the virtue-ethical perspective on nanotechnology. For now, I would like to introduce several ethical questions and dilemmas regarding humans living extraterrestrially, with the focus on living extraterrestrially on Mars.

4. Ethical Dilemmas of Extraterrestrial Human Life on Mars

This chapter addresses the central ethical concerns arising from human interference with potential extraterrestrial ecosystems – should such ecosystems exist and eventually be discovered – as well as with the broader natural environment and intrinsic beauty of planets from which we did not evolve. At the same time, it reflects

critically on our own ethical condition as we prepare to live on these worlds, whether as members of scientific missions or as short- and long-term settlers.

Specifically, this chapter focuses on Mars, which is likely to become the first planet in the solar system to host a sustained human presence. It raises fundamental questions about our ethical relationship with the Martian environment, exploring not only environmental impacts but also the challenges faced by individuals living in an inhospitable and lethal world.

This discussion highlights the risks of acting as cosmic vandals, while also considering how we might instead approach Mars with respect and ethical responsibility. The chapter critically assesses arguments on both sides of key debates – for example, whether terraforming can ever be ethically justified, or whether altering Mars's current climate and aesthetic qualities purely to suit human needs constitutes a moral failure.

Furthermore, to illustrate the complexity of establishing ethical norms in extraterrestrial contexts, the chapter examines the contentious issue of euthanasia. Even on Earth, this remains ethically and legally controversial; it becomes even more complex when considered within the fragile, high-risk environments of off-world settlements. By exploring these questions, the chapter aims to illuminate the broader ethical frameworks we will need to develop to guide responsible human expansion beyond Earth.

4.1. Contamination of the Martian Environment

Contamination will go both ways. For quite some time, settlers on Mars will remain heavily dependent on resources from Earth. Starships will fly back to Earth, supplying Earth's economy with minerals and natural resources from Mars, before returning with food supplies, materials and new settlers; a human colony must develop on the red planet. Forward contamination and backward contamination will begin from the very first human-led mission to Mars; in fact, it has already begun. It started when rovers were sent there to explore and dig into Martian soil. NASA has so far landed five rovers (Sojourner, Spirit and Opportunity, Curiosity and Perseverance) on Mars. It's likely that each brought with it a level (even if very small) of contamination to the planet. Rovers do not end their missions by turning into

space junk; it is highly likely they will have brought with them certain microbes, which are capable of surviving challenging conditions and the long journey through the vacuum of the universe from Earth to Mars. Hence, it will be hard to prove life on Mars in the areas where those rovers landed and operated. Some scientists might argue that if primitive life forms are found in these areas, and they are similar or even the same as Earth-like life forms, it will be much harder to prove their actual origin. Some might even speculate that any microbes are most likely to have originated on Earth and then, having been brought by the rovers to Mars, successfully integrated into Martian soil over a number of decades.

Much more important for proof of Martian life is that any areas with liquid water trapped under crusts of ice are, in future missions to Mars, properly preserved and protected. A special system must be put in place to prevent contamination during explorations that aim to discover the existence of Martian life. Furthermore, it would be fascinating to find out whether this life evolved in parallel to life on Earth, or whether this life is unique and compounded completely differently to ours. The most acceptable theories suggest that Mars, once a live planet, was possibly always contaminated with rocks from Earth and vice versa; as has been proven, many Martian rocks[23] ended up on our planet. In a special study from Caltech and Jet Propulsion Laboratory (JPL), which Caltech manages for NASA, research conducted in the laboratory of Paul Asimow (MS'93 PhD'96) proves that the meteorite that hit Sherghati, India in August 1865 is from Mars. After more than a century of study, the meteorite segments called 'shergottite' were proved to be alien, from the red planet.[24]

The biggest environmental impact on Mars will certainly be from the colonisation of the planet, which raises several complex ethical issues that require careful consideration from a virtue ethics perspective. It is important to consider the potential impact on both the Martian environment and the wellbeing of the colonists, as well as the rights and autonomy of any potential native Martian.

[23] A Martian meteorite is a rock that was formed on Mars and then, because of the impact event, ejected from the planet and traversed interplanetary space before entering Earth's orbit and eventually landing as a meteorite on the ground. As of September 2023, 277 meteorites that originated from Mars were found on the Earth's surface. The data is collected by several institutions including NASA and organisations like the Meteoritical Society based in Virginia, USA.

[24] This study is described in the 3 May 2023 issue of the journal 'Science Advances'.

As mentioned in the first chapter, Milligan (2015) sees our intervention into an “unknown ecosystem” as a great paradox. Coming out of the global pandemic, we all still remember how important it is to wash our hands and use antibacterial products. In contrast, if we find a bacterial form of life on Mars, it must change our relationship with the red planet. As virtuous human beings, we respect our lives and we must respect the lives of others, even if it is in a primitive form. Without doubt, our interference on Mars would have a profound impact on potential life on Mars. Changing the eco-system and perhaps even killing it for reasons of scientific research would be wrong, as would any kind of interference with the potential flora of the planet. This could be a problem for our virtuous character, as to kill something for our own benefit does not make us a good human being. But as virtuous beings we want to have a good life, we want to flourish, and many scientists and explorers see extraterrestrial human life on Mars as an opportunity for a better life.

Milligan argues that we have no right to conquer a planet we are not made of. The primitive life forms there might evolve into something greater and more complex, perhaps – after millions of years – into a sophisticated life. Whereas Robert Zubrin (2021) believes that if primitive forms of life are found on Mars, that life has had long enough to develop into something greater and complex, but it didn’t because it simply cannot.

On Earth, we are developing ethical norms that apply to highly evolved species, among them our pets, wild animals at risk of extinction and, in the past decade, animals in farms, safaris, zoos and other deprived ecosystems. A movement that is leading towards eco-socialism[25], a new way of living and living standards, is

[25] This movement can be described as an eco-social movement or eco-socialism, which seeks to harmonize environmental sustainability with social justice. It is grounded in the belief that the exploitation of both nature and people is deeply connected, often driven by capitalist systems that prioritize profit over ecological balance and human well-being. At its core, this movement promotes ethical practices toward the environment, such as reducing pollution, preserving biodiversity, and transitioning to renewable energy. But it also emphasizes social equity – ensuring fair access to resources, protecting marginalized communities from environmental harm, and creating systems where economic activity supports, rather than depletes, the planet and its people. Rather than seeing humans and ecosystems as separate or in opposition, eco-socialism insists on co-existence and interdependence: that human life can only be sustained through healthy, resilient ecosystems, and that economic models must evolve to reflect this reality. Key principles often include environmental justice, democratic control of resources, community-led sustainability efforts, opposition to unchecked industrialization and consumerism. In essence, it's a holistic approach that blends ecological awareness with a commitment to equality and collective responsibility.
While Karl Marx didn’t use the term “eco-socialism,” some of his writings hinted at a concern for the "metabolic rift" – the idea that capitalism disrupts the natural balance between humans and the environment. He argued that capitalist systems alienate people from nature and overexploit resources for profit.

growing. Global warming and climate change are forcing us to drastically consider our consumption of animals, including the brutality that comes with slaughtering them and the pollution that is caused by animal breeding.

One of the arguments in the first chapter is Regan's deontological view. He argues that animals have moral rights because "they are subject of a life, and these rights adhere to them whether they are recognised or not".

It is almost certain that there are no deer or rabbits on Mars, or any other animals like there are on Earth. But finding microorganisms there would be a substantial scientific achievement. Milligan's argument is that this will be one of the greatest findings and proof that life is spread in the Universe, and we cannot touch that life. At this point, and by our logic, the Universe does not belong to us. We are sharing it, and we must not take utilitarian decisions. This view was set out in previous chapters.

But colonial powers can take these decisions. They act according to their own demands, triggered by an individual or a small group of people. A possible scenario is that settlers will go to Mars as evolutionists and their presence on Mars will be nothing but human evolution, where our civilisation makes a giant leap to the extra-terrestrial one and will be able to preserve life (if any) on the red planet. These settlers will have to adapt their lives to live in a lethal environment, without oxygen and an atmosphere to protect them from solar radiation and possible solar flares. This argument requires a debate in a separate chapter, which follows.

4.2. Ethics in Terraforming

Robert Sparrow (1999) applies an agent-based virtue ethics to issues in environmental philosophy regarding our treatment of complex inorganic systems. He considers the ethics of terraforming hypothetical planetary engineering on a vast scale, which is aimed at producing habitable environments on otherwise hostile planets. His main argument is that the undertaking of such a project demonstrates at least two serious defects of moral character: an aesthetics insensitivity and the sin of hubris. Trying to change a whole planet to fit our ends is arrogant vandalism. He maintains that these descriptions of character are coherent and important ethical

concepts. He demonstrates how the arguments developed in opposition to terraforming, in a somewhat far-fetched example, can be used in cases closer to home to provide arguments against our use of recombinant DNA technologies and against tourist developments in windless areas.

Terraforming is the hypothetical climatic and geophysical engineering of other planets on a grand scale with the aim of turning so called-barren planets in our (or for that matter another) solar system into habitable, Earth-like ecosystems. Zubrin (1986, 2011, 2016, 2022) is convinced that Mars can be terraform in 50 to 200 years. Meanwhile Elon Musk has suggested a much faster terraforming procedure, by nuke Mars-dropping a large number of atomic bombs on the poles of the red planet; this would heat up the planet by an average of at least 5 degrees Celsius (https://www.youtube.com/watch?v=gV6hP9wpMW8). In a very simple explanation, this process would enable the breaking of ice in the atmosphere and ground and contribute to the composition of a thick atmosphere (currently it has a thin atmosphere). A thick atmosphere can protect living creatures from cosmic radiation, so that humans could possibly walk freely on Mars; without protective suits but still needing an oxygen tank to breathe.

The process of terraforming could have a major impact on Mars's ecosystem. If life exists on Mars and it is based on organic components, this would enable that life to rise from underground to the surface, as the atmosphere would now protect its cells. Terraforming would bring a massive environmental change; some might say it would return the atmosphere to the planet, which around 3-4 billion years ago was Earth-like. It could be argued that protecting Earth-like life would be an act of virtue, but bombing the planet with nuclear weapons will also fundamentally alter its beauty. Olympus Mons, the biggest volcanic mountain in our solar system, could collapse, new craters could appear, and the planet may no longer even look red if it has a thicker atmosphere. Sparrow sees this as clear cosmic vandalism.

Even if we presume that Mars currently sustains no life at all and that terraforming will not affect any living thing, will cause no suffering, and will violate no rights that other life forms might possess, there are still complex inorganic systems on Mars. The planet also has a unique geography and complex physical and chemical systems, including its atmosphere and climate.

Using agent-based virtue ethics, Sparrow argues that terraforming reveals in us two serious defects of character. First, it demonstrates that we are suffering from an ethically significant aesthetic insensitivity. We would become cosmic vandals. It also involves us in the sin of hubris. We show ourselves to be suffering from an excessive pride, which blinds us to our own place in the world. In attempt to shape another planet to our ends, Sparrow indicates, we are seeking to become gods.

The ethics of our interactions with complex inorganic systems is that our actions towards them should be governed by reflection on how these actions reveal our character. We should cultivate virtues and avoid vices in our relation to the natural world.

When we contemplate levelling mountains, destroying ecosystems and terraforming, we should pause to reflect on whether we reveal ourselves to be blind to their beauty or to be suffering from hubris. Virtue ethics makes it possible to develop a further account of the value of the complex inorganic system. They have the value of virtue by the character traits that they can expose in us. They are a sort of moral touchstone.

How does environmental ethics play on our home planet? Among the most prominent advocates for respecting nature is Paul W. Taylor, who has said: “Actions are right, and character traits are morally good in virtue of their expressing or embodying a certain ultimate moral attitude…respect for nature” (2011,80). To him, all living things in the Earth’s natural ecosystem possess worth. Taylor reflects on the whole of nature, including nonhuman animals, and his philosophy might be replicable to Mars, albeit that we have no proven evidence that life on Mars exists in more complex forms.

When an individual possesses inherent worth, it is not because we value them or assess that they have value or not, it is about our concern; we have a reason to be concerned about the welfare and interests of individuals with inherent worth. Caring for them is conductive to our flourishing.

We have a disposition to aim at certain ends and to pursue certain purposes: avoiding doing harm, demolishing ecosystems and interfering with the natural status of live beings. It is the conative (2011,81) dimension of the attitude of respecting nature.

The practical dimension (2011,82) of a respect for nature involves being disposed to engage in reasoning, decision-making and actions that align with the goals and values that one holds regarding the environment. This aspect of attitude is not merely about holding certain beliefs or principles, but also about translating those into effective and consistent behaviour that supports and promotes ecological wellbeing. It requires the capacity to thoughtfully deliberate on the consequences of one's actions, make informed decisions that align with ecological values, and take steps that contribute to achieving outcomes that respect and preserve nature.

In this sense, the practical dimension bridges the gap between abstract ethical principles and tangible environmental practices. Sandler's example (2007,67); if someone values biodiversity, the practical dimension involves taking steps to support conservation, such as making responsible consumer choices, engaging in habitat restoration, or advocating for policies that protect ecosystems. Ultimately, it is about being committed to realising goals that reflect a deep respect for the natural world, through both thought and action.

The affective dimension (2011,83) of the attitude towards respect for nature refers to the emotional or affective responses a person has towards events or situations that impact the Earth's natural systems. This involves being inclined to experience positive emotions, such as satisfaction or joy, when witnessing occurrences that support the preservation and flourishing of wild communities, species populations and individual living organisms. Conversely, it also entails being predisposed to feel displeasure, concern or distress when confronted with occurrences that cause harm, degradation or destruction to these natural systems.

In essence, the affective dimension emphasises the emotional connection and empathy one has toward nature. It means genuinely caring about the wellbeing of ecosystems and feeling a sense of moral responsibility toward protecting them. When a person experiences positive emotions in response to the thriving of nature and negative emotions in response to environmental harm, it reflects a deep-seated respect and concern for the intrinsic value of the natural world. This emotional disposition can motivate a person to take actions that align with preserving and safeguarding nature.

The valuational dimension (2011,81) is indeed regarded as the core component of the attitude of respect for nature. It involves a fundamental value judgment that nature itself, including its ecosystems, species and individual living beings, possesses intrinsic worth, independent of its utility to humans. This evaluative stance forms the basis for how one perceives, reasons about, and engages with the natural world.

According to this perspective, the other dimensions – conative, practical, and affective – are thought to stem from this central evaluative stance. If someone truly believes that nature holds inherent value, this belief will naturally shape their reasoning (conative), decision-making and actions (practical), and emotional responses (affective) in ways that are consistent with this respect for nature. The evaluative dimension ensures that these responses are not isolated or conflicting but are instead cohesive and aligned with a deep respect for the intrinsic value of nature. In this view, the evaluative component is the guiding principle that influences and integrates all other dimensions, ensuring a holistic and consistent moral attitude toward the natural world.

The attitude of respect for nature is “the most fundamental kind of moral commitment that one can make” (2011,90). Taylor’s argument for the attitude of respect for nature advances in two stages: any open-minded, rational, factually informed person would accept a system that he calls a “biocentric outlook”. And this biocentric outlook provides the explanatory background that makes sense of the individual’s attitude of respect for nature.

The biocentric outlook consists largely of scientific naturalism and a naturalistic understanding of human beings. A teleological centre of life is a living thing that is internally organised towards its own ends or good. There is no position nor justification for maintaining the superiority of humans over members of other species; humans are part of this world and members of the Earth’s community as individuals, just like other species. The natural world is an interconnected system that humans depend on; all individual living organisms are teleological centres of life in the same way and the same sense – like the first two aspects of the biocentric outlook, it is a matter of naturalistic fact. Living organisms have a good of their own.

The fourth claim of the biocentric outlook means there is no non-question-begging standpoint from which to justify claims about the superior worth of humans. This type of worth is associated with the moral subject and not with moral agency and moral responsibility. The moral agent is a subject who is expected to respectfully possess capacities in virtue and who can act morally or immorally, in a praiseworthy or blameworthy way, according to obligations or without. From teleological point of view nonhuman organisms lack these capacities. They are not able to rationally conduct themselves in a situation, make intelligent judgments, make solid decisions, or understand moral concepts. Their actions have no moral worth, and they can't take moral responsibility for their actions. However, this does not prevent them from being moral subjects.

Being a moral agent is not necessary the condition of being a moral subject, as moral subjects can be treated rightly or wrongly. Senile people, infants and people with severe intellectual disabilities are not moral agents, and commonly recognised duties prevent moral agents from harming them. Nonhuman living organisms are also not moral agents, but this does not settle the issue of whether they have inherent worth in the sense relevant to being moral subjects (2011, 14-24).

Taylor's environmental view claims that we are not inherently superior or have greater inherent worth than members of other species. There are lots of capacities we have compared to other species: we are good artists, mathematicians, moral philosophers…but other species can also do things we can't, for instance photosynthesis and silk spinning. The difference is in evolution, which went in a different way for us than for other species. One of Taylor's questions is: if evolution went the same way for other species and they gained the same cognitive and psychological capacities as us, would we presume that they have greater worth than we do? Each species has its uniqueness, and evolution brought them to the same place as us. They are equally important; if evolution hadn't have gone in their favour, they would now be extinct. Inherent worth is also not dependent upon uniqueness. Each person has the same inherent worth, regardless of how similar their traits, history and genetic makeup is to other people.

Taylor's claims are an obstacle to Zubrin and Musk's ideas of terraforming Mars. Taking over the entire planet to fit to our ends makes it wrong for two reasons. If there are simple or even more complex forms of life on Mars, we must not act upon

them as superior “avatars”. Second, considering the ecosystems in our own planet and acknowledging that some people treasure awareness and care towards other species, Milligan’s question of if we are allowed to go and conquer ecosystems, we are not made from needs to be carefully considered. Can we justify terraforming, which might potentially destroy extraterrestrial ecosystems?

Ronald L. Sandler (2007,69) understands the difficulty of asserting the superior worth of individuals of one species over another within a naturalistic framework. The problem he sees is that there is no ready standard by which to justify the claim. To us, different things are valuable, and we don’t find photosynthesis or spinning silk highly valuable, even relevant. But in the lives and individuality of plants and butterflies, they are. There is no non-question-begging basis for the claim that we have greater inherent worth than individuals of other species. As he says: “Everything in scientific naturalism favours the conclusion that we are just another variety of biological organism.”

Focusing on our planet, Sandler (2007) is concerned about ethical naturalism and interpersonal benevolence, but not as much about aesthetic values and nature. He focuses on and emphasises what is distinctive, novel and promising about the virtue-orientated approach. He distinguishes between virtues and vices in environmental ethics, and admits there is a lot yet to be done with the issues associated with virtue-orientated environmental ethics. This is crucial, because environmental virtues and vices are the normative heart of ethics, which are in many cases only partly or even superficially specified in the literature of environmental ethics. Sandler distinguishes between claims to be humble, open, sensitive, frugal, tolerant, appreciative and compassionate, but it is another thing to detail the dispositions constitutive of those traits. He doesn’t show that the virtue-orientated approach is preferable to all its alternatives. His argument is that it is superior to standard monistic approaches; it incorporates what is insightful about environmental pragmatism, while avoiding some of pragmatism’s problematic features. He emphasises the pluralistic aspects of the approach, as environmental ethics claims many dimensions of our relationship with the natural environment. Our relationship with the natural environments is complex, diverse and dynamic, and presents many environmental challenges.

The case study of terraforming is a deliberate example of how complex the argument “should we or should we not terraform Mars” is, depending on which example of terraforming we take. Arguably both Zubrin and Musk’s proposals lead to Sparrow’s definition of cosmic vandalism. Both cases could result in the returning of an atmosphere and better living conditions for extraterrestrial humans, but Sparrow may assess this as fitting our ends, which is a non-virtue. Zubrin could defend this with a contra-statement that considering potential Martian life is in a primitive form, we must protect human life. Zubrin already assessed (2022) that primitive molecules “can’t develop into something greater and better” , the question remains is this the right opportunity for them to develop into something greater, because the atmosphere would now protect their cells and life could start again on the surface of Mars. An upgrade to Zubrin’s argument would be that we must protect human life and we must eventually go and live elsewhere in the solar system, so terraforming Mars stands as a platform for extraterrestrial humans to flourish on a host planet. Zubrin’s argument is that the nature will take its course, we are in a half way of the life of our sun, if we out to survive as civilization, we must spread around the galaxy.

The ethical questions regarding terraforming Mars lie within our evolution; as we once parted from the Kenyan valley, we are now conquering space. Yet this evolution is a result of a constant social revolution – since that Kenyan valley we have formed countries, social and technological systems, built rockets and now we are heading to extraterrestrial places. There is no doubt that our interest in living and spreading to Mars plays well to our ends, but should we see it from the perceptive that we are not superior individuals? The conclusion of this part will be delivered at the end of the subsequent subchapters.

4.3. Who are the Colonists of Mars and What is their Agenda?

The first generations of human colonies on Mars will be made up of more than just scientists exploring possible lifeforms. Several countries are already planning to build large settlements there. For instance, the UAE is planning that by the year 2117, 600,000 people will permanently live and work on Mars.[26]

[26] The United Arab Emirates (UAE) has indeed expressed long-term ambitions for Mars exploration. In 2017, the UAE announced a project called "Mars 2117", which is a 100-year plan to build a human settlement on

For the future of humanity, Mars is one of the most important objects in our solar system for two reasons: first, it is close to the asteroid belt, which is crucial for sourcing the energy that is so crucial for our Earth civilisation to survive and to further develop. Earth's energy resources are heavily extracted and mining the asteroids will significantly contribute to our everyday energy needs. Equally as importantly: we must go to Mars to learn about our past and our future. Related to this is interplanetary protection. As we know from the past, Earth has already been exposed to several mega asteroid crashes, which profoundly changed its habitats and destroyed species such as dinosaurs. One of the aims of the new Martian civilisation will be to contribute to interplanetary protection. As such, early settlers on Mars might quite quickly enter into trade relations with Earth, supplying us with much-needed minerals. Nanotechnology on Mars will most likely play the most important part.

Some astro-scientists believe that the first human colonists will land on Mars in the next decade. Countries like the UAE, USA, China, Japan, India and Russia are fast developing space programs. Alongside these countries there are several individuals who can also afford space programs. And since their space rockets reached the space, our civilisation started talking about democratization of space.

The behaviour of the owner of SpaceX and Starlink, Elon Musk, is ethically questionable, trashing the lower Earth orbit with expired satellites and creating further space junk, which endangers everyone on the planet. Mathematicians predict that with 1.8 million pieces of expired satellites already polluting our LEO (NASA in 2025 predicts there are 100 million fragments orbiting LEO) and an additional 25,000 from Starlink, by 2025, when Earth's population will be much over 8 billion, there will be more chance of one of us being hit by an expired satellite than being struck by lightning. Space junk is equally dangerous for the astronauts living and working on the International Space Station. Nevertheless, we need satellites for everyday use, we can spot weather conditions ahead of a storm that is developing into a level 5 hurricane and protect the populated areas where the hurricane will hit. Satellites are very important for spying and crucial – as demonstrated in the current war in Ukraine – for monitoring war zones and movements of the enemy's army. In

Mars by the year 2117. The vision includes the possibility of supporting up to 600,000 people on Mars in the distant future, but this is aspirational and not a current or near-future plan.

another example, they are used in areas such as oceans, mountains and other places where physical antennas and other sophisticated cover would be impossible to install.

Hence, ethically questionable was as well the “discovery” of America and the actions of Amerigo Vespucci and Christopher Columbus. Their discoveries were amazing, but they led to disease, slavery, murder, war and of course the formation of a nation that is among the most powerful in the world.

In 1492 one of the wealthiest men on the planet, Lorenzo de’ Medici, died; England and France signed the peace treaty; and King Ferdinand II of Aragon and Queen Isabella I of Castile conquered the Nasrid kingdom of Granada; but history will always remember the most important event of that year – Columbus’s discovery of America.

Jayme Schwartz (2018) argues that space exploration driven by a few rich individuals can be a very dangerous and fragile mission. Her example she used in one of his talks at the conference is based on speculation that Donald Trump can afford the space program. Schwartz’s opinion is that Trump is a good example of an individual who can afford the space mission but whose ethical standards are questionable and who will go down in history as one of the worst American presidents. During his presidency he encouraged his voters into unrest and hate; he made many dramatic moves but didn’t bring any solutions.

Trump represents morally questionable people whose conduct is unorthodox and even sick. If a man like him can send a colony to the Moon or Mars, how ill will this colony be? If he runs out of money and cannot afford it anymore, he can simply walk away. These dark thoughts of Schwartz are justified by the fact that the first human colonies to the Moon and Mars will be backed by benefactors from Earth. The trend of global peace, which has dominated the past few decades with the exception of the wars in Iraq and Afghanistan, Syria and Ukraine have changed the financial structure of states. It is highly unlikely in the foreseeable future that a single state could afford a sole mission of a human colony on the Moon or Mars. But it is highly likely that few rich men will support an extra-terrestrial human colony, financially and technologically.

Both the Moon and Mars are lethal environments for humans. The design and technology of human bases are still in development and the first generation of scientists and explorers to Mars might go there on a one-way ticket – there will be no return in their lifetime, as the technology to bring them back does not yet exist (as per year 2025), although Elon Musk is claiming that he will have it.[27]

This brings us to another ethical question. Scientists are keen to discover what is on Mars; as far as the evidence shows, the minerals on its surface could be very important for humans. They will work there, sending their results back to Earth, to the people who own the mission. In exchange, their benefactors will regularly supply the colony with scientific instruments, clothes, medicines, and food. The colony on Mars will have to be very self-sustained and self-driven. Their recycling system will have to be developed to precise, technologically advanced standards.

We exercise philosophical concepts like freedom, liberty, and ownership on a daily basis on Earth. As we know, sometimes wars start because our exercising of these concepts are based on the rights and wrongs of certain societies.

But to the humans on Mars, the concepts of freedom, liberty and ownership are far more challenging than we can imagine. As a consequence of predictable situations considering human nature, dispute among the members of the colony is likely. Here on Earth, disputes are solved during a mediation process, at courts, councils and other legal services. But this is not an option for a small colony.

Furthermore, who will own the oxygen supply pipeline needed for survival on Mars? Who will be in control of the buttons that switch oxygen on and off? How would scientists and explorers be paid their salary? And even if they do get a monthly pay cheque, their life expenses will be far higher than their earnings, and where are they going to spend that money? They are not coming back, it is a one-way ticket and there are no shopping malls, cinemas, car shops and cultural centres on Mars. What about their life insurance policy? I can imagine there will be no insurance company on Earth covering their life or medical insurance.

[27] In November 2024 Elon Musk wrote on portal x: “I am highly confident that we can send several uncrewed Starship on Mars in two years. If those ships don’t incremate the crater count on Mars, crewed ships can be sent in 4 years.”

A major question regards the colony itself. How will life function regarding social status? Is the relationship between the scientists and explorers there ranked according to the military or spaceship command, or is it that in principle everyone acts according to their own consciousness, will and duty?

How can we see the progress of this society – its growth and potentially its political structure? I argue that philosophy, in particular ethics, should be the pillar of support to answer these questions, and perhaps to develop new systems to support future societies.

4.4. Feudalism in Space

While the first few missions to Mars in the decade immediately after the first landing will be both government funded and commercial, in time they will become commercial only, led by private investors and benefactors.

The possibility of benefactors and sponsors of the space mission becoming tyrannical towards the Mars settlers in terms of supplying necessities such as food, air and water raises concerns about the virtue of justice and fairness. Additionally, if the colonist is not paid fairly for their labour, this will go against the virtue of fairness and reciprocity.

Charles Cockell (2022) believes that in the lethal environment of Mars, tyranny will emerge from people who have control – those who have control over oxygen, food and water production, the governance of extraterrestrial authority… Hence, the first settlers are likely to endorse tyranny for a variety of practical reasons, thinks Cockell. To protect human life and to make the mission possible and successful, there must be a form of self-imposed tyranny always present. Practical examples of this include undertaking an outdoor walk; this will not form part of free movement or any kind of right-to-exercise treaty. Solar radiation in a weak Martian atmosphere creates a lethal environment for humans, who will be forced to spend most of their living time on Mars in underground shelters, tunnels and domes with heavily protected anti-solar radiation covers. Commands from only a few must be respected and obeyed for the sake of the whole colony. Everyone must play an important part in a small society of settlers. Agents must follow strict rules and anyone missing out of the small community will endanger the lives of the rest. For example, the first 30 settlers

will include many professionals, among them one doctor. She or he will be vital to the whole group, and loss of his or her life will heavily endanger the lives of the others. Furthermore, the question of punishment arises when someone who is crucial to the community of settlers commits a crime. His or her punishment immediately becomes a punishment for everyone else; to exclude, for example, the planet's only doctor from the community and place them in a Martian prison is likely to harm everyone else as well.

If the only doctor in the small colony commits a crime and is able to avoid punishment because his or her practice is so crucial to the colony, which might suffer an epidemic spread, then social justice and social hierarchy as we know it will be altered. If circumstances dictate that that person holds a particularly important position, they might end up seeking more power and becoming a tyrant.

Zubrin's argument to Cockell is quite as simple. If there is tyranny on Mars, then no one will want to join the mission. People living in modern societies on Earth would not tolerate it and therefore would not take on this challenge. Private benefactors must have a non-tyrannical concept in place to make the missions desirable to join and successful.

As we learned from the enterprise examples on Earth, they don't necessarily endorse the virtue ethical concept. The closest example for this is offshore oil and gas platforms. Most of these platforms are operated by publicly listed private companies. Benefactors are a bunch of managers and administrators who run the oil companies a long way from the middle of the sea, in nice, polished offices in city centres. They must listen to the board and look after the investors' and owners' money to satisfy them by making profits. Workers have no freedom of movement, mostly because there is none on the open sea. Their day-to-day rights are limited, their work schedule is long, and they are not allowed make their employment contracts public. Additionally, their work conduct is unknown and according to their contract must not be shared but kept secret. They live and work in isolation, and their human rights are violated every moment of their existence there. Not to mention their lives being in danger.

On April 20th, 2010, the world's biggest ever environmental disaster caused by human failure took place in the Gulf of Mexico. We know it as the Deepwater Horizon

oil spill. In September 2014, a USA District Court judge ruled that BP, the owner of the oil plant, was primarily responsible for the disaster due to gross negligence and reckless conduct. Human error led to the disaster. Yet we learned barely anything about the relationship between the workers and the owners; the survivors had to sign a non-disclosure agreement, and their assessment of the disaster was not publicly shared or exposed.

There are some factual similarities to missions to Mars. The first several missions to the planet will be led by private companies. They will regulate contracts with the astronauts and settlers in the first few colonies. They might not disclose details of these contracts, and what they do disclose is likely to be limited to details about insurance. It is yet to be explored whether any insurance company will offer policies for individuals going to live and work in a lethal environment. At the moment, such policies do not exist. The salaries of the first settlers are bizarrely unimportant, because if they do earn money for their work, they will not be able to spend it. There are no shopping malls, health clubs, pubs or cinemas waiting for them there. Any mission to Mars will be one of the most expensive in human history, and the cost of the life of any employee of that mission will far outstrip the value of their monthly pay slip.

Benefactors of these missions hold all the strings and will be able to do whatever they want to. Life decisions will be made according to their perception, and these calculations will be based on any benefit to the company rather than to humanity, and almost certainly not for the workers and astronauts.

This example demonstrates the direct connection between such missions and the opportunity to exercise tyranny and feudalism in space. The potential exploitation of the colonists by those in power, including those on Earth – working on the presumption that any benefactors may remain on Earth, but might also be on Mars – would be a violation of the virtue of care and respect for the wellbeing of others.

4.5. Institution-led Missions to Mars Versus Private

Missions to Mars led either by government-run institutions or international institutions such as the UN or similar are likely to deliver the best outcome in terms of virtue ethics.

Over the centuries, noble and fine institutions have evolved to help the human family to flourish, and to serve individuals and societies so they can achieve a good life. Often, institutions which did not achieve this aim were either abolished, or societies had to change or destroy them, particularly during revolutions or war. One recent example is the Guantanamo Bay detention camp, or if we go further into our past, to Medieval England, where magic was the "industry" used by kings, servants and the poor, we would find practices that are now almost entirely replaced by science, medicine and pharmacy. Some institutions, such as libraries, academies, schools, courts and parliaments evolved alongside social evolution, and we are still using them today. They support our wellbeing and enhance our lives, and we have needed them throughout our history as a means to a good and happy existence. They help us to satisfy and achieve or reconstruct our needs, perhaps save time, and make our lives better. They are our daily exercise of virtue ethics.

If we are to achieve a successful and ethical mission to Mars, it should be institution led.

One of mankind's greatest institutions for space travel is NASA. However, because of the USA's fragile political system, where NASA's budget depends not on government policy but on decisions made by small, fragmented and decentralised groups in Congress, potential major plans are often swamped. Despite this, it is possible that at the end of this chain of groups and subgroups, there might be a billionaire who is in the position to bypass all the complexities of Congress and send his or her own mission to Mars.[28]

[28] As of 2025, the U.S. government has established a new agency called the Department of Government Efficiency (DOGE). This department is reportedly influenced by Elon Musk, the founder of SpaceX – a private company leading efforts to send humans to Mars. The primary goal of DOGE is to streamline bureaucracy and ease regulatory barriers, a shift that has already proven advantageous for Musk. Looser regulations have allowed for an increased number of test flights of the Starship rocket, SpaceX's vehicle designed for Mars missions. Additionally, the U.S. Congress is currently controlled by the Republican Party, which is seen as politically favourable to both SpaceX and Musk. Many observers believe that this combination of reduced regulatory oversight and political alignment could significantly accelerate progress toward a crewed mission to Mars. Moreover, it is widely believed that former and current President Donald Trump, known for his desire to leave a lasting legacy, is particularly eager to be remembered as the leader who made human landing on

Given that NASA's funding is so heavily dependent on decisions made by Congress, any mission to Mars was – until the billionaires arrived – impossible. Seventy years after landing on the Moon, NASA still hadn't achieved a human landing on Mars, nor established a permanent lunar base.

Hence, what would actually happen if the Manhattan Project would be run and completed by a private company. As indicated earlier with Musk's attempt to nuke Mars, I argue that it will be very difficult to control actions of billionaires on other solar objects outside Earth, where there is no army, ratification, arbitrage...

On a wider scale, there is now a possibility of forming an independent international organisation for extraterrestrial humanity to protect the interests of those who are increasingly becoming extraterrestrial.

Such an international institution might be a better option to lead missions, although the question of whether they would act according to ethical norms remains. Quite possibly, institutions such as this could be established much later, when there is a second or a third generation living and working on Mars. It might also have a different purpose, for example, focusing on how to run and maintain interplanetary trade and politics. Here, the biggest concern, that things will be for a substantial length of time in the hands of benefactors, remains.

Some might argue if billionaires achieve in their mission to Mars and successfully expand our civilisation to extraterrestrial, they might deserve a bit more than just a trophy-an acknowledgment of "mission completed". Successful democratisation of space would appear more likely if any projects are run by private companies that are funded partly by private investors and partly by government subventions and commissions. For instance, the Starship and Artemis projects are not 100% financed by the private sector but mostly by commissions from NASA, other private companies, and government funds.

In the past decade or so, while the democratisation of space was furthered by three well-known billionaires, two of them – the owners of Virgin Galactic and Blue Origin – have no immediate plans to expand their business model to flights to Mars; they

Mars possible – surpassing even President John F. Kennedy's legacy for endorsing the Apollo Moon landing. This ambition could serve as a strong driving force behind the current political support for accelerated Mars exploration.

are mostly focused on the soon-to-be profitable space tourism within the lower Earth orbit and, in the foreseeable future, to the Moon. Interestingly, in the past few years, two countries UAE and China – have announced space programmes and mission to Mars. We can only speculate as to how their missions will play their part in the bigger picture.

Thinking a bit further ahead, as much as we can foresee a colonial power being imposed from Earth to Mars, due to shortages of food and essential equipment, the first generation to settle there will be still heavily dependent on Earth. However, this might not be the case for the second or third generations. They might well refuse any dictatorship or tyranny from Earth on Mars, although tyranny on Mars itself will still be possible.

Becoming a high-tech society brought with it an addition to the human family. Our social lives changed substantially with new forms of media. Digital media such as Instagram, Twitter and Facebook are vital tools in our everyday life. Their ethical practices are questionable, given that they use algorithms to manipulate and direct the opinion of users in order to achieve certain goals. Good examples of this are two significant events in 2016: the UK's European Union membership referendum and the USA elections. Cambridge Analytica, a British consulting political firm manipulated computer algorithms to target undecisive voters on both sides of Atlantic, USA general election and British Referendum on EU. As things stand, no one can stop their positive or negative activities, and how they are used is down to the virtue of the users.

It goes without saying that the media will play an important role in the evolution of extraterrestrial human life, for many reasons, particularly as a tool for settlers not only to keep in touch with those on Earth but also for everyday communication. Here, the possibility of the media preventing tyranny on Mars arises. One example of this could be that settlers on Mars would live in a form of Panopticon, and their experiences could become a form of entertainment that is live streamed to subscribers on Earth (although this would be subject to a 20-minute delay, which is how long it takes for the signal to travel from Mars). If a billion people were fascinated enough and willing to pay a monthly subscription, the income generated might well cover the costs of the mission.

In principle, Jeremy Bentham's 18th-century Panopticon is a concept of a prison which is designed so all the prisoners are placed in the cells around the circumference and are observed by a single security guard from the centre. Prisoners don't know when the guard is looking at them, so they consciously behave well.

In the case of Mars, instead of the prison guard in the middle, there would be a camera for live streaming. Subscribers who are paying for access to the stream will be able to monitor the whole situation, thus not only possibly preventing violations between the settlers but also measuring the Martian authorities. A Panopticon would take control from individuals who might violate others' rights, but on the other hand it would also remove a certain level of privacy and the freedom of those living in the colony. They will all have to work and deliver the right standards, following the protocol. The question is whether this would be possible to enforce. Would anyone travel for seven months to a lethal planet, and live and work there in the most challenging conditions, knowing they were being watched the entire time?

However, if the live stream were limited, say, to only the working day, this might reduce the chances of someone taking advantage and becoming a tyrant.

This might also have the effect of preventing the potential for tyranny to be imposed by a benefactor who has remained on Earth. In any case, this possible solution would only work in the early stages of any Mars missions and for the first of the settlers. When the colony grows, and more people arrive, Martian society is likely to enter a political system that will eventually establish trade with Earth. At this point, things will dramatically change.

Another speculation on how society on Mars could work fairly to avoid tyranny is Michael Waltzer's (1983) example of the San Francisco Savages. The Sunset Scavenger Company, which has operated since 1921, is a cooperative owned by the workers, who drive the trucks, and carry the rubbish bins. Waltzer picks up on an example from sociologist Stewart Perry who investigated this case as "dirty work and pride of ownership". The company is run democratically, its officers are elected from the ranks and their salaries are the same as those of the other workers. They are all referred to as stockholders; every member is a worker and engaged in the common work, every member does their own share and expects every other

member to work and deliver the best performance to increase the collective earnings.

This system would prevent the possibility of the formation of any kind of tyranny among the settlers on Mars, although it wouldn't entirely guarantee that any benefactor of the mission would not proceed with tyranny.

4.6. The Concept of Autonomy

There is no simple way to describe autonomy. Broadly speaking, the ideal concept of autonomy is that an agent is self-governing; that agent can decide by themselves what is valuable in their life; and they live their life in accordance with their own decisions.

There is not one single autonomy – consider 'moral autonomy', 'political autonomy', or 'personal autonomy'. Most thinkers will link moral autonomy to Kant. He takes virtual circles of concepts like freedom of will, acting morally, acting autonomously, and acting with duty and reason. For Kant, in order to be a moral agent you have to have autonomy, you must possess laws for yourself, and if you do you are free, otherwise you are just acting randomly. Your action must be based on a determination; it is not an external thing, it is a law you are giving to yourself.

Autonomy to Kant is a property of the will by which it is a law to yourself (independently of any property of the object of volition) or, since every law must be universal, the condition of an agent who is "subject only to laws given by himself but still universal".

It can be hard to understand what Kant meant by autonomy, and there are some open questions that cannot be answered. For instance, Kant's initial definition of autonomy raises the question of why the property of the will being a law to itself should be equivalent from any property of objects of volition. How does autonomy as Kant conceives it relate to the more familiar notion of freedom?

In his article 'Kant On Theory and the Practice of Autonomy' (2003), Paul Guyer suggests looking into Locke's conception of freedom as a condition of a person, "to think or not to think", to move or not to move, according to the preference or direction of any other person. What is the relation between autonomy and this traditional

conception of freedom as a liberty of an agent? And what is the relation of autonomy to the traditional concept of freedom of will?

There are different normative roles that autonomy can play. Joel Feinberg distinguishes between several closely related meanings that the word ‘autonomy’ can have: a capacity, an actual condition or a right, or sovereign autonomy. Often related to other nouns such as freedom and liberty, autonomy creates an ideal environment for an agent to flourish and have a good life, from a virtue-ethical perspective.

It is more complex to foresee or predict what autonomy will be in a lethal environment. For instance, what could autonomy be on Mars? The fundamental question is how can we exercise autonomy in very restricted, self-imposed, lethal environments, where every second of our life is jeopardised and depends on machines, nanotechnology, even biomedicine (which we will examine in part two of this thesis)? We cannot survive without these, so in this sense our autonomy is constantly violated, and crucially not by the state, nor by artificially imposed governments or society, if there is any at all at the beginning of our missions to extraterrestrial places. When every step we take is consciously prepared and rehearsed for safety reasons and in order to survive, what does autonomy mean in a world where there is no freedom of movement?

Even here on Earth in our modern society, there isn’t a single concept of autonomy – there are many ways to understand what autonomy is. The basic one is that autonomy is self-governing, and the agent must understand what self-governing means. One broad component is part of that is internal, it is what is going on in your mind, what is processed in your brain. You settle on a plan and decide for yourself what is valuable, but it requires that you do this in a way that you are independent. It is not just a case that you endorse something for yourself, but it is also about ambitions, values, goals. Picking your own ambition is deciding for yourself, so that you are not manipulated by other people. It is a pattern of life you want to live by, but also a life that you are continuing to live. An autonomous life means one must choose to pursue all these goals.

To some thinkers, this great noun is sporadically separated and translated differently depending on our religious beliefs, social status and gender. Or is there a general

meaning of autonomy that can work for everyone and can be transmitted to extraterrestrial worlds?

4.7. Different thinkers' Views on Autonomy

For John Christman (1988, 190), the core concept of autonomy is on individual self-government. In our current world, autonomy has a value and it is directly linked to the fundamental virtue-ethical perspective. If we are a good citizen and we respect our autonomy, and at the same time we do not harm others so they can exercise their autonomy for the right reasons, then we can flourish and we can live a good life.

It is also important to understand how autonomy was conceived by societies in the past and how we understand it today in Western democracies. I argue it is not only one or the same autonomy, but also many, navigated and interpreted very differently throughout our social evolution. Looking at these different cultures, we must consider that autonomy as a practice cannot be understood as a universal principle, but could mean many variations depending on cultural perspectives. Furthermore, when we are trying to predict how autonomy would work when the future of our humanity lives in extraterrestrial environments, we should perhaps first understand the genesis or evolution of autonomy as a part of a social act.

The concept of autonomy first came into prominence in Ancient Greece and was mostly used to characterise city states that were self-governing. Sophie Grace Chappell (2023) traces the word 'autonomous' far back into history to several Greek philosophers: Herodotus (430 BC) with the adjective 'autonomos'; Thucydides (400 BC); Isocrates (340 BC); and Xenophon (360 BC) with the abstract noun 'autonomia', although, as she acknowledges, the word was not distinguished by Plato or Aristotle. The latter only mentions it once in 'Politics' when he states that individual citizens are autonomous only if they do not live under a tyrant, established or aspirant.

Chappell takes the approach based on historical and forensic validations that the word 'autonomus' was widely used in Sophocles' 'Antigone' and that is basically a term of constitutional law. A polis, which was a city-state in the Hellenic and Ionian structure, gives itself an autonomy (from 'auto' meaning self and 'nomoi' meaning

law). So back then, the state's laws, rules and gods were above the individual, and sadly even above the moral act in a burial.

For Chappell all this is preserved in the play 'Antigone' by Sophocles (441 BC), where the protagonist Antigone disobeys Creon's rules and, even knowing the consequences, she insists on burying the body of her late brother, Polyneices. Antigone, alongside Haemon and Eurydice, dies at the end of the play, causing great distress to Creon. The play addresses challenging themes of civil disobedience, liberty, morality, authority, gender and mortality.[29]

In modern times, we still have an autonomous state; a better word is possibly a sovereign state, although, politically, the terminology 'autonomous' better describes a nation. This is simply because in order to prevent wars and unrest, states must constantly work together in large organisations; for instance the EU, G7 or NATO. To work together affectively in these organisations takes a chunk of adjustments, compromises and diplomatic affords. One example is territorial disputes, such as that between India and Pakistan over the Kashmir region, where both countries see their autonomy being violated. In contrast is the example of the Russian war and its attack on Ukraine, where one-nation Russia understands Ukraine as an autonomic part of Russia.

To reach the right conclusion, I suggest we separate between bodily autonomy and autonomy. But first we must understand what autonomy means to a person living today in a liberal democracy in the Western world; then we can only speculate on what one's autonomy will look like in the very challenging extraterrestrial environment.

Most philosophers would agree that autonomy is not just free will, but probably corresponds to a special case of free will. There are many different takes on autonomy: personal autonomy, feminist autonomy, autonomy in moral and political philosophy, personal autonomy. And bodily autonomy – where autonomy is not just

[29] In comparing modern notions of autonomy with those from Ancient Greek times, we must consider that autonomy – as we understand it today (individual freedom of will and self-governance) – was not a universal right in classical antiquity. In Ancient Greece, especially in tragedies like Antigone by Sophocles, autonomy was more often expressed through moral duty, family loyalty, and divine law, rather than personal freedom or civil rights. Antigone believed divine law (the will of the gods) was higher than the law of man (Creon's rule). By burying her brother, she was obeying religious and moral law, even though it meant defying political authority. From her perspective, not burying her brother would be the real betrayal of the gods. So, in that sense, she did not jeopardize her faith – she risked her life precisely to uphold it.

considering our psychological and social status but also medical and pathological status.

4.8. Violation of Bodily Autonomy

The UAE space programme plans that by 2117, 600,000 of its nation's people will permanently live and work on Mars. (https://space.gov.ae/; https://wired.me/science/the-uae-wants-to-put-humans-on-mars-by-2117-its-plans-start-now/). This raises two fundamental ethical questions. What kind of society are they aiming to build on Mars, and what will happen to the second and third generations of humans who will be born and evolve into the Martian gravity, which is a third of the Earth's gravity, and therefore much weaker. Children born on Mars will have human genetics and, importantly, by the process of evolution they will not be made by the host planet.

This brings questions on two ethical dilemmas that are directly connected with bodily autonomy. As a human race, the second, third and all future generations will never be able to return to Earth; they will not be able to, for instance, visit their grandparents or any of their Earth-bound relatives. This is for the medical and biological reason that once their bodies evolve into Martian gravity, upon their return to Earth their organs and bones will crack, squeeze and implode in the first few minutes after landing (Binstead Kim, We're Going to Mars).

We can feel for the generations of humans living on Mars, because they will be stuck there in a very challenging environment and without oxygen or an atmosphere. Even if they still have some choice, their chances will be extremely limited. Living in Earth's conditions means having oxygen for free, food resources, and a vast array of social activities. In contrast, humans on Mars will not be part of a large animal kingdom, and vegetation and sources of organic forms and organisms will be hugely limited.

Considering there is no free oxygen available on Mars, it must be produced. There will be very restricted chances to venture out from the Martian settlement, which is the only safe environment to protect human cells from solar radiation. The straightforward questions are: is bodily autonomy violated in these circumstances, and if so, who is responsible? And can we think about autonomy at all in this place?

People work and spend a certain amount of time underwater in submarines. The oxygen supply in submarines is limited, but also because of the pressure difference with the outside environment, the people cannot exercise any kind of movement outside the submarine, because if they do they die. Autonomy is restricted, outside environment is deadly, there is no oxygen and outside pressure would implode human body.

According to Ben Colburn's (2010) concept of autonomy, it is the ideal of individuals deciding for themselves what is a valuable life and living their lives in accordance with that decision. Arguably people do not live under the sea in submarines, they are only there to carry out a mission, so it might not be the right example to some; nevertheless, it is a good example of a challenging environment. On Mars this limitation to an arguably small indoor and closed environment, with a different pressure than the outside world, can work as a plausible example.

The conclusion based on Colburn's parameters on autonomy is that in both cases to live in a lethal environment is a choice of the individual person, who themselves decided what was valuable in their life, and this person lives in accordance with that decision. The problem arises when this person, let's call her M2 (second generation of human Martians), was not asked for her decision. Her life – where and how she is going to live it – was decided by her parents when she was conceived. The paradox here is that at a certain level we are all in this position; we were all once conceived, our lives were decided prior to our birth, although we do live on the planet we are made of, our species as well as us evolved in.

Is it possible that there are two autonomies, one for those living on Earth and one that we ought to consider when living in a lethal environment? Clearly for the first generation of Martians or people-scientists and explorers who pursued living on Mars by their own volition, there is no violation of autonomy, but this does not mean there is no violation at all. They might be happy there, this may be the life they have worked hard for, for some of them this will be the peak of their career. But we could think that this kind of life is a violation of autonomy in a sense, that an agent who evolves into a planet she or he is 'not made of' and who lives in a very restricted and lethal environment, is a self-imposed violation of bodily autonomy. Nothing is Earth-like, earth-known and, to use Hanna Arendt's (1958) word, 'earthen' there.

Those humans will have left the animal life - “animal laborans”, to Arendt’s understanding, a life that has lost meaning (1958).

Bodily autonomy is violated by self-imposed restrictions on freedom, liberty as we exercise it on Earth, and freedom of movement, if you like. More on these ideas in further chapters.

Is it really much different for M2, if this person only knows life as it is on Mars and has, for evident medical and biological reasons, never experienced life on Earth? Hence, taking Colburn’s parameters into consideration, M2 has their bodily autonomy violated only if we compare her life with the life of another human on Earth. Although in this case we may not have the right comparatives: two bodies based on the same DNA are strictly speaking not the same anymore, as one evolved in Earth’s gravity and M2 evolved in Martian gravity.

This brings us to the conclusion that different environments can lead to different assessments of bodily autonomy. Until the challenges of the second and future generations of human Martians are unveiled, we can only speculate.

One study concerning bodily autonomy was carried out by Jérémy Rabineau (2022-2023), into the cardiovascular system in microgravity. As we live on Earth, our heart works according to gravity, which means it pumps more blood to our legs and less into our brain. Astronauts living and working in the International Space Station face challenging conditions and quite often faint when they get equal or even more blood to their brain.

The research shows what happens when the astronaut goes from gravity on Earth to zero gravity on, for instance, the International Space Station. What we don’t know and will only find out when it happens, is the impact on the human body, our blood and heart, when astronauts are going from zero gravity to low gravity. Speculation can sometimes prove extremely wrong and perhaps fatal, but the only way is to test it there. This example suggests another question on the violation of bodily autonomy.

There are several more examples that are related to the fragility of the human race, and perhaps a good one to mention is ovaries. Exposed to a higher level of solar

radiation, eggs could be affected and quite possibly to the level that women could become infertile.

Furthermore, one mainstream proposal of how to space travel is to put the human body into hibernation. The European Space Agency suggests that this method could be used in fewer than 10 years' time, for the long flight of humans to Mars. Crew members could be put into protective slumber for weeks and months on their way to distant destinations. Hibernation on a seven-month trip to Mars would not just prevent boredom in a small space ship, it would also save mission cost, as a hibernating crew wouldn't need to eat or drink and would require far less oxygen than if awake. There are other rather odd benefits of hibernation as well. Research in animals suggests that the bodies of hibernating astronauts might waste away much less than the bodies of those awake in microgravity. Upon arrival the hibernator would be fit and ready to commence a challenging exploration almost straight away after regaining consciousness. The fine-tuning of hibernation, also known as torpor, is already underway.

This example shows two types of violations of autonomy: the violation of bodily autonomy and autonomy as social status. Even if an agent has good intentions and they've made a 100% decision to pursue their plan, for those several months of hibernation they will lose autonomy over their body, their life and fundamentally their existence. The agent now exists only with the support of technology, the machines that are supporting their life. During hibernation they have no control or possession over their body. They are unfit to make any decisions, hence at some level they are transcendental human beings unaware of the 'world' and life around them. Even though this decision was made voluntarily and autonomously, the situation they are in when handing over their body and mind to the control of machines is a complete violation of their autonomy. Hibernation in space travelling requires a separate research or at least much deeper debate.

An ethical analysis would in this example conclude mostly in two parameters. From the virtue-ethical perspective, it would be more humane and rational for humans not to suffer on a long flight to have a good life, and in that respect hibernation is the best option, although the question of whether it is ethical to give up consciousness and the chance to make autonomous decisions remains wide open. The second

parameter is embodied in the first one – is the absence of self-determination, consciousness and autonomy at any point of human life ethical after all?

In conclusion, making a choice to proceed with hibernation is an autonomous decision of an agent, although as soon as the same agent becomes unconscious and transcendental, unfit to make any autonomous decision, then his or her autonomy is violated.

For the last two examples on hibernation and considering the function of the astronaut's heart, I argue that they are both cases where we can see violation of bodily autonomy and autonomy as it is in a broad social context. Both of the cases make it evident that autonomy is handed over by an agent to machines, by the decision of an agent.

As in 'Antigone', in the aforementioned Sophie Grace Chappell research, agents during the process of hibernation have no autonomy, and the rules, gods and laws are the machines that are powering them.

4.9. Other Implications for Autonomy

Now, focusing strictly on autonomy as it is. Everything mentioned so far is a prediction. We don't know how this will be imposed, implemented or executed, as no human has landed on Mars and no human has ever travelled that far from their original home planet.

Scientists are predicting that other restrictions could violate autonomy, as there are psychological factors as well. No one can know how long-term travel, on average 140 million miles away from Earth, will affect the psychological part of our brain. When down on Earth, we look up at the sky and see Mars as a dot. When on Mars, the Earth becomes that dot and all the life we have ever known and experienced is suddenly far away; about seven months to travel back, if the outcome is a success.

We can assess the autonomy of the first settlers on Mars in this case based on the view of Ancient Greeks mentioned by Sophie Grace Chappell earlier. Life in a lethal environment will be possible only with a large amount of technical and scientific support. In order to prevent possible casualties and trauma, settlers will have to obey laws, regulations and guidance imposed and implemented into the everyday

life and activity of the settlers. Therefore, it is quite possible that autonomy will mean something else there. To obey the rules, regulations and even artificial intelligence will be a must. A wrong move from one of the settlers could bring a crash or even demolition of the whole colony. First and future generations of the settlers will have to give up much autonomy as we know it so far. Once, when Old Greek civilization believed in Greek Gods-"they" and the emperors dictated how to live life, and it is quite possible that in the near future in lethal environments there will be an AI or another invisible authority that will be in charge, and autonomy will be challenged.

It is clear that at least for the first few decades on another colony there will be no government or other form of extraterrestrial authority challenging autonomy. Here, astrobiology professor Charles Cockell goes even further, with his suggestion that settlers on Mars will live in a kind of a self-imposed tyranny; we will examine these issues in a future chapter.

Colburn says that autonomy means deciding for yourself what is valuable and living your life in accordance with that decision. In Colburn's philosophical work, he mostly thinks about the nature and value of personal autonomy. Living an autonomous life means living a life which is valuable for you in your own eyes. It means being (at least in part) the 'author' of your own life, a phrase he borrows from Joseph Raz, based on Raz's claims that autonomy is an ideal of self-creation.

In Colburn's words, it's worth emphasising that physical distancing (not jumping into the sea) shouldn't mean social isolation. The autonomous life is not a life of isolation, but one in which we develop deep ties with others, through valuable relationships and shared ambitions. He endorses new technologies, as they give us ways to maintain our web of connections with others, even if we can't, for now, be in the same place as them. Finding ways to maintain and deepen those connections can counteract the unravelling of our shared lives.

4.10. The Value of Life is in Autonomy and Vice Versa

These concepts and parameters can be well adopted on Earth, but the moment humans become extraterrestrial and hand over their lives to machines and technology, autonomy as we know it on Earth is diminished.

In the virtue-ethical perspective, Shannon Vallor says that technology is implemented into human life; there is no human without technology and no technology without the human. Technology and humans are connected from the beginning of civilisation – from the time of the bow and arrow, humans created technology to live a good life and to flourish. Autonomy is also part of a good life and a life we value and treasure. Is it possible that autonomy is nothing more than a technology, a human invention that helps us achieve a good life? During our process of evolution, mostly our social evolution, we invented great institutions, governments and ethics. They all serve us as tools and, like technology, they help us to flourish. Is autonomy not just a noun, but a part of a universal technology?

4.11. Other Questions on Autonomy

Bodily autonomy concerns our own bodies, our choices, our power, agency, and dignity. Sending people to Mars violates bodily autonomy from biological, psychological, and social perspectives.

Living in a weaker gravity will alter the body construction of individuals landing on Mars; it is predicted that individuals' heights will increase by about 10cm soon after landing (Zubrin 2022). Scientists do not yet know what the impact or consequences of this will be.

Food chains will again be very compromising. Sources of certain animal proteins will be available from the start; we have the technology to grow shrimps and certain type of fish in incubators. Food company AlgaCraft from Edinburgh has the technology to grow algae, which can serve as an excellent source of minerals. The company has been commissioned by the Mars Society to supply the Mars Desert Research Station with its unique food products. (https://www.eng.ed.ac.uk /about/people/dr-matjaz-vidmar). Nevertheless, food production will have to begin from day one of the landing, and it will not be achievable without technology. Extraterrestrial humans will heavily depend on nanotechnology.

Equally important is the question of women on Mars. Society on Mars will fail if it does not create future generations. Women will play a crucial role in the Martian society; they will have to produce babies.

Understandably, the first settlers will be highly motivated; living on Mars will be the peak of their career. This might not be the case for any subsequent generations.

Those who are born and evolve into Martian gravity will never be able to return to live on Earth; and in any case, there might not be any rockets to fly them back, or if there are, they will be owned by the privileged few who are able to decide whether to perform such a flight. Even so, their bones and organs would have developed in Mars's weak gravity, and as such, landing on Earth would crack their bones and compress their organs. Their painful death would be inevitable shortly after landing.

To understand this from Walzer's perspective, the lives of humans born on Mars will be socially compromised. Someone who is born there and grows up wanting to become, for example, a veterinarian, will be unable to, because for a substantial length of time there will be no animals on Mars. Another important point is that the first and second generations of humans on Mars might not be motivated to live and flourish on the planet in the way their parents did. They will still have a level of contact with Earth; they will study the planet their ancestors came from yet might never be able to visit it.

As ethical human beings, we must consider the wellbeing of the second and third generations of humans on Mars. Having said all that, is extraterrestrial human life even permissible from the virtue ethical perspective? We might find the answer to this if we look more deeply into nanotechnology.

4.12. Extraterrestrial Liberty

The meaning of liberty beyond Earth – in space, or in any extraterrestrial society – is yet to be ascertained. On Earth this noun has different meanings according to the cultural or geopolitical environment, so we cannot even claim there is one liberty that has a single universal meaning. Quite often we realise that liberty can mean something completely different, for instance for a woman who lives in today's Afghanistan and a woman who lives in a multicultural Western society. Even among Western societies, liberty during the pandemic meant one thing for an individual in Sweden and another for an individual in Italy or Spain, where people were extremely restricted not just with freedom of movement, but also by the fact that if they did not take a vaccine, they might lose their job in the public sector.

Another good question would be, does liberty come with our social evolution? Quite possibly. An unmarried woman in medieval Rome would have her whole face and body covered in lace so that no one could see her face, and she was only able to walk outdoors when accompanied by an elderly and married woman (or widowed), or a man. These days in Rome unmarried women can drive scooters, perhaps wearing helmets for their safety, but otherwise walk around uncovered, something quite impossible for women who currently live in Saudi Arabia.

This chapter will not search for all the answers on what liberty means in certain cultures on Earth in order to compare it with possible liberty in extraterrestrial human life. Instead, I will focus on liberty in a place where oxygen is not free and cosmic radiation can kill human cells in just a few seconds. Liberty where the pressure outside the settlement on Moon and Mars or a spaceship is lethal, and humans can only survive outdoor walks when wearing specialised spacesuits and using other equipment.

For this reason, I will look further into Ben Colburn's (2010) view on autonomy and liberalism, especially his chapter 'Dangerous Freedom', in which he considers that increased freedom can impair autonomy. His example of Odysseus and the Sirens strikes me as a good comparison of a human living in a Martian dome, a settlement of a few hundred, or a human living long-term in a space vessel. Appealing to the previous chapter on bodily autonomy, I must adopt Colburn's main question regarding autonomy and freedom: "Is it possible that an individual can adopt a valuable goal which involves their freedom being restricted?" (Colburn, 2010, 72).

In answering, Colburn describes a case where autonomy is promoted with certain restrictions, which can deliver a better option for the individual to choose, in order to determine whether increasing their freedom would compromise exercising their autonomy. For this he uses the example of Odysseus and the Sirens. Odysseus is convinced that the experience of the Sirens' singing would add great value to his life, so he must listen to their songs. He asks the crew to tie him to the mast, which will prevent him from following his desire to jump into the waters, following the Sirens and drowning, like many before him. Being fastened onto the mast will allow him to listen safely, although he will not be able to move. Odysseus's freedom was restricted, he was prevented from jumping into the sea, hence his curtailment promoted his autonomy. To Colburn, an increase in freedom would detract from his

autonomy; if his crew had untied him, he would be free, and he would jump into the sea to follow the Sirens and eventually die.

Between 1788 and 1868, around 162,000 convicted criminals were transported from the prisons of Great Britain and Ireland to colonies in Australia. In the early 18th century, the British government also transported criminals from prisons to North America; this established practice was stopped with the American Revolution (Hughes, 2003). We might see this as the reverse of Colburn's example. Prisoners were given an amount of freedom as they were no longer in small prison cells, although their autonomy was still compromised.

With this example we cannot clearly indicate that freedom takes away autonomy or vice versa; for instance, prisoners may have preferred to stay in their homeland where they would be able to return to their families after serving their sentence. Also, we can't claim that with 'freedom' in the new world they would achieve autonomy. Although when freed from prison, they would eventually be granted certain levels of autonomy. Most of the prisoners worked in the fields and mines, places where labour was much needed to build a new city. Later on, they were given small barracks to live in and autonomy over their free time. They were able to make some decisions about whether to buy cigarettes or alcohol, when they would cut their hair and whether they would shave. I am of course talking about a certain level of autonomy, as most of them had little money, perhaps not enough to travel to the next town or village.

Many would say that travelling for seven months in a small 'tin can' of a space vessel is a kind of prison. At the end of this journey, individuals will land on a lethal planet they are not made of, yet to know if microbiological life exists there and if it could affect them. Living a self-imposed controlled life in small domes, dependent on technology, means that even if there is some freedom, it has substantial limitations. Technically there may be freedom of movement, but we will return to this issue later.

As an overview: will the settlers, scientists and explorers, those few hundred who will be the first to set foot on Mars, have their freedom violated on every step of their extraterrestrial life? Hence will their autonomy be compromised or limited? Can we compare this to Colburn's example of Odysseus and the Sirens? Odysseus must be tied onto a mast, with limited freedom, in order to fulfil his desire and practice the

autonomy to listen to the Sirens. And a human explorer will live for two to three years in a small and restricted environment, firstly in a spaceship and then on a lethal planet, before re-entering the spaceship for the flight back home.

For a long period of time, if ever, there will be no prisoners flying to Mars. For those few astronauts who make the journey, it will be their own decision, something they have worked for most of their lives; it will be the pinnacle of their career. This challenging journey will be voluntary, and their autonomy will possibly be much greater than Odysseus's. Traveling through space means many limitations, hazards and compromises, therefore there will be a great amount of autonomy in decision-making. At the end of the day, it will be hard to control people miles away from Earth, the signal to Mars travels 20 minutes, either on Mars or space vessel people will make their own decisions whether to listen the control from Earth or disobey it.

Crew numbers will be limited, and each member of the extraterrestrial expedition will manage many different jobs and tasks. There will also be very limited contact with ground control on Earth; the signal from Mars to Earth takes about 20 minutes, so on most occasions this will be too long to wait for help. Any decision, even substantial ones, will be made on the spot by the crew and members of the colony on Mars. This gives everyone not just the right to take autonomous decisions, but the need to, as there will be no other option, hence there is a possibility that the society there is organized by a dictatorship or similar social acts.

Visiting the French crew 278 during their simulation mission training at Utah's Mars Desert Research Station, I realised that the commander was also a doctor, heart specialist, scientist and nutritionist. If someone suddenly goes into cardiac arrest, the person in charge will not send a consultation message to Earth, waiting 40 minutes to get an answer, but they will act straight away. She or he will take an autonomous decision not just for themselves, but on behalf of the patient and possibly the whole crew.

If the solar weather changes during a flight to Mars and the commander gets information that a solar flare is heading straight towards the spaceship, they will take an immediate, autonomous decision either to change the navigation of the ship or to completely switch off the system, which could lead to a derailing and losing the direction towards the red planet. Coburn's assessment is right: with very limited

liberty, the autonomy of individuals living in a space vessel or on lethal planets and other solar objects in the Universe is greater than in many cases on Earth.

Hence, in the last three paragraphs we can refer to autonomy as well as liberty.

4.13. Euthanasia in Extraterrestrial Human Life

One of the most pressing ethical questions regarding human extraterrestrial life is that of euthanasia. Presently, euthanasia is only legal in a few countries in the world, five of them in Europe. Considering that the extraterrestrial environment is lethal to humans and getting to the nearest hospital would mean travelling through space for months back to Earth[30], should euthanasia be permitted if, for instance, an astronaut is dying on Mars? On Earth, legality dominates the conversation on euthanasia, but in space it must be considered differently, as charity.

I will support my argument by referring to Philippa Foot's article on euthanasia, and to Jacob Haqq-Misra's article in which he suggests that humans living on Mars will create a transformative value to the new-extraterrestrial humanity, where no laws, money or ownership should be transferred from Earth and this "new humanity" should play things out independently, by their own choices. Many would say this transformation could take humanity on a very dangerous path; nothing is safe, predictable and taken for granted in a lethal environment on a barren planet. On the other hand, this could be a hazardous test for virtue ethics and the future of humanity. In challenging circumstances, a virtuous person should have the opportunity to act for the best of their colleagues.

Legality in extraterrestrial human life deserves another dissertation to itself, but it will be briefly mentioned in a separate chapter.

Jacob Haqq-Misra sets out his argument on the premise that "new humans" on Mars should be liberated from any controlling interests from Earth, allowing Martian settlements to develop into a second independent instance of human civilisation.

[30] The legality of euthanasia differs from the legality of passive euthanasia. In most of these countries, they are able to end life for those who are in a long, deep coma, or whose life will end without medical support. There are 10 Western democracies who have implemented euthanasia by law: New Zealand, most Australian states, Canada, Ecuador, Colombia, and, in the EU, Spain, Portugal, the Netherlands, Belgium and Luxembourg

Mars as the next frontier should not be protected by laws and treaties from Earth[31] and no ownership, money, politics or laws should be transferred from Earth and implemented on Mars.

As noted by the ecologist and microbiologist Garrett Hardin, solving a population problem requires a fundamental extension of morality, hence there is no shortage of suggestions as to how humanity should extend its morality. As Haqq-Misra says, humanity has had many transforming experiences that have guided the development of civilisation and led humanity to a new way of thinking. Humans must find a way to develop new moral tools to help them to strive in the extraterrestrial human life.

In this chapter, I will conclude that the legal concepts of euthanasia may lead to a transforming experience on Mars. To set the foundations of this understanding, I will first introduce Haqq-Misra's example on transforming experience. When we are developing novel ideas, we are exposed to certain experiences that challenge our beliefs, ideas and preferences, and provide a deeper insight. His example is that of a concert violinist who is taken against her will to an improvisational rock concert, and her musical senses are so aroused that she changes her career to jazz violinist. Transformative experiences can challenge our core preferences, often at unexpected times, and force us to change our preferences and methods and consider new perspectives. Transformative events act as catalysts for epistemic change by disrupting existing beliefs, introducing new knowledge, and prompting both individuals and communities to reconstruct their understanding of the world. These events are crucial in the dynamic process of knowledge development and adaptation.

Haqq-Misra suggests that extraterrestrial humans living permanently on Mars should claim their planetary citizenship as Martian, which requires giving up any national or local citizenship or affiliations. In another words; to maintain geopolitical stability on Mars, all residents and settlers should renounce their citizenship from their country of origin. No nation should claim ownership of the "New World," nor should any government interfere or impose geopolitical demands on the Red Planet.

[31] Currently, maritime laws and the Outer Space Treaty (1967) apply to all the objects in our solar system; not all countries have signed it. The new treaty for the Moon – The Artemis Accords – is signed only by few countries (UK, USA, UAE, Italy, Australia, Canada and Luxembourg) and not by China and Russia, who are proceeding with their own Moon projects

Martians cannot represent or claim to be of any group on Earth and cannot acquire wealth on Earth. Governments, corporations and individuals on Earth cannot engage in commerce with Mars. He has several other proposals too, however they are not crucial for the question of euthanasia on Mars.

Based on this premise, euthanasia on Mars could be a decision and action taken among members of a small extraterrestrial human community, regardless of Earth's policies and laws. But this decision could be also very dangerous, because there is the possibility of abusing this action and turning it into murder on a barren planet where there are no police, courts or institutions to protect human rights. On the other hand, there will be more freedom, liberties than is allowed in most countries on Earth – this can be exercised on Mars for two reasons. One is practical when there is no chance of survival because the nearest hospital is seven months' travel back to Earth. And the second is humane: for instance, if a dying person is in unbearable pain and begs for mercy and compassion. To review the concept of euthanasia on Mars or any other extraterrestrial human world, even a spaceship, I will first consider Philippa Foot's view on euthanasia; she finds the solution that euthanasia should be considered only as charity.

In her paper on euthanasia, Foot questions the word "euthanasia" as described in the 'Shorter Oxford English Dictionary', where the definition specifies only the manner of death.[32] But Foot points to occasions where someone could deliberately drug someone to death, then claim their acts are euthanasia. Foot, of course, finds this argument ridiculous because we take for granted that in euthanasia it is death itself and not just the manner of death that must be kind to the one dying.

Foot thinks of the horrors of WWII and the killing of Jews, and even in the years before the war when Nazis killed disabled and mentally disabled people who were considered a burden of society. Foot clarifies that for this reason it is very important not to use the dictionary version of euthanasia, and she uses it by the first proviso that by this act (of euthanasia) we mean one of inducing or opting for death for the sake of the one who is to die.

[32] Oxford English Dictionary (three meanings for the word "euthanasia");1. a quiet and easy death,2. the means of procuring this, 3.the action of inducing a quiet and easy death. Foot's critique is that none of the three gives an adequate definition of the word as it is usually understood. For Foot " euthanasia" means of procuring it or the action of inducing it.

Foot determines two conditions of the act of euthanasia: that someone is deliberately allowed to die, for his or her own good, and not only when positive measures are taken to see that they do so. The second point is that an act of euthanasia concerns the question of fact versus belief. It is important that the one who performs an act of euthanasia believes that the death will be merciful for the subject.

To Foot, the essential issue to discuss is the question of how someone can wish for the death of someone else. She considers the circumstance that someone is to die anyway, so to die sooner and spare more pain would be better for the sick person. On the other hand, she ponders that if someone is not a good person at all, is it justifiable that in the same circumstances this person is offered less suffering and a quicker death? At the end of the day, we all do bad things sometimes, and Foot does acknowledge the premise that life is good.

In normal circumstances, the man who saves someone's life is a benefactor, although Foot here suggests another example where having your life saved is not so much a benefit but its reverse. Her hypothetical example is that a doctor who saves a patient's life and heals this person from a deadly disease doesn't contribute much if that person is a Jew living in the ghetto and will end their life in a Nazi extermination camp. The main question is: would a longer stretch of life always be a benefit to the person who was given it? Death by a bullet is bliss compared to the many millions who have died of hunger or torture, hence prolonging someone's life is not always at the person's benefit. Foot here drives the first conclusion: while life is usually a benefit to someone who has it, it is not always. At this point she asks on what ground is the assertion made when we say life is good, life is beneficial?

Foot's presumption is that many people have more evil than good in their life, but we do not conclude that we will do these people no service by rescuing them from death. Foot's suggestion of a solution is that there is – in the case of human beings, animals and even plants – a certain conceptual connection between life and good. She says it is not the mere state of being alive that can determine that, but rather a life that comes as some standard of normality. The idea of good is linked to the life when good things are there and not when they are absent; here Foot considers a normal-ordinary human life, but the connection between life and good might be broken if the person is unconscious, in a coma, or in a stage of extreme senility.

Ordinary human life can also have segments of evil, but on a larger scale this is the life of a human who is a member of a community, who goes to work, has plans for the future… and who can lie down and rest for the night.

As per Foot's example, this kind of life was not possible in concentration camps, where all the human goods disappeared.

Foot's main question is whether acts of euthanasia are ever justifiable. She comments on two topics: one, where acts of euthanasia considered only in themselves, and their results are morally unobjectionable, and another, where it would be acceptable to legalise them. The question of the practice of euthanasia and on potential abuse remains open; Foot here focuses on the act of euthanasia in itself. Why the choice of death is made, and where objection may lie when one opts for the death of another.

She says there are two different virtues whose requirements are, in general, in contrast to such action: the act of unjustified killing is in contrast to justice, and the act of allowing someone to die is in contrast to charity. Two grounds of objection of inducing death are distinct. A murder is an act of injustice. An act to relieve suffering and stop the pain of a dying person is a charity. Injustice may be involved either in an act or as an omission, and the same is true of a lack of charity. When a person reacts unjustly, this means that this person has infringed a right, since justice has to do whatever a person is owed as a matter of right. There are different kinds of right, in the sense of having a liberty, the distinction is having a "claim-right", or "right of recipience".

If someone's right gives me a "duty" to provide something for someone, then I have no right to refuse it. What I lack is the right of liberty. I am not at liberty to interfere with someone to refuse the service. Here Foot asks, where does the right to life belong?

People usually have the kind of rights that are good for them. How does the right to life affect the morality of the act of euthanasia? Are such acts sometimes or always ruled out by the right to life? Although the act of euthanasia is, by Foot's definition, a matter of opting for death for the good of the one who is to die, hence there is no direct connection between that to which someone has a right and which is for someone's good.

Where rights exist, it is someone's will that counts, and not someone's estimate of benefit or harm. Foot's example is an army that is retreating on a cold winter day and comrades must leave some wounded soldiers behind. They have two options: to serve a shot of mercy, so that soldiers don't fall in enemy hands, or to leave them there to potentially die of starvation or freeze to death. But one of the soldiers demands to keep a comrade alive, as it seems clear to him that they have no right to kill him. However, they would not give him a life-prolonging drug. The right to life can sometimes lead to a duty to provide a positive service, but not in this case. What it does lead to is the right to be left alone.

What are the boundaries of "active" and "passive" life, killing and allowing to die? Here Foot refers to philosopher James Rachels, who doesn't believe that the difference between active and passive should be relevant anywhere. His example was if someone saw a child drowning in a bathtub. If that person doesn't help them, it is the same as if they were holding the child's head under the water, he said. If it makes no difference, it means that one act would be as iniquitous as the other; allowing death is as bad as killing, otherwise it gives rise to the possibility that in some circumstances one is impermissible and the other permissible.

Foot finds Rachels' example wicked, as it is contrary to justice to hold a child's head under water, something no one has the right to do. To leave the child to drown is a lack of charity. The case of the retreating army is different, as charity would have required that the wounded soldier be killed, and justice required that he be left alive. In such a case it makes all the difference if someone opts for the death of another in a positive action or whether he allows him to die.

An analogy with the right to property will make the point clear: if someone owns something, this person has the right to it even if its possession harms the person. Someone's rights do stay between us and the action we would dearly like to take for this person's sake. They would also prevent an action that would take for the sake of others. Foot's example here is a man behind the steering wheel in an uncontrolled car, which could run over many people on the pavement. In this case it is better to take the life of one person than of many. My own example would be a

drunk neighbour with a loaded gun, threatening the whole neighbourhood; in the fear that he could kill many, special police kill the neighbour.[33]

Moving to Mars, in a hypothetical example, a scientist threatens to blow up the pressure chamber, which will result in blowing up the whole settlement and killing everyone. It would be better to eliminate or kill this scientist with their evil intention, rather than killing many. These decisions are mostly based on the utilitarian ethical principle, hence killing someone for a "good reason" to save the rest is not equal to delivering euthanasia on the grounds of compassion.

Killing the scientist may appear to be the most effective way to prevent catastrophe, but a virtuous person must weigh not only the consequences, but whether the act reflects values such as justice, compassion, and practical wisdom (phronesis). A morally exemplary individual would seek alternatives – negotiation, restraint, or containment – before resorting to lethal force. The virtue of justice is particularly relevant here. Would it be just to kill someone for a threat or intention, rather than an action already taken? Even in high-stakes scenarios, justice demands fairness and due consideration, not expediency. Practical wisdom involves discerning the best course of action in a given context, balancing moral virtues without falling into extremes. It does not ignore consequences but insists that how we act is as important as what results. Virtue ethics also considers the moral development of the individual and the values shaping the community. Even if killing the scientist were to save lives, such an act could compromise the moral integrity of the person involved and set a precedent that erodes the ethical foundation of the community being established on Mars. Whereas utilitarianism might justify the killing as necessary for the greater good, virtue ethics urges caution. One might accept that lethal force is the only option – but only if it arises from practical wisdom, is guided by virtue, and is treated not as a solution of convenience, but as a tragic last resort. The goal is not merely survival, but the preservation and development of moral character, and the nurturing of a flourishing society – even in the most extreme conditions.

[33] On 6th of May 2008 Mark Saunders, a British barrister was shot dead by police after a five hour siege at his home at Markham Square, Chelsea, London.

The distinction between passive and active has a special importance in the area of euthanasia. In the case of James Rachels, that it is often more humane to kill than to allow to die.

Active nonvoluntary euthanasia is not morally permissible; it is ruled out by the right to life. Only in a case where there is a contract between a person and their doctor, then special conditions create the right to life-preserving action, but it is not always certain what this contract actually involves. In the case of voluntary euthanasia, no right is infringed if a man is allowed to die or even killed at his own request.

There is another objection that morally holds against inducing the death of another. Charity is a virtue that gives attachment to the good of others. If we think that life is normally good, this creates the premise that life should be saved and prolonged. While justice forbids the act of euthanasia, charity can require it when the death is for someone's own sake. Charity will be in favour of someone's death to, for instance, stop pain and when death is inevitable, rather than against it. Yet again, there is a question on the distinction between voluntary and nonvoluntary and how charity dictates this. If someone wants to live and there is a presumption that that person will be benefited if their life is prolonged, then the question of euthanasia is irrelevant. In some cases, it is justifiable to prolong life.

Then there is the example of when someone wants to live but it is better for this person to die. The utilitarian ethical approach is clear. In his book 'Ethics in the Real World', Peter Singer (2016,82) examines the case of babies who are going to die. In the chapter 'Pulling Back the Curtain on the Mercy Killing of Newborns', Singer justifies euthanasia for newborns who will, no matter the treatment, never be able to leave the intensive care of neonatal units or live a quality life.

This case is linked to the practice at the University Medical Center Groningen in the Netherlands. Eduard Verhagen, an attorney and medical doctor, and his colleague Pieter Sauer divided newborns into three groups for whom decisions about ending life might be made. In the first group there were newborns who would die within hours after birth even if all the existing medical resources and life-support machines were available to support their life. The second group were newborns who required intensive care units including respirators and whose prognosis for a good outcome were very poor. This group included infants with severe brain damage; if they

survived intensive care, their life was judged to be poor and without quality. The third group was so-called “hopeless prognosis”, newborns who were victims of “unbearable suffering”. This group included babies with the most serious form of spina bifida, the failure of the spinal cord to form and close properly. It is important to note that infants in this group may no longer be dependent on intensive care.

Where can utilitarians find in this case a virtue ethical norm, to live a good life, a life you are looking forward to, to prosper, to cherish, to be successful? Among several issues for the utilitarians is also the fact that neonatal units are expensive and when a severely disabled newborn survives the treatment, they will remain heavily disabled and possibly considered a burden not just to the family but also to society. In most EU countries, national health systems are supported predominantly from the social budget, as are special needs schools (if and only if this child can progress to such a point where they receive education), care centres and other facilities for the heavily disabled.

Verhagen and Sauer published their article in 2005 in ‘The New England Journal of Medicine’, in which they documented 22 cases of newborn euthanasia – all the cases were between 1997 and 2004, and in four of the cases Verhagen was in charge of the hospital at the time. He stated that he believes euthanasia to be justified in the cases of unbearable suffering. He said these important decisions were made on the basis of an honest and comprehensive talk with all the parties involved, especially parents, and not just doctors, who are also afraid of the consequences. This is known as the Groningen Protocol, which some find extremely controversial, especially as in all 22 cases the newborns were suffering because of spina bifida, which is not considered a lethal disability.

In another chapter, ‘Choosing Death’ (93,2016), Singer considers a case where a patient, Gillian Bennett, is suffering from severe dementia and wants to end her life before, as she states, “I have nearly lost me”. She wanted to opt for euthanasia when she was still capable of doing so and not at a later stage when her husband and children would most likely be prosecuted (and liable to up to 14 years in prison) if they were there for her or assisted her. If the law permitted it, and those assisting her with euthanasia were not at risk of punishment, she would not have felt the need to end her life so prematurely. Instead, she could have chosen to wait until the

disease had progressed to the point where she would lose self-awareness and no longer be able to respond as a coherent or recognisable person.

Her argument was that she didn't have to end her life so soon; it is considered an ethical step for the utilitarian to end your life when you are no longer able to be part of society, in fact you take huge resources from society when your life is ending – you need the care of nurses and your family, as well as medication. You are not aware of much of your life anymore, so ending your life with euthanasia is ethical.

In a hypothetical case on Mars, there is a heavily wounded astronaut who has lost his legs in an explosion. He is still bleeding heavily and there is hardly any chance of survival; the pain and suffering is severe. The closest hospital is a seven-month flight away, plus it's impossible in that time, as the flight back to Earth can only happen when the two planets are close enough, approximately every two years. There are some reserves of morphine available, but if it is used now the stock will run out for future injuries, where a wounded astronaut has a chance to survive. If the injured astronaut asks a colleague to perform euthanasia, this would be an act of charity. The injured astronaut would consider the circumstances a charitable act too, because his actions would contribute to a better outcome in future when an astronaut was suffering and would be able to take morphine. Foot's example in these new circumstances on Mars indicate a double charity act from two parties: the dying astronaut and his colleague. The actions of both involved are justifiable and, as much as charity serves as virtue, this outcome is also utilitarian.

Back to Foot's view; there are many situations where someone wants to live even though it would be better for that person to die. It could be that someone is afraid to die, or just doesn't fully understand the whole situation. Charity doesn't always dictate that life should be prolonged.

What about voluntary euthanasia: if someone wants to die because they are a burden on someone, if they were told (even wrongly) that their life is ending… what about suicide? Foot considers the morality of euthanasia both voluntary and nonvoluntary, both active and passive, and says killing someone without their will or consent is never justified. A person killed for their own good never justifies the act, unless this person has consented to it. Someone's rights are in breach with this action, and they are in opposition with justice.

Foot's paper has a strong condition for euthanasia: euthanasia means to benefit the one who dies. Some people could be considered a burden on society, as mentioned in Singer's case of Mrs Bennett, or newborns with a severe disability; doctors often think about parents and siblings when they consider whether to perform a surgery or not on a very ill child.

On the other hand, Foot insists in her article that life can be good for people who are, for instance, tetraplegic, or have Down's syndrome. Regarding Mrs Bennett, Foot might clarify that we must distinguish regarding the level of senility, the level of dementia.

Charity is among the "Neglected Virtues" (2022, 223). Foot defines justice as a virtue that concerns "what we owe each other in the way of non-interference and positive service", whereas charity "is the virtue that attaches us to the good of others". Charitable acts occur only when others need assistance that we do not strictly owe them. Lack of charity means that we fail to aid in those cases.[22]

In conclusion, euthanasia in extraterrestrial human life requires two considerations and several different outcomes, none of which are straightforward or can be free from abuse, and these considerations are also predictions, as no human has yet lived or even stepped foot on Mars.

The first consideration regards the view of Haqq-Misra and his suggestion that no laws should be transferred from Earth to Mars. This may well be implemented just for those human Martians who go to the red planet with a one-way ticket. In the case of a violation and abuse of the legal systems that dominate on Earth, they would not act accordingly to them, even in a case of euthanasia where a particular person was previously a citizen of Luxembourg, where euthanasia is permitted.

[22] To Rosalind Hursthouse, charity is greater than justice; she says that sometimes it is possible to treat a person inhumanly in the name of justice, but it is much harder to do it in the name of charity, which she also relates to love.
Philosopher John Hacker-Wright differs from the secular notion of charity with the thought of Thomas Aquinas, who says that charity is a matter of friendship with God. A charitable person loves God the same way as human friends love one another, he said, it is reciprocal good will, each for the sake of the other (2022,226). Charity plays an unique part among the virtues, as Hacker-Wright claims it has an architectonic relation to the other virtues, where mercy is an aspect that deals with natural vulnerabilities. Mercy is a virtue that requires us to love other human beings and their vulnerability and to address their physical and spiritual suffering.

The practice of this human Martian does not apply to any legality on Earth anymore, so this individual can act upon their own ethical beliefs. The actor has every chance to abuse the situation and perform euthanasia on a colleague even if there is no indication that death will come soon; they can also perform euthanasia as an act of charity and mercy if an astronaut can survive but does not want to because they have severe injuries. No one would wish to live in these circumstances in a small Martian village, as they cannot be a support to the small community, their poor quality of life would contribute nothing and they would be, in a way, a burden. If the astronaut performs euthanasia on a wounded colleague, even though the wounded one may survive, this actor may be challenged on moral grounds and, if they are to return to Earth, also on legal grounds. Utilitarian ethics may recognise the burden to society in a small settlement on Mars, eating food and breathing oxygen (both limited resources), so if to end life is a wounded person's wish and, on the premise that no one is to return to Earth, it is acceptable.

This situation brings us to a second consideration of a utilitarian ethical decision, where an astronaut colleague performs euthanasia, knowing that the colleague can survive his injury, but because the colleague doesn't want to be a social burden; here they may think the decision to end life is favourable.

The final consideration is when a wounded astronaut is dying and their last wish to end their life sooner should be granted. This requires from his colleague an act of charity and mercy, even if the colleague does not have a one-way ticket and upon return to the Earth legal procedures may follow; but also if the dying astronaut does not want it. Let us say oxygen is running out in both astronauts' backpacks and time to go back to the settlement is also running out, I suspect rational thought will play the biggest part here and the wounded person will be left behind.[34]

There are, of course, other considerations, but in transformative ethics euthanasia in extraterrestrial human life might be less complex to decide, knowing there will be no institutions and possibly no legal implementations there for some time. Virtue ethics – with its sense of compassion and mercy – might be an important ethical

[34] There is no oxygen on Mars and the atmosphere is very thin, which means that cosmic radiation will kill all organic cells. Astronauts in protective suits will be able to remain on the surface of Mars for quite a long time.

normative but considering the fact that it is a barren planet, utilitarian practice might become the norm.

5. Proposal for Panoptocon on Mars, (Conclusion to Part One)

Building on the ethical dilemmas examined in the previous chapters, and taking into account the likely structure of the first missions of settlers and travellers to Mars, this chapter proposes a concept designed to offer a viable framework for how Humartians – humans on Mars – might live responsibly on the Red Planet.

The idea is inspired by Jeremy Bentham's Panopticon. In a separate study, I have addressed the practical considerations of constructing such a Martian dome, including the choice of materials, given the high costs associated with lifting mass into space. That technical analysis lies outside the scope of this thesis. Here, the focus is on the Panopticon as a social and potentially political philosophy that could help organise early settlements in a way that is ethically mindful and socially inclusive.

The proposed model is intended to accommodate not only astronauts or scientific specialists but also ordinary people who may wish to travel to Mars – teachers, nurses, librarians – individuals who are not billionaires yet still aspire to live, work, or conduct research there. This approach aligns with the spirit of the 1967 Outer Space Treaty, which affirms that outer space is the province of all humankind, not merely a privileged few.

The Panopticon on Mars is my design and proposal for one of the first settlements for extraterrestrial humanity, developed with careful attention to the ethical controversies assessed in earlier chapters. It is not intended as a permanent or final solution, but as an initial model that seeks to balance practicality, inclusivity, and ethical responsibility in humanity's first steps toward interplanetary settlement.

5.1. Introduction of Conclusion

A human mission to Mars is one of the greatest challenges of modern society. We must go to Mars to foresee our future and to learn about our past. A human mission to Mars will accomplish two major aims: it will enable us to explore and flourish with our technological and scientific development, but also to strive us into extraterrestrial

humanity when we will, according to the Kardashev scale[35], finally reach a “level one civilisation”[36]. Another reason why we need a permanent human base or society on Mars could be for our interplanetary protection – we will be able to derail or even destroy dangerous meteors heading towards Earth, so far, our only home. Scientifically, we must learn why Mars lost its electromagnetic field and the atmosphere evaporated into space and so the chances of life became infinitely small. It is also important for energy resources – we are halfway through the life of our Sun and eventually nature will take its course. If we are to survive as a human civilisation, we must seek other opportunities and live elsewhere in our solar system and beyond. For this enrichment of our current civilisation, we must establish permanent human settlements on Mars. As confirmed by the creator of SpaceX, Elon Musk, a return ticket to Mars will begin at $250,000 in one of his latest posts on platform X, he suggested it will be even cheaper, $100,000 [2]. Hence, this price is more than most people on Earth can save in their lifetime, and many talented, enthusiastic and scientifically capable people will have to remain grounded on Earth for their entire lifetime. Considering that, for instance, a schoolteacher or council worker would like to go to Mars, the development of a Panopticon based on core ethical considerations for a lethal environment is an idea that could result in a faster, more accomplished transformation for humanity, at zero cost to those going extraterrestrial and a very small cost to their sponsors on Earth.

---

[35] The Kardashev scale is a measure proposed by former Soviet astrophysicist Nikolai Kardashev (1964). His method measures a civilisation’s level of technological advancement based on the amount of energy it can use. This hypothetical scale measures cosmic consumption. For example:
Type I. civilisation-planetary civilisation can use and store all the energy available on its planet.
Type II. civilisation-stellar civilisation, can use and control the energy at the scale of its planetary system.
Type III. civilisation-galactic civilisation, can control energy at the scale of its entire host galaxy.
According to the American astronomer Carl Sagan, humanity is currently going through a phase of technical adolescence, “typical of a civilisation about to integrate to the Kardashev type I. civilisation”.
Robert Zubrin adapts the Kardashev scale to refer to how widespread a civilisation is in space, rather to its energy use.

[36] Astrophysicist Avi Loeb proposes a classification system for civilisations based on their capacity to prevent self-destruction and ensure long-term survival. He identifies four classes: A Class A civilisation would possess such advanced scientific and technological capabilities that it could create a small universe – a feat that lies far beyond our current understanding of the laws of physics. No known civilisation has demonstrated such abilities. A Class B civilisation can successfully prevent self-inflicted catastrophes, such as climate change or nuclear war, through global coordination and foresight. A Class C civilisation recognises these existential risks but struggles to address them effectively. Humanity, according to Loeb, is currently a Class D civilisation – one that largely ignores or denies such threats, lacking the unity or will to act decisively for its own long-term survival. Loeb suggests that progressing beyond Class D is essential if humanity is to secure its future and potentially become a spacefaring species.

5.2. The Panopticon on Mars

The Panopticon is a concept of prison first developed by Jeremy Bentham (1748-1832), a statesman, philosopher and some might say sociologist (although sociology as a discipline of science didn't exist at the time). Bentham received a commission from the government, and around 300 prisons all over the world followed his concept. The prison was made in a circle with a diameter of 100+ft, an auditorium and chapel in the middle, a fire escape on the side, and each guard monitoring 96 prisoners.

Foucault's (1975) adaptation of Bentham's Panopticon is a pragmatic architectural model of modern disciplinary power. In this system, guards stand in the centre of a tower while the inmates are in separate, round prison cells, observed by the guard. The inmates don't know when they are being observed; the point is that they could be observed at any time, hence they must behave as if they are always being observed. As a result, control is achieved more by the possibility of tracking and monitoring the subjects of the observation than by actual supervision or heavy physical constraints.

In principle, the Panopticon can be adapted to any system of disciplinary power: school, factory, hospital, even police station. This system can pervade many aspects of modern society. The fundamental power relation of pre-modern sovereignty, which was once possessed by kings and judges, is now replaced by this new instrument of modern discipline.

In his book 'Discipline and Punish: The Birth of the Prison', Michel Foucault presents a genealogical study of the development of a softer and more modern approach to prisoners, in contrast to torturing and killing them. Torture and killing as public spectacle started to disappear from the end of the 18th and beginning of the 19th century. Before that, people were tortured, amputated, and exposed dead or alive to public view. But while punishment as spectacle was disappearing, it transformed into punishment as administrative practice. Many countries including Austria and Switzerland and some US states used convicts as free labour; the justice system no longer took public responsibility.

As in existential phenomenology, as well as in Nietzsche's nihilism, Foucault brings the body into the focus of history. 'Discipline and Punish' is an examination of

historical practices through which the body becomes an object of techniques and deployments of power. Foucault shows how disciplinary techniques produce “docile bodies”: the bodies of prisoners, soldiers, workers, schoolchildren… All these bodies were subject to disciplinary power so that they could be at the same time useful and controlled. The human body becomes a machine: a tool that can be optimised, improved, functionally upgraded and calculated. Its functions, movements and capabilities were broken down into narrow segments, analysed in detail, then reconstructed in a maximally effective way. New, supposedly enlightened, reforms became a vehicle of more effective control. To punish less but punish better.

By historicising the body, Foucault’s genealogies also have distinctive philosophical implications; hence modern institutions operate with a markedly different rationality than those in the past, which were aimed solely at the retribution of pain. Foucault concludes that the current system operates in two ways: it aims to both punish and correct, and therefore mixes two practices, juridical and scientific. He argues that the intervention of criminal psychiatry in the field of law, which occurred at the end of the 19th century, contributed to a gradual shift in penal practice. The focus shifted from a crime to the criminal, from the action to agency, or individual. This entirely changed the observation and approach directly to the “dangerous individual”, referring to the danger potentially inherent in the criminal person, hence new forms of scientific knowledge such as criminal psychiatry enabled the characterisation of the criminals themselves, beneath their acts. Foucault argues that this shift resulted in the emergence of new, insidious forms of domination and violence.

The subject’s formation and how the subject operates in modern penal institutions is at the centre of Foucault’s observations. The modern prison does not just punish by depriving its inmates of liberty. They are subject to observation where they are categorised on the basis of their delinquency, in relation to the idea that they have a different personality – they are people with a dangerous criminal nature.

Foucault argues that the new mode of punishment has become a model to control an entire society, as mentioned before with hospitals, factories and schools modelled on the modern prison. However, he did not think that the deployment of this model was due to the explicit decisions of some central controlling agency. Foucault’s analysis shows how techniques and institutions develop for different purposes.

At the core of Foucault's picture of modern disciplinary society are three primary techniques of control: hierarchical observation, normalising judgement, and examination. Control over people can be achieved merely by observing them. A perfect system of observation would allow one guard to see everything. This appeals directly to Jeremy Bentham’s Panopticon.

What is described above, a prison on Mars, might put off many people who are excited as I am about the human Mars mission. Their argument would be: why do we need a prison on Mars? If we have one, no one would want to go there as no one wants to live in prison. The reality is that Mars will remain a prison to many humans for at least a couple of hundred years, during the period of terraforming. For the same period of time, there is a key ethical question yet to be answered: are we going to Mars as good citizens, or as cosmic vandals?

Another important question is how we are going to implement the abstract nouns, phenomena we have developed here on Earth throughout our social evolution – nouns like freedom of movement, liberty, autonomy – because we still struggle with geopolitical instability, wars and revolutions. If we can live respecting virtue ethical norms – a good life where we can flourish – a related question is whether it is ethical to terraform a planet that we are not made of, we didn’t evolve from, and which is not our own.

Considering all these questions, I argued so far that virtue ethics is the right way to answer the ethically related problems with our future-extraterrestrial human life.

As much as Vallor’s virtue ethics (2016) is the principal of the irreversible human condition, which means technologies and humans will lift off together because of a predictable and necessary human development-upgrade, Arendt’s thinking is more orthodox – with lift off, the human condition (1958) will change forever into something different, a new human. The ethical norms of this ‘new human’ are yet to be tested; for now, we can only analyse it according to predictions and possible outcomes. Hence the fundamental ethical questions are relevant only for now, while we remain grounded for a few more years.

In the context of colonising Mars, several ethical issues arise from a virtue ethical perspective, and we ought to consider them.

Mars is currently a hostile and lethal planet for humans, with an average temperature of -60 degrees Celsius and a thin atmosphere that cannot sustain human life for long periods of time. Surviving on Mars will require constant production of oxygen and water, limited freedom of movement and exercise, and living in underground tunnels, passages and domes with protective anti-radiation shelters.

Terraforming the planet could change this, although the first and crucial step is to restore the electromagnetic field on Mars. Former NASA chief scientist Dr Jim Green spoke about this technology at the Mars Society Convention 2022 [3], at Arizona State University in Phoenix.

Three billion years ago, Mars was a blue planet. Over 2.5 billion years, it went through a rapid climate change. NASA's Phoenix mission discovered water right above the surface. The latest analysis from the data of Nasa’s Mars Inside Lander proved again this finding in July 2024. Mars is hot inside, with a solid and liquid core and convecting silicate mantle. There is also a significant amount of water under the crust. The atmosphere is dominated by CO2, and enormous temperature variations locked a lot of water under the crust of Mars. To bring the liquid water to the surface, we need to raise the pressure and temperature.

Mars once had a significant electromagnetic field, but the planet lost it at least 2.5 billion years ago, possibly 4 billion years ago, after an intensive burst of radiation associated with sunspots released magnetic energy that formed solar winds and solar flares on a massive scale. Scientists predict that solar wind has been stripping the atmosphere of Mars at a rate of 1.3kg per second, observed as an average stripping[37].

Today, Mars's atmosphere is in equilibrium with the solar wind. This means that what it strips must be outgassed, and we have an average of 7mbar of pressure

[37] On Earth, one of the last events like this was in 1859, the so-called ‘Carrington Event’ (as mentioned before). People were able to see the auroras in Hawaii, the Caribbean, south Japan, Cuba and Mexico. Geometrically induced from the electromagnetic field, it caused telegraph systems in North America and Europe to go down, and in some cases operators got electric shocks and telegraph pylons threw sparks. Less severe storms also occurred in 1921 and 1960. In 1989, a geomagnetic storm knocked out power in larger sections of Quebec. In July 2012, scientists observed a large Carrington Event, but this time, the solar flare geomagnetic storm trajectory narrowly missed the Earth.

change per year on Mars. If we stop stripping Mars, its pressure will increase, leading to a rise in temperature.

Heliophysicists believe that Mars's stripping is due to extreme solar wind events on a massive scale. We are now realising that the sun does this, and our only inhabited planet is vulnerable to this phenomenon.[38]

To generate a magnetic field to protect the area where NASA's human mission will take place, in contrast to the film *The Martian*, NASA aims to build the settlement in a single area, which is yet to be confirmed.

A successful terraforming of Mars can only happen if the planet is protected from solar waves and solar flares, and if the conditions on the surface improve regarding temperature and pressure. There is a dispute among scientists: some believe that terraforming can start without the return of Mars's electromagnetic field.

It is important to note that terraforming does not mean that the atmosphere will be full of oxygen, and that humans can walk around freely. Humans and animals on Mars will still need breathing machines. It will take possibly a million years to release enough oxygen into the Martian atmosphere so that life would be comparable to the one we know on Earth. Terraforming will create an atmosphere that will protect humans from solar radiation and enable the growth of certain crops and the creation of food chains and supplies.

That said, many would argue whether such an impact and involvement of humans on a planet we are not made of is ethically justifiable. Others argue from the perspective that Mars has no life at all.

When studying space, Mars, and other extraterrestrial environments, we must consider which ethical perspective is most adaptable for such challenging environments and places. Virtue ethics is an attractive ethical perspective. The desirable qualities of the virtuous person include a keen sense of judgement so that he or she can determine which principles are best suited to guiding actions, depending on the case. In situations of great uncertainty, the virtuous person will fare better than the non-virtuous person because she or he can reliably predict (in

[38] I refer to the article I wrote for Space Flight Magazine, May 2023.

the Aristotelian sense) which virtues will be relevant and which courses of action will best accommodate those virtues.

More knowledge about this still-uncertain situation is needed. We need to understand what entities are in play, what relationships exist between those entities, and what perturbations will have which effects. Terraforming Mars is necessary for humans to live a good life, to flourish and be happy, and to succeed in what ethics is teaching us. Terraforming is integrated into our social life and technology; both are mutually connected, and we can only separate them artificially. Therefore, we will terraform Mars, and the judgment on its real beauty is yet to be seen.

Sparrow argues that complex inorganic systems have the value of virtue because of the character traits they can expose in us. They are a sort of moral touchstone.

With the agenda of some countries like the UAE, which is planning to build a city of 600,000 people on Mars and the advanced space programme from SpaceX, which is already testing Starship rockets to take up to 100 people to Mars, according to the owner of the company Elon Musk, the question of how we can manifest free societies in the cosmos is not just relevant but urgent.

Most of the individuals and private companies who are working on the space programme and navigating with speed the idea of humanity going extraterrestrial, are not focusing on dilemmas regarding terraforming, liberty of human going to work and live there, violation of their autonomy... They are not just pioneers in space, they are trying to democratise space, where democracy is not necessarily something positive but rather something extremely challenging. Conquering other planets in our solar system and beyond will lead to a completely new humanity, which will forever be changed ideologically as well as sociologically and biologically. I would like to explore the possibilities of democracy in human space communities and look deeper into extraterrestrial liberty.

As previously mentioned, Cockell (2022) argues that tyranny could emerge in situations where individuals control essential resources such as oxygen, food, and water. In contrast, Zubrin offers a compelling counterpoint, reminding us that no one would willingly travel to Mars only to live under tyranny. However, Cockell suggests that such tyranny may, in certain contexts, serve a more constructive role –

potentially even becoming self-imposed as a necessary measure to protect all participants involved in a high-risk mission.

In his book 'Interplanetary Liberty' (2022), Cockell explores the possibility of democracy in space. He says the nature of political power in space will be linked to the size of the population; this population will not be in the hundreds or thousands, the likelihood is that at least for the first few decades there will be fewer than 50 humans on Mars and the Moon. On Mars there will possibly be around 10 or so people. Most extraterrestrial settlements will begin on a small scale, although some countries already have plans to build substantial space cities.

As already mentioned, another speculation on how society on Mars could work fairly to avoid tyranny is Michael Walzer's (1983) example of the San Francisco scavengers, hence this system would prevent the possibility of the formation of any kind of tyranny among the settlers on Mars, although it wouldn't entirely guarantee that any benefactor of the mission would not proceed with tyranny.

The question of what kind of government structures will emerge in these settlements in the near future (let's say 2100) remains wide open. China and the UAE will definitely play a major role in forming new extraterrestrial habitats. Neither of these countries favour democracy.[39]

With smaller extraterrestrial human settlements, Cockell suggests a mechanism to dilute the unpredictable tendencies of a direct democracy in a form of mixed constitution, whereby the democratic assembly is balanced by an executive council that may still be elected but considers matters in a more detached mode from the assembly as a whole. The idea is that governmental structures are more stable when they cooperate in mixed forms of deliberation; this can be traced back to post-aristocratic structures, as well as mob rule or even forms of Marx's "lumpenproletariat" (Communist Manifesto, originally published 1848). The classic thinker on this matter is still Adam Smith, to whom the only legitimate function of

[39] The question of democracy becomes a philosophical one when considering extraterrestrial humanity, particularly in environments that are inherently life-threatening. Personally, I do not believe democracy plays a meaningful or endorsed role in such contexts. Reflecting on the UK referendum on EU membership and past elections in the United States, I am inclined to view the outcomes of democratic processes with a degree of scepticism. The implications appear rather bleak – though this is perhaps a topic best reserved for separate research

government is “the defence of the rich against poor, or of those who have some property against those who have none at all”.

One of the core questions is who will owe property on the extraterrestrial settlement on the Moon or Mars. I argue that this will most likely be benefactors from Earth: the entrepreneurs and business moguls who are already driving the space mission. They will also own the oxygen pumps, water tanks, and all the most important things for humans to survive, hence is it possible at all that these individuals will live their extraterrestrial life by any democratic standards? Another very important question: is democracy in a lethal environment, on a solar object that is days or months away from everything Earth-like, possible at all?

Some might argue that the first few extraterrestrial individuals – scientists, explorers and space tourists – will be better off living according to an army-like regime. This utilitarian practice will rely on army-trained standards that will help prevent a human casualty. Techniques that are pre-trained and rehearsed could deliver the best possible outcome and possibly prevent loss of lives and injuries in extraterrestrial environments. In this scenario, everyone on a spaceship or pressurised Martian camp will have to obey rules and orders and take steps every moment of their lives to protect their own life and the lives of the small community of travellers. As much as Cockell’s concept gives a positive spin on space travel, I must assume that an army hierarchy and obeying rules in order to survive would turn the space environment into a form of tyranny.

Self-imposed tyranny comes from an environment when everything must be done according to rules, protocol and rehearsed practices, otherwise the whole system might fail. One example of this is depressurising and pressurising while entering or exiting a spacecraft or space city. After performing an outdoor walk, humans on the Moon or Mars must step into a small space between the outdoors and indoors to pressurise. If this procedure is not followed correctly, it can bring a high risk of explosion, possibly compromising the lives of the colony. This is because if the small chamber explodes, it can lead to an explosion on a larger scale where the whole colony could die.

To conclude, the members of the small colony will have to look after each other, constantly observe what others are doing and check every step. Every decision they take will be premeditated: this is a form of self-imposed tyranny.

Considering all this, another very important question is how many democratic decisions one can make on Mars. Living in a small, sealed, pressurised compartment with limitations and restrictions on going outdoors does not necessarily deliver the chance to exercise democracy. When life is limited to a few rooms and underground passageways, there are not many political decisions to make, nor economic plans to accept. Members of this campus will mostly be scientists who are trying to complete their research, but also space tourists who will be there to observe their mission. Day-to-day decisions will most likely be led by consulting everyone and then being confirmed by the commander, who may accept the democratic option as long as the safety and wellbeing of the members of the campus are not violated.

Will there be political freedom on Mars? I am again only referring to Mars as an example – this could also refer to a space vessel or the Moon, or Titan and Europa… all the possible places for human extraterrestrial life. One possible option that Cockell foresees is that “the novelty of the space frontier will drive society towards the development of the codified form of rules (similar to a civil law), since customary practices that may provide the basis of something akin to common law will not yet exist” (2022, 113). Cockell thinks this will drive the extraterrestrial society to some kind of revolutionary spirit, where entirely new rules and interpretations would spring immediately into action to serve a new branch of humanity.

Another very important way to prevent tyranny or any kind of suppression on Mars is the prevention of interference from Earth. Astrobiologist Jacob Haqq-Misra (2015) talks about a separation from Earth; he believes that future Martians, for instance, would need to have serious provision to realise their necessary isolation. To achieve economic independence, Martians would be obliged not to acquire wealth on Earth, and technology, resources and other objects brought from Earth to Mars would become permanent on that planet; also, no individuals from Earth may own or claim land on Mars. But considering that the Mars mission will most likely be sponsored by billionaires from Earth, would this plan be achievable at all?

Cockell thinks that a federal system could nurture liberty at the solar-system scale. In the far future, many societies will possibly be spread across many extraterrestrial bodies in and outside our solar system. They each will develop their own social and political system; overall federation of the solar system will be the way to govern. Each planetary state would be able to make their own decisions, and based on that they would contribute and work together towards common goals agreed by the others.

But in all possible outcomes, liberty cannot be assured, with constitutions, political structures and all the changes in human societies heading extraterrestrial. Structures will be formed by people for their own benefit – this is where the virtuous will again play an important role.

There might be a collapse in society in the first settlements on Mars because of many factors, including psychological and medical factors. We cannot assume that people who are far away from Earth, who spend seven months on a small spaceship and then go to another small place, a Martian settlement, will act happy and relaxed. What are the implications for the brain and for basic human understanding? There will be fear, and a lack of sunlight, which might contribute to other psychological consequences. This speculation is important, because such a scenario might happen sooner than we think.

Other than liberty, there are questions around the system of justice in extraterrestrial humanity, education and art, human rights law, and the constitution. Some people have predictions about liberty, democracy and tyranny, but the rest of the very important nouns that we take with us when we leave Earth remain open.

The formation of a court system in a small Martian settlement would be very difficult, if not impossible. To recruit judges and a jury from a very small number of individuals would be a tough task, as would choosing a judicial system. Cockell's suggestion is the implementation of civil law into extraterrestrial society; I find this a naïve and dangerous idea. First, we do not know all the circumstances of extraterrestrial human life, as no one has yet lived upon an object in our solar system permanently or for a long period of time. Furthermore, civil law relates to the country it's in, where residents can execute it according to long-standing practices. These can be widely acceptable in some countries and not acceptable, or even a crime, in other

countries. An example is punishment by stoning. Some countries with Sharia law still have this practice, among them the UAE, a country that plans to be one of the first to have a permanent human colony on Mars.

It would also be likely that civil law would not be just in one isolated colony. If there was a dispute between different individuals or companies in two different colonies on Mars, which law would be used? And for some time, we wouldn't be able to fly police, soldiers or detectives to Mars, so who would give the evidence that is so crucial in court hearings and prosecutions? Cockell believes that criminal activity is inevitable beyond Earth. Some of these crimes could potentially threaten many people; for instance, the de-pressurisation of a segment of habitat in which people live. Some crimes might be the same as those on Earth – assault, theft, public disorder, murder – but there could also be new crimes. Cockell's examples are tampering with a spacesuit, damage to life-support infrastructure, and deliberate damage to oxygen-producing infrastructure. His suggestion for minimising criminal activity in space is to screen people prior to their departure, and to implement highly sophisticated and efficient technology that may be embodied in a new branch of human society beyond Earth (2022, 332); with this, criminality may be eradicated.

Finally, there is a big question about whether bioengineering – modifying humans to give them greater liberty in space – is acceptable. It is a very difficult ethical issue, although we must consider that engineering humans to survive in other worlds brings advancement to the human race and helps them flourish in extraterrestrial life. Arguably, from the virtue ethical perspective, this is an acceptable and welcome procedure. But importantly, the focus is on the question of whether human bioengineering can contribute to human liberty in space.

One of the biggest questions related to extraterrestrial life on Mars is how we can exercise freedom of movement. A walk outside in a lethal environment will compromise the health of the settlers, so it is important to understand that when there is a small community of people, each one plays an important part, and each one must stay well for the safety and wellbeing of the entire community. I will now discuss the salient points concerning autonomy and liberty.

The case for Mars is obvious from two perspectives. Everyone going to Mars will make an autonomous decision. He or she will land there with a great amount of

autonomy, but their autonomy will be compromised by the fact that there will be much less – sometimes zero – liberty and freedom of movement. Yet some autonomy will remain. A different question regards the violating of bodily autonomy. Bodily autonomy concerns our own bodies, our choices, our power, agency and dignity. Sending people to Mars violates bodily autonomy from biological, psychological and social perspectives.

Funerals as we know now will be almost impossible, outdoor cremation cannot proceed without the oxygen, and for the same reason dead bodies, if composed outside the Martian dormant will remain preserved for a very long time.

There are other questions on liberty in the post-human solar system, Cockell suggests. Extraterrestrial humans could have their minds engineered to achieve better critical thinking, or we could make humans less aggressive or more altruistic, through DNA and hormone changes. This engineering is ethically unacceptable on Earth, but if this is the only way to survive extraterrestrially, it could be imposed beyond our planet.

This will not fit the ethical framework and norms as we know them now – that human life is the most important thing and ethically we must protect it. But beyond Earth, it could be that engineering humans is the only way for them to survive and live in liberty.

Considering the obstacles and limitations to the ethical norms we practice daily on Earth, and also knowing that schoolteachers, librarians and social workers might want to go to Mars but don't have $250,000, I came up with the proposal of the Panopticon on Mars. Before I will draw a conclusion, I must present a few very important facts.

The most successful TV programmes that attract the biggest audiences globally and the largest sums of money are reality shows. In recent years, streaming services have managed to engage with the biggest volume of people. The power of the viewing public is substantial, with Netflix having 238 million subscribers and an annual revenue of $32 billion, followed by Amazon with 200 million subscribers and $35 billion annual revenue, and Apple with 25 million subscribers and $1.5 billion annual revenue.

A schoolteacher who wants to perform an experiment to educate children globally needs only 250,000 subscribers to pay $1 each and they can buy a return flight to Mars. My proposal of Panopticon on Mars is to sponsor the first few hundred astronauts travelling to the red planet and, in return, we will be able to see a real picture of what the day looks like there, and monitor that person, whether it's a scientist, teacher, or even a comedian. The sponsorship must be paid upfront considering that most people from Western societies can afford a dollar to support a human Martian.

As the picture 1 shows, the Panopticon on Mars compartment has a similar structure to the original. In the centre, instead of a guard there are numerous cameras, capable of rotating around the mast, following the movements of the individual that is being sponsored. The audience has become the guard. Inmates in Panopticon on Mars will not know if and when they are being observed, but they will act as they are observed the whole time so they will interact with others accordingly.

This constant awareness that they could be monitored and observed at any time will put them in a situation where they will not want to do anything wrong, but they will also interact with each other in compliance of the rules and regulations. They will be able to leave the social platform at any time to a back room, where they can enjoy full intimacy behind the area of observations, as the picture shows; there are also restrooms here. It will be important to respect that there might be a sole occupier in each of the back rooms to prevent a potential argument or any other form of aggression against the inmates. In the outlined circles of corridors, the inmates can socialise.

The Panopticon on Mars can be placed on the surface of the planet, so the ground floor area can be used for research, drilling, taking samples…This will reduce the potential danger of performing outdoor walks, being exposed to cosmic radiation and reduced pressure. Importantly, this is only suitable for certain experiments, not all. For instance, finding lifeforms on Mars requires searching in areas with no human contamination. The glass-like half-ball-shaped "roof" is made from filters, to protect the inhabitants from solar radiation and to collect solar power for energy use. The cubicles with private rooms will have the option to be completely shielded from daylight. At night people will be able to observe the night sky and be able to adjust further filters on the whole roof area. It is important to recognise that we already

have the technology for the Panopticon on Mars, so the disclosure of materials and designs is not the subject of this article.

In the case of Panopticon on Mars, there are two problems regarding freedom: freedom that can be controlled by cameras, and the loss of freedom that prevents humans going outside because of cosmic radiation.

In the case of Mars, instead of a prison guard in the middle, there would be a camera live streaming events. Subscribers might pay for access to the stream and will be able to monitor the whole situation, not only possibly preventing violations between the settlers but also measuring the Martian authorities. A Panopticon would take control from individuals who might violate others' rights, but on the other hand it would also remove a certain level of privacy and the freedom of those living in the colony. They will all have to work and deliver to the agreed standards, following the protocol. The question is whether this would be possible to enforce. Would anyone travel for seven months to a lethal planet, and live and work there in the most challenging conditions, knowing they were being watched the entire time?

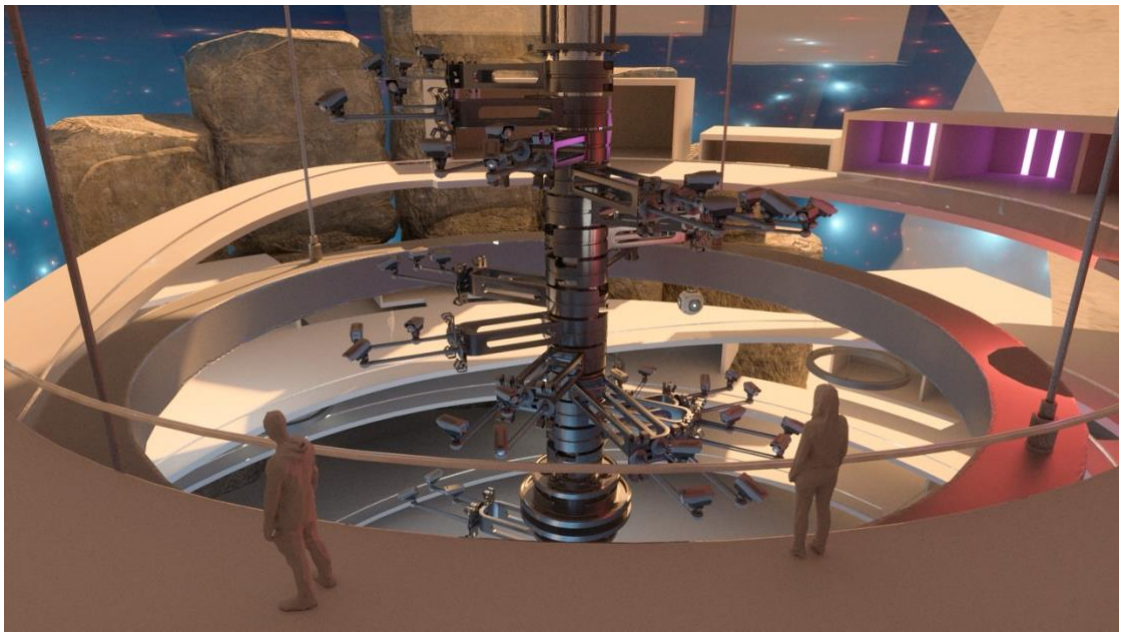
As Foucault analyses, the human body is a tool that can be optimised better; streaming to Earth, the audiences are the guards; and disciplinary techniques are nothing but a function within obeying the rules – this is the potential life in the Panopticon on Mars.

This is the ethical view of humans in relation to the planet we are about to conquer. 'Occupy Mars' is a slogan that Mars Society convention attendees like to wear on their T-shirts. But what about us, the humans living and working in a lethal environment, possibly 10 to 20 years from now?

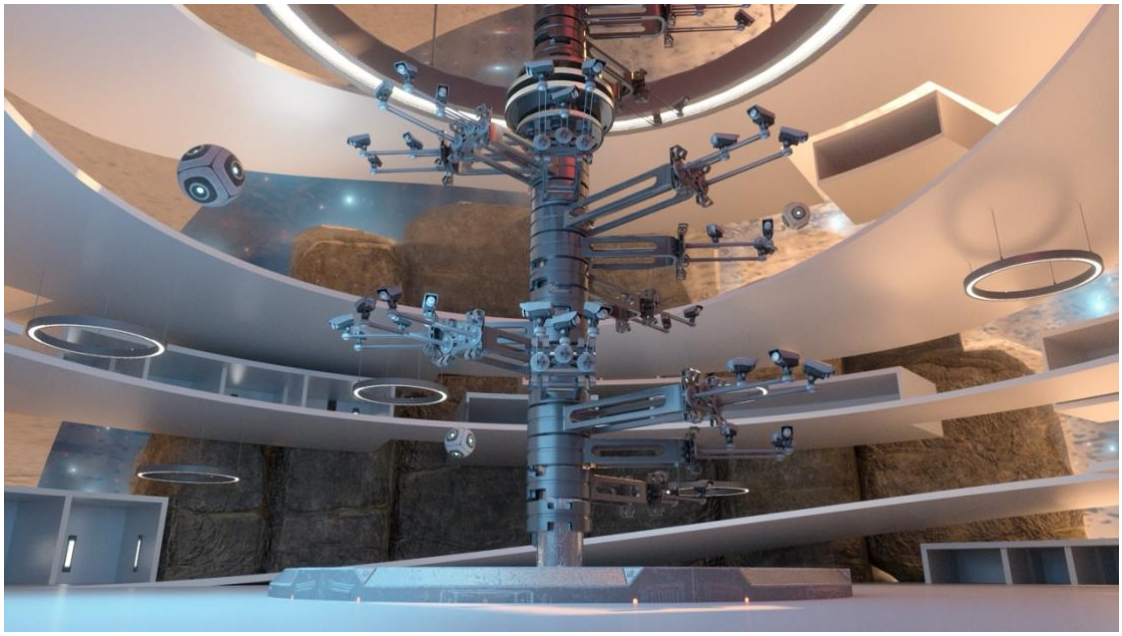
The signal between the Earth and Mars takes around 20 minutes, so this will not be a live streaming as such; there will be a delay. Humans will always rely on technology – as Professor Shannon Vallor says, there are no humans without technology and no technology without humans. After all, technology brought us into space and helped us achieve the ability to be extraterrestrial. Space will remain a lethal environment where basic needs like oxygen, water and food will need to be technologically provided for humans to survive. Cockell thinks that the human body may be engineered to cope with short periods of oxygen deprivation or to operate at lower oxygen concentrations that we are used to at sea level. Cockell's example

here is engineering a haemoglobin molecule that can bind and deliver oxygen to the body's cells more effectively, as is seen naturally in some people who live at high altitudes. He admits these changes are rather vague compared to a real situation where humans live in a completely oxygen-free zone.

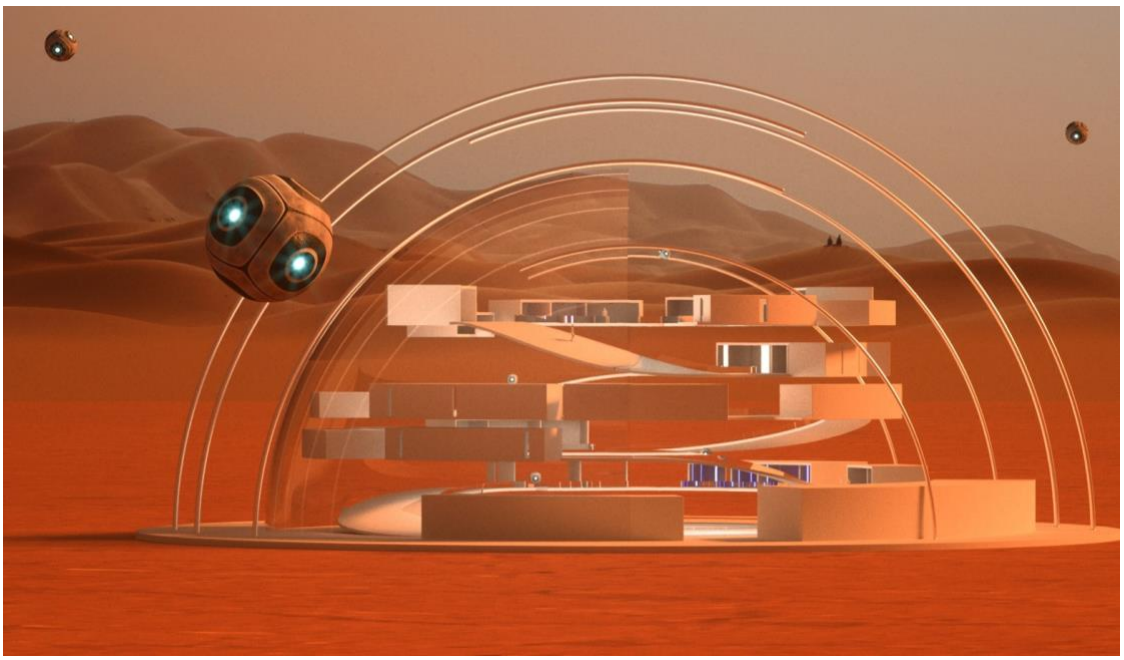
PICTURE 1



PICTURE 2



PICTURE3



5.3. Conclusion of the First Part

Considering all ethical dilemmas and scientific facts about the planet, this research serves only as a prediction. I must agree with Arendt that we are embarking on a new and dangerous mission, hence I believe this is our human condition – we were never set to remain on Earth, after all we created heaven, which is something above us and better than us. Here I must refer again to Arendt, who points out that there are many workers on this planet: bees, ants, even birds are workers during the nesting season, when they must build their nest to secure the future of new generations. But there is no other creature that we know of who has an idea first and then strives and works towards the realisation of it. This idea then becomes a material tool, a scientific and technological achievement. Vallor sees the core element where technology and human are the same and technology enriches us, because the human condition drives us towards a good life where we can flourish and reach towards the stars.

Many of these ethical questions will not be applicable for the first hundred people on Mars. As the development of modern space vessels is rapidly progressing and SpaceX remains positive about its goal of a human mission to Mars in the next decade or so, concepts still haven't been developed about how humans will actually live and work on Mars. Panopticon on Mars serves as a good example, considering all the philosophical and social issues facing extraterrestrial live on the red planet.

PART II

6. Ethics in Extraterrestrial Nanotechnology

6.1. Introduction

In part two of this thesis, I will predict that our ethics in extraterrestrial human life will be implemented in and extend into new fields. Our extraterrestrial life will be possible only with the strong support of technology. This has two major problems: technology can develop too fast, and we cannot always predict its consequences. This can bring civilization back from its striving point; for instance, when new technology was used to develop the atomic bomb.

Our ethics – so far grounded in what Hannah Arendt might term Earthen traditions – will be implemented in, and extended to, the context of extraterrestrial human life, viable only with the strong and sustained support of advanced technology.

This important section examines evidence for what may be described as a new human condition in extraterrestrial environments. Living on a lethal and barren planet will necessarily limit the use of traditional forms of labour, while scientific and technological systems will increasingly substitute for, and redefine, the meaning and role of human labour. By anticipating these shifts, the chapter aims to illuminate the ethical imperatives and responsibilities that must guide our adaptation to life beyond Earth.

Yet the use of biotechnology and nanotechnology that is not legal on Earth can be tested in space, which could contribute to completely changing life as we currently know it. For example, a human society on Mars could build an invisible border, a net of nanotechnological particles, that would cut to pieces any living being, machine or object that approached the planet or an area on the planet uninvited. It would be unimaginable to use something like that on Earth; although we are always creating new war zones, we are still a collaborating, globalising planet. Yet if one nation wanted to live in total isolation from another on Mars, they would be able to do this. Here comes the next big question: would this sort of system last?

To see it from a virtue ethical perspective, it might not. Perhaps not the first or second generation: they will obey orders and commands given by leaders of the mission in order to prevent hazardous situations. Future generations will want to flourish and live a good life, even though they would be physiologically evolving under certain conditions (like lower gravity) to become a different kind of humans, perhaps ‘Humartians’.

Not even 100 years ago, life on Earth was very different. Most women in Europe had no voting rights and hardly anyone was talking about our relationship with the environment (after all, centuries ago we changed Alpine ecosystems by cutting down woods to build Venice). Even now, many societies don’t concern themselves with the question of how to slaughter animals without cruelty. Some people still eat cats and dogs, which is hard to imagine for the majority of people in Western societies.

I will argue that ethics in extraterrestrial humanity will develop much faster than we think; and that due to the problematic situations we will face when living in lethal environments, the use of technology and nanotechnology will be widely accepted – even the types that are currently prohibited on Earth. It may be that at the start of our extraterrestrial human life, consequential, deontological and applied ethics will play a bigger part, and I will try to prove that extraterrestrial human life will create a bigger space for virtue ethics, once nanotechnology becomes widely used in barren place like Mars.

To set this in the right direction, I think it is important to understand the ethical relationship between science and technology, particularly the nanotechnology that has brought us to the future we are at the brink of. An important question is: if the human condition changes, will ethics change as well?

6.2. The Human Condition

In her 1958 book, Arendt considers humanity in the aftermath of the scientific age. She defines the ‘modern age’ as the rise of science and the political and industrial revolutions of the 17th, 18th and 19th centuries; her ‘modern world’ includes the two World Wars, the first atomic bomb and the rise of totalitarianism. Also in this modern

world, the first satellite (Sputnik) started orbiting in the Low Earth Orbit, and automatism was developed to replace labour.

The modern world as we live in it now goes beyond the Earth. One of Arendt's main questions is: How did the rise of science lead alienated humanity to turn far away from Earth and the world we humans have created? She draws a clear distinction between Earth and the world.

What does it mean to be a human in this world, when human life has been going through fundamental transformation for thousands of years? Arendt thinks that human life will be very different from the life that went before; she worries about the future, although she doesn't determine whether it will be good or bad. She talks about the joy of creation, which makes our (outer) space more approachable.

Sputnik, and the satellites that came after it, represent the human desire to escape the Earth forever. To break from our human bonds with earthliness is to free ourselves from limitations, to release our bodies, our human minds and our universal intelligence to a life that will be free from gravity, but also free from those rules of earthly living that we will die, that we are mortal.

Arendt's interpretation and secularisation is a turning away from God, which we have already done, and now we are turning away from Earth. She ties up our alienation from Earth with science. Earth is an intrinsic part of the human condition. Only on Earth can man live without artifice, and only on Earth are we all like animals.

Faithfulness is part of our earthliness, but with the rise of technology we have gained a desire to control our lives. The animalistic aspects of human life are increasingly lost; we are losing our connection to human nature and becoming a human creation. Arendt talks about artificial insemination, test tubes and cloning. A goal is to create an artificial world on a new planet, perhaps, where we can live with perfect people, in a perfect environment, everything perfect on a large scale to satisfy our human desire.

Arendt thinks that for the first time in history we are able to achieve this, although she asks a political question in the first section of her book: whether we should now rebel against the human condition and earthliness, or not. She says there is no

reason to doubt that we can do so, and that this is a question for every one of us, not just for scientists and politicians.

The second threatening event is automation, which releases us from labour. Labour is a deeply human activity. It is the activity on which we act upon the Earth: in order to keep ourselves alive we have to produce food, shelter and all the elements we need to live.

With technology – mainly automation but now AI (although Arendt wrote this book nearly 70 years ago) – in a position to free us from labour, then the question is, what is left? In our historical human societies, few were able to free themselves from labour: aristocrats, thinkers, those who owned slaves. But now we are reversing the situation; now it is a few of us who are labouring and working very hard. The vast majority of labour will get to a situation of economic surplus, if not now then very soon. We have evolved from a labour society to a non-labour society. To Arendt, this is one of the greatest challenges – we are losing the cycle of life.

Sooner rather than later we will live in spaceships, where the entire atmosphere is created by humans and nothing is created by chance. There is no faith left – this is the loss of Earth and earthliness, this is a fundamental change in the human condition. We now have the capacity to change what is human, not in our nature but in our condition. On this point, Arendt is not a prophet but an evolutionist.

What is, in this sense, a common world? Once we sat around a table and the table unified us in a human bond. What is the purpose of art, the work that lasts and which we continue to talk about? It holds us together.

Possibly what Arendt didn't foresee is that we are now going even further. With our creativity, design, technology and scientific inventions, we are closer than ever to creating a 'perfect' world where humans don't have to work, and – what is more frightening – with AI overpowering our everyday life, we don't have to think, hence as explained in the following chapters this might not be the case.

For instance, nanotechnology will help us survive and progress as a civilisation on another planet; most likely this will first be tested on the Moon and Mars. AI will be introduced on a massive scale to our everyday lives, and with further improvements it will replace doctors, perhaps one day even parliament and governments. The

question that arises is not what kind of human life there will be, but who we will become.

Imagination allows us to foresee how our lives could be stored in the cloud, together with our memories, and live on without our mortal body for thousands of years. We will be able to see our past, live our present, we will be able to feel because we will design ourselves to the extent that it might be called evolution.

That said, in a million years from now, our Universe may figure it out with equations and be full of clouds that will never have a desire to become something mortal, because their new design will not let them. At this point there is no return. Our designs and AI will be able to replicate many worlds and universes, perhaps recreate the entire initial singularity. One might argue this isn't possible. This thesis remains firmly agnostic to such a perspective.

Arendt correctly sees the differences between humans and other animals, or even insects that are focused on labour, such as bees. To her, their labour also brings productivity. The difference is very important. Humans are the only species that first create new designs in their heads, minds, dreams if you like, then these designs – like scientists' tools – serve us all and allow society to progress.

If we already have these ideas of the perfect world – with no labour and the Universe perfectly run by AI – there is just the question of how long this will drive us to that extent. There will be some political fractions on the path towards this reality. To think that some of us might one day live on Mars, which will enter into trade and enterprise with Earth, and that we will build our own society there – these new types of human societies could actually just speed up this process.

As already mentioned before, the second and third generations of people born on Mars may evolve to Martian gravity and will not be able to come back to Earth, so will be even more distant from life here. For hundreds of years, there will be no animals on Mars due to the process of creating an atmosphere and terraforming the planet. There will be no direct contact with the Earth's kind of life. And the process will head towards the complete opposite of what was once our human condition.

This is the path we cannot prevent and, possibly, this is who we always were. We were meant to reach far beyond; it was set in the ancient books, in Sophocles'

Antigone and many sci-fi novels of our time. Yet we must not be naïve and we must remember Icarus's wings – it only took 2,000 years between them being designed to us flying far beyond our Mother Earth.

Arendt understands that there are two ways in which humans engage with the world. First, we think about it and second, we act upon it. Arendt focuses on human actions – how humans act upon the world ('vita activa').

The first form of action is labour. Labour is the politically necessary repetitive process of perpetrating human life as a biological species. The second form of action is work. Arendt understands work from where humans posit a goal and then set about realising it through the purpose of action – such as the production of durable goods. This is the worldliness of life; this is our human creation. The last form of action is what Arendt regards as free-initiative activity done in a public sphere, where the outcome of the activity is unknown in advance, and it is unpredictable. Action is always creative – it is always free in the sense that it is not biologically necessary.

Action reveals the reality of what it means to be human. When we are initiating an action, we are always revealing something about ourselves, by what we decide, and by explaining it to others; this is the way we are.

The outcome of an action is never known, and it is never final. It merges with the human experience and history, and only historians can analyse it. Action can be daunting for humans; it can trigger events we cannot foresee. In order to act, Arendt says that humans have developed two mechanisms. The first is forgiveness: She argued that forgiveness is essential because human actions are unpredictable and irreversible. However, she did not claim that people are not responsible for their bad actions. Instead, she emphasized that forgiveness allows people to move forward rather than being trapped by past wrongdoings. A more accurate representation of her view would be: forgiveness helps to mitigate the unintended consequences of actions in the human world, but it does not remove personal responsibility for one's actions.

Humans cope with this fact via the practice of forgiveness. Arendt mentions Jesus Christ, who she regards as bringing the practice of forgiveness to the mainstream

of civilisation. She credits Jesus with recognizing the political significance of forgiveness, not just its religious or moral implications.

However, Arendt approaches this idea from a philosophical and political perspective rather than a strictly theological one. She contrasts forgiveness with vengeance and retribution, seeing it as a way to break cycles of violence and hostility in human affairs.

The second thing humans do to cope with the unpredictable nature of actions is the concept of promises. We seek to make some closure in the future by promising. The promise gives us the capacity to unite around a fixed object and empowers societies to achieve things.

The modern society as Arendt understands it is a labouring society, however she argues there is still work and action in our society, mainly in science. Science becomes the refuge of that work, because the scientist designs an experiment, fabricates particular tools, and does experiments through their work – Arendt cites Galileo's telescope as an example of this.

Also, when scientists carry out experiments, they interact with nature. Using the product of work, they initiate things and predict the outcome. In contrast, economies will become dominated by labour and the repetitive process of keeping life going.

Labour dominates our life, in terms of production and consumption. We are each of us small particles, a vast economic machine. The consequences of this is that our lives become personally meaningless. We are no longer living in a world that is meaningful to us; each of us can be replaced, the actions that we do are meaningless in our experience of them. We are alienated in our work lives, we are alienated in our domestic existence to which we can no longer attach traditional meaning, and even the world of nature has been reduced to mathematical equations.

Few of us have the capacity to live freely anymore, and this is the programme of a system, applying to politics in particular. In the old Greek state, individuals stepped forward and argued with others to get policies right; in the modern system, the main feature of politics is a government of administration and bureaucracy, and this for Arendt is a severe loss. Eventually we will be replaced by machines.

If I consciously connect the thinkings of Yuval Noah Harari – historian and author of “Sapiens” and “Homo Deus”, and Arendt – I conclude that for great achievements we need an idea, but we also need a belief in a form of ‘religion’, which will inspire us, guide us and stimulate us to achieve.

Before I conclude this section, I want to present the extraterrestrial idea of liberty and why I think that humanity becoming interstellar is a form of liberty. A very broad explanation of liberty which we can find on internet is: ‘a state of being free within society from oppressive restrictions imposed by authority on one’s ways of life, behaviour or political views’. And another explanation is: ‘the power or scope to act as one pleases’.

But there is a possible distinction between Arendt’s labour, work and action epistemology and her virtue epistemology. Arendt distinguishes between labour, work and action. Labour is the cyclical, necessary activities tied to biological survival (e.g. eating, producing food, maintaining the body). Labour is repetitive and does not leave behind durable creations.

Meanwhile work is the production of lasting objects and infrastructure that shapes the human world (e.g. building cities, crafting tools, creating art). Work gives permanence to human existence.

And action is the realm of political engagement, speech, and interaction among people; it is where freedom, plurality and new possibilities emerge. Action is the highest human activity because it allows individuals to express themselves uniquely and shape the world meaningfully.

Virtue epistemology, particularly in its Aristotelian form, links knowledge with intellectual virtues (e.g. curiosity, open-mindedness, practical wisdom). Human flourishing (eudaemonia) depends not just on acquiring knowledge, but on exercising intellectual and moral virtues in a free and meaningful way. If human flourishing requires the full range of human activities, then merely engaging in labour (basic survival tasks) might not be sufficient. Flourishing likely requires work (to create meaning and permanence) and action (to engage with others in intellectual and political life).

So would Arendt be concerned about space settlement and the problem of labour? If early settlers are entirely consumed by labour – struggling to survive, maintain oxygen, water, and food supplies – there is little room for work (cultural and technological development) or action (political life and free discourse). This would resemble Arendt's notion of a society trapped in mere survival, rather than one that enables true human flourishing.

But does this provide an argument against space settlement? If a space colony remains in a state where all effort is devoted to labour, then human flourishing as Arendt (and virtue epistemologists) conceives it may be impossible. This might be a reason against settling in space unless conditions allow for work and action, ensuring that settlers can create culture, engage politically, and pursue intellectual and artistic endeavours. However, if a space society can transition beyond mere survival (through automation and advanced technology reducing labour), then flourishing might become possible.

The environment in space will no doubt be a very restricted and dangerous place to live and work. I doubt there will be any political interference from Earth with Mars's government until, for instance, Mars[40] enters into a trade agreement with Earth, and this will not happen for the first few settlers and most likely not before 2100. There will be no authority, except a commander, so anyone not behaving according to the rules might be left behind in the Universe. There could be even worse punishments, such as switching off someone's oxygen supply.

Rubenstein (2022) talks about a new religion – Astrotopia, that promises the future of humanity outside of our planet. But a question Rubenstein doesn't have an answer for is how Astrotopia actually works, where it comes from, and what the mainstream belief or practice of Astrotopia is.

Harari (2015) is more analytical in his view on our social evolution. The central religious revolution occurred with the advent of modernity over the past couple of centuries, bringing a rise in humanism. The humanist religion worships humanity and expects humanity to play the part that God played in Christianity and Islam, and that the laws of nature played in Buddhism and Daoism. The great plan of the

[40] The United Arab Emirates plans that, by 2100, 600,000 of its citizens will permanently work and live on Mars, which is a mineral-rich planet. Mars may contain ores that will be very useful for future colonists.

cosmos traditionally gave meaning to humans; now humans are giving meaning to the cosmos. In humanism, people must draw from their inner experiences not only the meaning of their own lives, but also the meaning of the entire Universe. As Harari says: “Create meaning for a meaningless world.” (2015, 259).

Arendt’s framework suggests that a society locked in endless labour cannot flourish. This raises serious ethical and philosophical questions about space colonisation. Should we prioritise ensuring that any space settlement quickly enables work and action? Or does the prospect of long-term flourishing justify enduring a period of labour-heavy existence? Ultimately, this is a key challenge for anyone considering the ethics of space colonisation.

6.3. Posthumanism on Mars

One of the key questions when living an extraterrestrial life is around currency and payment for work. How do we do that – how can we justify someone’s work when they arrive in space and receive no salary, for even if they do receive one, how could they possibly spend it? For quite some time there will be no shopping malls, restaurants or sports centres on Mars, and it is unlikely that a spaceship would be so grand as to house all this entertainment.

It is possible that posthumanism will kick in; with our knowledge from cognitive science and neuroscience, we know about the hormones and neurological activity in our brain if we do something good or bad. Of course, it is important to realise that neuroscience still doesn’t know everything and we may need some time to understand the way our brain works.

But let’s speculate that in the future we will be able to have a small reader (a micromachine) either implanted under our skin or attached onto our head to read our cognitive reactions and collect all the data. This machine will create credits for our greatest achievements and minuses for what we’ve done wrong. So we could operate without money, as it is possibly not needed in our extraterrestrial life, where we will live in small compartments – either space vessels or domes on another planet. Therefore with a good score awarded because of great achievements, an individual could be fast tracked to a job upgrade, or a new and better home. Could we transform into a microchip society, where currency becomes a bonus token?

7. Nanotechnology And Extraterrestrial Human Life

Chapter Seven serves as a preparatory discussion for the subsequent chapters, which will confront ethical questions situated in largely uncharted territory – scenarios that we can, at best, only attempt to predict.

Nanotechnology is widely regarded as a near-future development with the potential to promote a more sustainable way of life, particularly through the use of cleaner energy resources. However, rapid and uncritical pursuit of nanotechnological innovation is likely to generate its own ethical controversies. For example, replacing traditional manufacturing and construction processes with nanotechnology-driven automation will make many forms of human labour redundant. Such widespread unemployment could destabilise economies, exacerbate inequality, provoke social unrest, and even risk triggering revolutions or large-scale conflicts.

Nevertheless, when considering settlement on Mars, the introduction of nanotechnology into daily life – into what might be termed every soul – is not merely advantageous but arguably essential. In an environment characterised by severe cosmic radiation and lethal conditions, nanotechnology will likely be the only means by which human beings can build, maintain, and sustain a viable presence. This chapter therefore explores both the promises and the ethical hazards of nanotechnology, laying the groundwork for an informed ethical assessment of its role in the future of extraterrestrial human life.

7.1. Introduction

One of the greatest physicists of the 20th century, Richard P. Feynman[41], was among the first to showcase the use of nanotechnology in everyday life. In his December 1959 presentation to the American Physical Society, he predicted the human leap towards nanotechnological civilisation.

Should Arendt and Feynman predict our future correctly, here are some arguments that the outcome of introducing nanotechnology to our lives could be extremely

[41] "There's Plenty of Room at the Bottom: An Invitation to Enter a New Field of Physics" was a lecture given by a physicist Richard Feynman at the annual American Physical Society meeting at Caltech on 29 December 1959.

positive, although it must be tested, and it will most certainly be used first on another planet before being imported to Earth.

Nanotechnology is the manipulation of matter on an atomic, molecular scale. Nanomaterials involve structures having dimensions in nanometres – typically between 1-100 nm. At such dimensions, materials can show significantly different physical, biological and chemical properties to materials in bigger dimensions, which opens up a range of new possibilities for technology.

Although not fully approved on Earth – the lawmakers are working on it – advanced nanorobotics (especially self-assembly technology) have the potential to support extraterrestrial human life, in particular that of the first generations of human statelets on Mars and the Moon. I deliberately avoid the term “human colony” on Mars, due to the questionable tactics of those who ‘own’ the Mars mission.

7.2. Nanotechnology and Evolution in Extraterrestrial Human Life

Are these people going there to colonise Mars, or are they going for the good of human evolution, as its navigators and drivers? If it is about colonisation, history teaches us that this is a painful process when one race (mankind, in this case) understands the new world as something to possess. If there is existing life in primitive forms on Mars, mankind will overpower it and take over everything as if it belonged to them.

Evolution is different. To Darwin, it is a necessary process driven by the survival of life, which can compromise its existence because it has developed more powerful mechanisms to make itself more resistant and stronger.

If humans are going to Mars on the basis of the principle of evolution and we find out before we set out that the planet has its own ecosystem, then our evolution can go three ways:

1. To preserve and respect the existence of life on Mars
2. To replace it with Earth-like life that includes humans, animals and plants
3. To integrate Martian life into Earthen life and vice versa

In each step of evolution so far, ethics have played almost no part, not to mention the colonial systems that deliberately avoided ethical standards. Far away from Earth, in a place unknown to any ethical standards, nanotechnology will not be just one option, but the only solution in order to survive.

One of the greatest advocates for a “radical abundance” and implementation of nanotechnology, replacing our current way of living that depends on production by heavy machines, is K. Eric Drexler (2013). We are increasingly seeing how pollution caused by carbon dioxide from heavy industries is heating up our planet. Drexler’s proposed plan is to introduce greener, biodegradable and self-sustained micro machines to our industries, and gradually replace the current heavy, large and polluting machines.

Drexler is not naïve; he is aware that the nature of carbon dioxide means it will not immediately disappear from our atmosphere. The gas is not washed away by rain or somehow blown off our atmosphere. Even if we take action as early as today, carbon dioxide will remain in our atmosphere for hundreds of years. Yet many developed nations agree that action must be taken now.

We could do this with the progressive introduction of small machines made of small mass molecules and atoms, but because our societies are based on geopolitical structures, this kind of interference would profoundly change the way we live. Factories would close, workers would lose their jobs.

Nanotechnology would also change our ethical stance and perceptions. If we start building these smaller, biodegradable and self-sustained bio-machines, everything we achieved during our Industrial Revolutions would become meaningless. Societies would change forever, as we radically abandon not just machines but also workers, which would most likely result in a revolution, if not a world war.

Drexler supports his thinking on radical abundance with a philosophical understanding of the difference between science and technology. He looks at science in its profound area of research of matter, which needs our understanding to enable us to source it, use it and perhaps manoeuvre a new understanding via equations. Using nanotechnology on Mars would most likely be the best or even the only way to go, considering that it would be prohibitively expensive to fly heavy machines to Mars.

7.3. Differences Between Scientific Findings and Technological Design Can Result in Different Views on Human Extraterrestrial Life

Everything that is touched, discovered and observed by scientists is here or was here – either as a constant or because of an irreversible sequence of accidents. Black holes always existed in the Universe, but they were proven (not by the equations yet) by scientists due to their advanced understanding of the matter.

History tells us that science doesn't require thousands of people working together to understand the fundamental basics of our Universe. Newton was not leading a group of hundreds that eventually brought him to a conclusion on gravity. Scientific observation is more likely the process of an individual or a small group of thinkers and researchers. In contrast, technological achievements typically require hundreds, if not thousands, of people to get the right design that is able to serve the required purpose. In practice, they are working together with the aim of developing something new, useful and modern to help create greater social enrichment.

Over the past few decades, nanotechnology has been used in medicine and commercially: the 3D printer is a good example. Nanotechnology and its myriad applications have the potential for enormous benefits in biomedicine, but also for serious harm – I am not talking about a social revolution here, but purely our biological structure.

There are examples where the ethics of using nanotechnology remain questionable. Drexler agrees that sometimes the best outcome of technological enrichment is when science and technology work together in unity, although this cannot always be supported as the right theory.

The atomic bomb was technologically accomplished based on the scientific discovery of the atom. And in this case, nanotechnology played a far more dangerous part. In addition, we all know the arguments against the laboratory production of 'superbabies' and human and animal clones.

On the other hand, many people have changed their views based on the latest experiments and inventions of animal protein. Scientists in the world's laboratories can now grow meat from animal DNA protein without slaughtering any animals. With this nanotechnology, settlers on Mars are on a mission whereby 'nano-meat' in the

human food chain could replace the consumption of animals who are born to this world, fed firstly by their mother and then by industry, and then slaughtered.

This example of nanotechnology serves a wider purpose than animal ethics. The first human settlers on Mars will not be able to bring any animals with them, for very simple reasons. No one can imagine that an animal – for instance a goat – would be happy travelling there for half a year in zero gravity, surviving the landing without any injuries and then living under Mars's surface or in a building where the animal must use an oxygen mask plugged into an oxygen tank. It would also be very costly to travel to Mars with kilos of grass to feed the goat properly, not to mention the consequences of solar radiation, which would most certainly affect the goat.

Pig protein, developed from live animal cells and multiplied in a laboratory into a pork steak, seems a possible alternative and would give settlers on Mars an animal protein to eat. Furthermore, humans on Mars would travel there with a few robots and, as a current program predicts, houses, labs and other facilities would be sent to the planet ahead of their mission. But in the future, more and more people would arrive, the settlement would eventually become a village and later a town of thousands, and these Martians would need proper machines to support them.

Here on Earth, a very simple machine made of metal weighs a tonne or even more. To transport something that size to Mars would require a great amount of energy, not just to shuttle it out of orbit but also to land it safely on Mars. The lives of the first generations of settlers on Mars will have to be much simpler and, in a way, comparable with the lives of indigenous people on Earth. But settlers there will require the use of machines to be able to maintain life on a day-to-day basis and to form an economy that will eventually grow and be able to enter trading partnerships with the one on Earth. Drexler predicts that nanotechnology will eventually make our future life more sustainable, with a better use of energy: it will be biodegradable and lead to a society that will eventually burn and release less carbon dioxide into the atmosphere.

The paradox is that societies on Mars, in order to become a civilisation one day, must terraform the planet. According to Robert Zubrin (2019,2021), the technology for this already exists. With our current knowledge, and the fact that we are brutally overheating our planet, it would take less than 250 years to terraform Mars, bringing

the temperature of the planet to around 25℃, which would create an atmosphere, although humans and other live organisms on Mars would still depend on oxygen from oxygen tanks.

This whole process will still not lead to a second level of civilisation as based on the Kardashev scale – that is, one that can source energy from an entire solar system. Nanotechnology will only move us further towards this target. It is likely that successfully transitioning into a new era of nanotechnology will happen on Mars before it happens on Earth, for all the reasons mentioned. If this is a successful transition from industrial societies based on the use of heavy machinery, then nanotechnology will be introduced to societies on Earth.

7.4. Ethics and Radical Abundance

There are arguments that nanotechnology is ethical, as well as arguments that it is very unethical. It could be ethical from the time when it is fully implemented into society: tiny robots operating in a self-sustained system, delivering cleaner and better products using the minimum amount of energy, which could satisfy the demands and needs of mankind. But before that, it could destroy societies as we know them. The social structure that works today, and which brought us the great inventions and giant machines that started the first and second Industrial Revolutions, will lead humanity to what Drexler calls ‘radical abundance’.

Does radical abundance mean to give up on ethical absolutes entirely? Or is there a fundamental chance that absolute good and universality can be delivered on the grounds of Kantian social and political norms, to establish some new non-absolute grounds for ethical acquiescence and judgement?

Scientific theories and engineering designs contrast profoundly at the level of logic. In “The Logic of Scientific Discovery” (1959), Karl Popper observed that universal theories can, in principle, be falsified by one decisive experiment, yet cannot be proved by even a million concordant experiments. After centuries of success, Newton’s theory of gravity falls short.[42] It came up short against Einstein’s theory of

[42] Newton’s theory of gravity works well for most everyday situations and is still widely used today. However, it falls short near very massive objects, like the Sun, where gravity is extremely strong. In such cases, Einstein’s theory of relativity is needed, as it explains gravity more accurately by describing it as the bending of space and time.

relativity, which proves stronger gravitational effects close to massive bodies. Einstein's big idea was to prove that the presence of matter/energy results in the curvature of space, and that the closer you are to a more massive object, the stronger gravity behaves.

"In logical terms, a universal physical theory corresponds to a universally quantified statement. In this deepest, logical sense, the questions implied by design and inquiry are opposite; in mathematical terms they are duals." (Drexler, 2013, 127). In contrast to the logic of scientific findings, technology, and in particular nanotechnology, plays a far greater part. The design must work; if it doesn't work it is a failure and the logic is that it serves no one, so its existence is equal to nothing.

7.5. Space Exploration: Natural Evolution or Colonisation?

Back to the ethical question on how we are going to Mars and the Moon, as a colony or as evolutionists. From a philosophical perspective, we must first understand who the first settlers on Mars and the Moon will be, and what their agenda is.

If they are going there only to conquer and exhaust other objects in our solar system to make an economic profit, then we are talking about colonialism. As history has taught us, colonial powers usually work in a regressive way and there are many downturns before progress can be made. In the case of Mars, if primitive lifeforms do exist there – and the answer for this is yet to be found, even with the latest discoveries and collections of material from Martian air and soil by the Perseverance rover in the Jezero Crater – then the question of whether the colonialism of Mars is ethical remains wide open.

In their day-to-day lives, these settlers will depend heavily on nanotechnology. They will have to produce oxygen, source minerals, and grow their own food. Their movements and work will be supported by nanotechnological machines, which are biodegradable and made of resistant materials, as Zubrin suggests in his books "Case for Mars" and "Case for Space". The chemical structures of such elements must not be fragile in temperatures below zero or above 100℃.

The most positive outcome is that we will be able to see our future and we will have a chance to adopt a new way of living on Earth too. Perhaps, if it is not too late, we will be able to use nanotechnology's greatest achievements to enrich our life on

Earth. That said, our current civilisation has accomplished a giant leap to a new reality, of humanity living elsewhere in space, and this was mostly reached by our development as a scientific and technological species.

We are heading into our extraterrestrial existence for several reasons; the most bizarre one being just because we can – not all of us yet, but several extremely rich people backed by few dominant countries. Another, more sophisticated, reason is because we must. We are halfway through the life of our Sun and when nature takes its course our planet will start becoming uninhabitable; and, frankly, by polluting it and destroying its ecosystems we are fast-tracking this process. We must start looking for alternatives in our solar system and beyond; first taking natural resources from the solar objects in our neighbourhood, and then potentially finding possibilities to inhabit Earth-like worlds.

8. Ethics in Nanotechnology and Technology

This chapter is dedicated to a critical ethical review of nanotechnology. It is important to evaluate a range of philosophical perspectives on how nanotechnology might develop, as well as to identify the areas and fields in which it is already being incorporated or actively integrated.

While the use of nanotechnology remains controversial on Earth – raising significant ethical, social, and environmental concerns – it may become a widely accepted, indeed indispensable, practice in the context of extraterrestrial human life. In particular, settlement on planets with harsh and inhospitable conditions is likely to depend on technological solutions that only nanotechnology can provide.

This chapter emphasises the need for careful, context-sensitive ethical evaluation – considering each case individually, attending to specific situations, and distinguishing clearly between beneficial uses and potential abuses. By adopting such an approach, we can better understand both the promises and the perils of deploying nanotechnology in the development of sustainable and ethically responsible extraterrestrial communities.

Extraterrestrial humanity- this plan is backed by our science and technology, but the question remains: how can we enrich this plan and do we need ethics for space exploration? We are where we are because we evolved – both by biological

evolution (we are taller and live longer than people in the 18th century, for instance) and by social evolution, where we humans are part of society. Integrated into both is the evolution of science, which can push us to even faster development.

And, over the past few decades, another evolution has started. When we set foot on another object in the universe, we had to compromise and accept that our nature from this point is hugely supported by nanotechnology in order for us to survive in a lethal environment, and that this will change existing societies. Ethics has never played a part in our biological evolution; rather, history indicates that Lower Palaeolithic humans were cannibals, something that is ethically unacceptable these days (although there are still tribes who do this). And eating animals is still widely accepted; even though we have animal ethics, they are not appreciated by the majority of people. Ethics in science is often overlooked, and when combined with advances in technology, it can raise serious questions about the moral implications of scientific achievements. Examples include not only the creation of the atomic bomb, but also the potential development of ‘superbabies’ and artificial food that could alter our DNA over time.

In contrast to this, social evolution can be highly driven, although not always, by ethics. Nanotechnology is the fastest evolution; over the next few centuries it will play the most important part in our biological evolution and the evolution of science. In order to implement ethics in space exploration, we must understand the relationship between science and nanotechnology, the way the two can support each other and how they will drive humanity into extraterrestrial spaces.

The ethics of nanotechnology is the new ethics, not yet tested; quite possibly it will be driven by colonial powers and the strengths of our evolution (social, biological and nanotechnological). But can this be based on a more universal ethical norm? Could respecting universal ethical norms be an obstacle, and even life-threatening to the individual and society in extraterrestrial human life?

Is nanotechnology giving rise to new ethical problems? This is a question asked by Fabio Bacchini (2013). Answering this question, he makes a distinction between new ethical problems and new instances of old problems. His suggestion is that nanotechnology will bring new ethical problems, in that they are new occurrences of well-known types of ethical problems.

He concludes that nanotechnology may require new normative standards, or new analytical tools. He thinks the ethical issues that arise from nanotechnology will have a considerable impact on our ethical theories, norms and values. Even though no nanotech ethical problem will actually be ‘new’, the ethical reflection on nanotechnology will bring a rich, deep, and complex source of ethical dilemmas that humanity will likely confront in the future. As we advance in fields like biotechnology, biomedicine, or even climate engineering, terraforming and nuking, we’re tapping into a vast reservoir of ethical issues – issues that will demand new frameworks, careful deliberation, and potentially difficult decisions.

Nanotechnology is indeed different from other technology spheres, and many of the empirical facts of nanotechnology are relevant to its assimilation, hence Bacchini finds it hard to claim that nanotechnology raises any new ethical problems. But nanotechnology raises ethical issues in fields such as legal and regulatory issues; research, funding and priorities; equality; environmental, safety and health issues; privacy; and medicine. As all these issues already exist, we cannot identify them as new issues, so in the case of legal and regulatory matters we must assess nanotechnology from a legal perspective. This is also the argument of philosopher Fritz Allhoff, who says that nothing within the legal and regulatory sphere of nanotechnology differs from other technologies.

As Bacchini sees it, the ethical problems remain the same, yet the details of the ethical issues can be different. He considers nanotechnology as just a branch of technology. He cites examples where philosophers see risk assessments. Whether these ideas are applied to the environment, medicine, marketing practices, or anything else, the central framework should be the same, because all these instructions share the same structural features. If nanotechnology is subject to a relevant framework, it is hard to think that there are any features to challenge such a framework, or otherwise introduce any novel moral consideration into it.

Bacchini’s example is Ibo van de Poel’s important distinction between two different notions of ‘newness’; a distinction we can use when considering whether nanotechnology gives rise to any new ethical issue, i.e. whether the ethical issue is new and is not raised by any existing technology or it is not dealt with any field of an applied ethics. Another example would be that the ethical issue is new if we still lack adequate normative standards to deal with it. Bacchini finds this definition

problematic, especially because van de Poel changes his assessment in the course of one paper and claims that ethical issues can be new when they require new normative standards.

Bacchini's definition of what constitutes 'a new ethical problem' depends on the intrinsic newness of ethically relevant arguments structuring the problem. He talks about 'instinctive newness', meaning the impossibility of being exhaustively within the framework of any older ethical problem. Instinctive newness cannot be understood as appearing on the stage for the very first time. In practice it is quite possible that the new instance of an old ethical problem will bring some interesting new ethically relevant arguments. The 'new' ethical arguments can be new in the sense that they are expressed for the first time, and we cannot paraphrase them as ethically relevant arguments relating to an old ethical problem.

How can we responsibly make a distinction between new ethical problems and new instances of old problems? Nanotechnology is giving rise to new features of ethical problems, which will be psychologically relevant to the changing ways in which we frame and argumentatively structure older ethical problems. Bacchini claims that psychological relevance is easier to find than ethical relevance. Nanotechnology will lead to further research and future ethical assessments and, as part of an applied ethics, it will always be looking for new tools to deal with ethical dilemmas. In this way, nanotechnology will be shaping rather than reacting to new technological ideas.

But is nanotechnology just a fancy term for a range of other fields in science – chemistry, physics, biology and quantum physics? Or is it a bespoke term for something new? Are the ethical and social questions arising from nanotechnology the same questions that arise from other fields? Bioethicist and philosopher of medicine, Søren Holm, says that it is difficult to specify exactly what could make an area of technology so special that it needs its own ethics, but a minimal requirement must be that it either raises ethical issues that are not raised by other kinds of technologies, or that it raises ethical issues of a different (i.e. larger) magnitude than other technologies. Is this the case for nanotechnology?

Many societies are already discussing the ethics regarding certain fields of nanotechnology, for instance its critical role in human-enhancing technologies, such

as cybernetic body parts, exoskeletons that give us superhuman strength and ultra-red vision. Biomedicine is already used, not just for testing on mice and rabbits, but quite often on humans too, to help us to fight genetic diseases and disabilities. In the distant future, nanotechnology might help humans to extend their lifespan to almost immortality. It might store our thoughts, memories and even feelings into computer avatar bodies to maintain our conscious lives forever (considering that nothing lasts forever in the existence of the Universe).

Here lies the first ethical concern about nanotechnology: regarding the economic and political agendas in place when that happens, we will depend on nanotechnology. Should we give our lives to nanotechnology to live forever? To transform our human life that is made of biochemical reactions based on atomic compounds of organic cells to a silicon one, or perhaps another nanomaterial-based life in a synthetic cloud; preserving our thoughts, mind and body. I would here argue with Bacchini that his view that nanotechnology is just a reaction to new technological ideas is rather short-sighted, when it could be linked to a completely new type of human.

In their paper “What’s So Special about Nanotechnology and Nanoethics?”, Fritz Allhoff and Patrick Lin (2006) try to prove that some of the issues that are emerging appear to be unique to nanotechnology. They refer to environmental health and safety (EHS) risks arising from nanomaterials. Research suggests that some nanomaterials are toxic to animals, and that they can enter small cells and so get into our food chain, with unknown affect to human health. The authors ask whether nanotubes could be the new asbestos, an advanced construction material that, decades later, was found to be of the most toxic materials ever used in our homes and institutions. Their claim is that when we introduce materials made of strong nanotubes into our lives, these can be toxic – then nanotechnology becomes its own field of ethical concern and not just part of a broad ethics such as environmental ethics.

The world’s strongest economies are pouring billions of dollars every year into developing nanotechnology, which in the foreseeable future will have impacts on broader society: social, economic, workforce, legal, ethical and educational implications. Allhoff and Lin say that no one should underestimate the fact that all the great institutions investing in nanotechnology – including government agencies,

universities, publishers and global organisations – are doing this because they know that the implementations of nanotechnology for our everyday life is irreversible. Another argument for considering ethics in nanotechnology as its own field is that the ethical implications of nanotechnology are greater and combine all other sciences, including chemistry and physics. But they say that we cannot really claim there is an ethics of chemistry or an ethics of physics, so for this reason perhaps we should reject the claim of ethics in nanotechnology.

But should we set tests or limitations on what is a real discipline and claim that only a true discipline can raise ethical issues? Allhoff and Lin suggest leaving the argument of whether nanotechnology is a true discipline because it doesn't really break new ground and rather understanding nanotechnology as a new height in our understanding about the world. In a sense it is like architecture and can be regarded as a convergence of aesthetic design and engineering. In this way, nanotechnology can be understood as a new discipline even though it is a convergence of other fields.

Alhoff and Lin also suggest that nanotechnology raises new ethical issues and adds a new dimension or 'flavour' to current ethical debates. To them, a good example for this is privacy, which may be an old debate but nanotechnology's introduction of invisible and undetectable objects and systems into our lives that didn't meaningfully exist before means it brings new urgency and reality to the issue of privacy. They predict that nanotechnology will take the debate of privacy into a completely new direction. Their example is in unwanted and unauthorised surveillance, which was traditionally focused on a few agencies, notably government organisations. But the introduction of cheap, ubiquitous tracking devices based on nanotechnology will decentralise surveillance. The whole debate will now turn into something very different.

Finally, they shine a spotlight on the use of nanotechnology in space exploration, human enhancement and longevity. They believe that ethics in space exploration overlaps with nanotech, because extraterrestrial humans cannot live, work and prosper in the lethal environments of barren planets, space crafts and other objects in our solar system without the implementation of nanotechnology. Terraforming, the production of oxygen and clean water, food… everything outside the planet we were made of can be possible only with the constant use of nanotech.

Allhoff and Lin predict that the future of nanotechnology can take us much further, to the extent that we will be able to produce all the physical objects we want from precisely manipulated molecules. They will be designed in a ‘black box’ of sorts, to serve our ends, but who will question if these ends are ethical? If we look to the future, we must set the question now: who will be able to put a stop to this, or control whether the outcomes are good, suitable and prosperous, and to what extent is it acceptable to use nanotechnology?

Things can, or possibly will, get out of hand. If advanced nanotechnology is our possible future, then it is quite right to shape the ethical questions about it now. Allhoff and Lin think that in the future man may produce weapons of mass destruction thanks to nanotech, and in that case it will be very hard to determine who is the terrorist and who is a good citizen seeking self-defence. This also comes back to the issues related to advanced forms of nanotechnology, including space settlements, AI, human longevity or immortality, all of which are based on molecular manufacturing on a nano scale.

Some scientists and critics think all these assumptions are premature and may not develop to that extent. But let’s not forget Feynman’s speech (essay), “There’s Plenty of Room at The Bottom” (1959), where exactly what he predicted over 60 years ago is now in a wider use. Technology is a key part of our lives and not just in Western societies; mobile phones are now used in small villages in developing countries as well as in the heart of metropolitan cities.

It will be interesting to see how nanotechnology will affect our lives in the future on Earth. Some societies are more open-minded about the implementation of nanotechnology, believing it will play a crucial role in human enhancement and upgrade human capabilities such as strength, sight, hearing, memory and longevity. They see it as the fullest potential of human lives.

Considering nanotechnology in extraterrestrial human life, it will be de facto the only way to survive. Therefore, we can assume that nanotechnology will develop faster and to a greater extent in extraterrestrial environments, where there will be fewer restrictions and considerations of whether certain nanotechnological products are ethically questionable or not. Nanotechnology is also expected to accelerate work

in artificial intelligence and other innovations such as increased processing speed, increased memory, quantum computing, happy hormones and genetic adjustments.

8.1. Social Impacts of Nanotechnology

Robert Sparrow (2009) suggests that regarding the social impacts of nanotechnology, we should open an ethical conversation about nanotechnology. He considers six areas of concern where we should seek answers regarding the ethical implementations of nanotechnology: health and safety; the environmental impact; law and regulation; the social consequences; science and technology policy; and broader philosophical issues. He says that the health and safety issues associated with nanotechnology have been subject to a thorough survey by the Swiss Re insurance company, and the environmental impacts of nanotechnology have been assessed by various environmental groups, movements, and institutions including the United States Environmental Protection Agency.

But Sparrow says the consideration of ethical issues has not yet alarmed the lawmakers, so in his article “The Social Impacts of Nanotechnology: An Ethical and Political Analysis” his focus is on the remaining three areas, in particular the social consequences of nanotechnology and the ethical issues they raise; he does not stretch this question to the possibility of extraterrestrial society, living and working on a barren planet. He also questions the terminology: should we talk about nanotechnology or nanotechnologies? He stresses that there are so many separate technologies based on nanotechnology.

Sparrow is critical of the predictions of Drexler (1986,1991) and Crandall (1997) and all who believe that the development of nanoscale assemblers will lead to a “post scarcity” world. He also refutes the predictions of some scientists that self-replicating nano-bots might threaten the world with an explosion of “grey-goo”[43]. He says that these ideas and predictions are far-fetched and that, rather than science-forecasting, they are science-fiction. He focuses on nanotechnology that already exists or is in development, without too many revolutionary leaps in our technological know-how.

[43] "Grey goo" is a hypothetical doomsday scenario in which self-replicating nanorobots consume all matter on Earth while building more of themselves. It’s often used as a cautionary example of how advanced nanotechnology, if not properly controlled, could spiral out of control and threaten life as we know it.

Yet Sparrow predicts that nanotechnology will soon become ubiquitous; it will be in our medicine cabinets, clothes, cars, living rooms, hospitals… When we think about the implications of nanotechnology on our lives, we must understand its characteristics and that properties from materials can no longer be straightforwardly extrapolated from their chemical makeup once we start engineering on a nanoscale. The properties of nanoengineered materials are partially a function of their physical structure at the nanoscale. Minor differences in structure at this small scale can result in large variations in properties of the material. It is a complex process in which we need to understand its physics and also its chemistry, but mostly how its physics affects its chemistry. For Sparrow, this is essential to the power of the nanotechnological revolution. This basic fact about nanotechnology is also the cause of its some of the most disruptive implications for policy and regulation. Sparrow concludes that therefore each new nanotechnological product needs independent assessment in relation to its possible environmental and health hazards. He believes that science needs to evaluate the risks associated with any new product, which will be an extremely demanding process.

Nanotechnology will be invisible to ordinary people, not just because the nano aspect of small particles cannot be seen with the naked eye, but also because its nano structure will often not be discernible to the person using it. Many consumers who come into contact with nanotechnology over their lifetime will not be aware that the product they are using relies on or contains nanotechnology. Sparrow reminds us that, even today, there are many technologies implemented in our lives that are ‘invisible’ in this way, and many of us use them but don’t know how they work.

Here Sparrow thinks consumers will be in difficulty. If nanotechnology becomes ubiquitous, products containing nanotechnology will no longer stand out and they won’t be advertised as such. Consumers will find it difficult to find out if the product contains nanotechnology unless it’s clearly labelled; but the components and particles of nanotechnology are so specific and vary widely on their physical and chemical structure that it will be difficult to label them. The invisible nature of nanotechnology may mean that consumers will not be able to rely upon notions of individual choice or consumer sovereignty to resolve ethical issues associated with nanotech.

Another element of nanotechnology Sparrow reminds us about is that it will be slippery to control and very difficult to regulate. Nanotech will be copied, pirated and traded illegally, and used in unexpected applications and contexts. He predicts that there will be a tendency for nanotechnology to 'escape' and to appear in areas that are not necessarily the ones where nanotechnology developed in the first place. This means that nanotechnology must be used carefully and in controlled fashion, away from utopian visions.

Sparrow says that it is hard to predict the social impacts of nanotechnology to our societies, but he thinks the biggest social impact will be the use of nanotechnology in health and medicine. This may help balance the power between citizens and governments, as well as between citizens and corporations. One concern about the use of nanotechnology in healthcare is that societies in developed countries will benefit more than those in developing countries. (This might change when nanotechnology techniques 'trickle down' and become cheaper, to make distribution more widely available.) This may contribute to social unrest, as some societies could reach a far greater life span – some say to 200 years – and others much less, because of their inability to introduce the best medical nanotechnology. On the other hand, nanotechnology in healthcare could also become problematic with many people living for too long and younger generations paying too much for their healthcare.

Another concern is about the balance of power between citizens and governments and citizens and corporations. Sparrow thinks about military applications and surveillance technologies, which could impact social power relations. He claims that a depressingly high percentage of nanotechnology research is funded by the military, and so it is directed towards military applications. In the long term, new weapon systems will be designed and created based on nanotechnology, for instance swarms of miniaturised drones (UAV) and other guided munitions (Altman 2004; Altman 2006, Ratner and Ratner 2003).

As Sparrow thinks military applications of nanotechnology do not have social benefits, it is hard to see whether countries are benefiting from it. After all, other countries can develop similar or the same nanotechnological weapons. If we consider the atomic bomb, when just the USA had it, it claimed that the war was shortened and civilians protected, but the aftermath was horrific for all those directly

affected. Today many countries have nuclear bomb, not for actually intended to be used, but mostly to serve as mutual deterrent.

When nanotechnology is being developed in the military, wider society doesn't necessarily benefit from it, and that money should be spent for a purpose that helps a larger number of people. Furthermore, Sparrow thinks the development of nanotechnology in the military has implications for social and political relationships within society. Modern armies are immune from civilian threats today in a way that they have never been before. Sparrow believes that nanotechnology will further widen the gap between the means of political violence to those available to the military and those available to the civilian population. He says it will be harder to overthrow governments, although here I argue that at least in one country – the USA – it is quite the opposite. Research shows that on average each American owes more than one firearm. On 6 January 2021 at the Capitol building, some Trump supporters claimed that they could overturn the government because, after all, the government knows they are armed. Some Americans believe that governments in Europe can manipulate their citizens because they know they don’t possess weapons. If the military works under the state’s control, this could well be alarming for the military itself. On the other hand, Sparrow indicates that in the future nanotechnology developed for military purposes will be widely produced and as such, in countries like the USA where the constitution gives individuals the right to self-defence, it could end up in the hands of the civilian population as well.

Military and technological power is not itself political power, and Sparrow reminds us that the ruling elite still needs an army to enact its power, and that these armies are formed from the body of the population. While they might be careful to maintain a good relationship with the public, Sparrow also sees the possibility that military nanotechnology will empower the already powerful. Some critics think the opposite to Sparrow (Altman and Gubrud 2004) and that nanotechnology could fall into the hands of terrorists and other criminals and will wield power beyond the control of governments. Sparrow doesn’t believe that nanotechnology will ever be that slippery, but will most likely be tightly regulated and controlled by governments.

Sparrow also predicts that nanotechnology will concentrate political power in the hands of governments in the case of improvement of surveillance technologies: face and pattern recognition techniques, cameras, listening devices, and other tracking

devices. An area that is already rapidly developing is the improvement of electronic and computer memory, which enables organisations to store, analyse, collect and share data. Developments of nanotechnology can help governments keep track of their citizens (Nature Nanotechnology 2007), therefore nanotechnology in hands of totalitarian regimes would easily maintain their power and control over their citizens.

Sparrow is concerned that nanotechnology in surveillance that serves governments in democratic and liberal societies will also serve non-governmental organisations and corporations. If a government can collect information about people, so will private companies: banks, insurance companies and other finance organisations will have a far greater access to personal information.

Another one of Sparrow's predictions is that nanotechnology will allow individual consumer goods to be uniquely identified and tracked. An existing, widely available, technology is Radio Frequency Identification (RFID), where items can be tagged with a chip or label. Sparrow says it is likely that manufacturing tracking devices on a nanoscale will become cheap and ubiquitous, and that governments and corporations will be able to use them to gather information about individuals. This will allow them to better manage their service to potential customers, but also to track down terrorists. Sparrow thinks this will lead to a 'surveillance society' in which citizens are not just watched and tracked to a greater extent than ever before, but also expect to be (Mehta 2002, van der Hoven 2006).

Among the philosophical questions Sparrow is asking is what will a society that adopts nanotechnology look like, and is that the sort of society we want to live in? I believe this is a relevant question for all people on Earth. Without a doubt, the nanotechnology on Earth that is yet to go into development will one day be transformative. For now, billions of dollars are spent by governments and private organisations to carefully replace current technology with smaller and more effective nanoscale particles. Here, the question arises: what if nanotechnology is the only way to survive on a barren planet, is this ethical from a philosophical perspective?

From the virtue ethical perspective, humans want to strive, live a good life, prosper and flourish, and without nanotechnology extraterrestrial life is not possible. Considering all the obstacles in extraterrestrial environments, nanotechnology will play a core part. Perhaps it will not be rapidly accepted and developed on Earth, but

this does not mean that, for example, humans on Mars will not use it from the beginning of their Martian life and develop it to the extent that any ‘grey areas’ as they considered here on Earth will not be a burden on Mars.

The problem arises if the social systems in an extraterrestrial society are not democratically set; then nanotechnology will not just be the only way to survive and live a good life, it could be abused. If there are tyrannical powers on a planet far away from Earth, and this thesis suggests the possibility for that, these powers will be able to abuse nanotechnology in all kinds of ways, to eliminate individuals who are against them, to hoard power, and to rule society through their tyrannical or authoritarian regime.

I have many predictions for that and each of them would require a separate thesis. But the ‘invisible border’ example is a good one. As already mentioned in one of the previous chapters, there are some governments that are planning to settle their citizens on Mars in the future. They aim to source natural reserves from the red planet as well as carry out science research. It would be unrealistic to think that these governments would build barracks for the army and police and settle these kinds of forces there to guide and protect their citizens.

But when they are in possession of important natural resources from the territory, and especially when they enter an exchange of resources with Earth, they will need to protect their territory. The easiest, cheapest and most efficient way to do this is to create an invisible border made of nano material, which contains micro atomic nano particles that can cut through human or any kind of organic and non-organic cells, and which serve as a defence. We’ve seen these examples in science-fiction movies, but in reality these systems are already in development by some armies. (Feynman’s predictions in his essay “There’s Plenty of Room at the Bottom” are already being made reality).

In conclusion, nanotechnology will shape extraterrestrial human life, and it will require a huge number of virtues to consider and maintain ethical norms and standards. Extraterrestrial humanity will face difficult challenges, and the use of technology will be a fundamental support of their lives. Human and technology are deeply connected; we cannot imagine humans without technology or technology without humans, but we can understand technology as part of our virtues (Vallor).

When Lin says that nanotechnology is not something new but just the extension of technology, can we also assume that accordingly there will be no new ethics? I believe there will be new ethics, all accompanied by the virtue-ethical norms. As Vallor says, technology can be part of our virtues. In an extraterrestrial society, humans will live in a very limited world with no army, courts or similar institutions. They will be their own institution and what they will exercise on a daily basis will be their virtues, their guidance to surviving on a barren planet.

9. AI in Extraterrestrial Environments

One of the most significant developments shaping contemporary societies is the invention of artificial intelligence (AI) and, prospectively, the emergence of superintelligence – what Nick Bostrom refers to as the supermachine. This chapter provides a critical framework for examining the dual potential of AI: it highlights both the dangers of its misuse and the specific contexts in which AI could offer essential support for extraterrestrial exploration and settlement.

If Ray Kurzweil's (2005) predictions prove correct and we are indeed approaching the creation of a singleton – a single, dominant superintelligent entity – then it is crucial to assess the ethical implications of such a development. Bostrom and Yudkowsky argue that superintelligence could eventually attain a form of consciousness and therefore merit moral consideration comparable to that afforded to conscious beings. Yet even Bostrom acknowledges that we remain far from achieving such a state, contending that we should prioritise understanding human cognitive processes and expanding our own cognitive capacities before attempting to build superintelligent systems.

Moreover, Bostrom suggests that the development of superintelligence should precede the full-scale deployment of nanotechnology, given the potential risks posed by the latter if left uncontrolled. This chapter critically examines these arguments and their relevance to the ethics of space settlement, particularly in light of the possibility that humans may land on Mars within the next decade. Such a development would almost inevitably involve the use of nanotechnology from the outset. Consequently, this analysis questions whether Bostrom's recommended sequencing is feasible in practice and explores the ethical complexities that arise if technological development proceeds along a different path.

Besides nanotechnology, which is still in its developing phase, there is another new technological field, also an emerging technology that needs much ethical consideration – AI. Nanotechnology and AI already work together in several fields. Many tech engineers would argue that nanocomputing is currently the closest correspondence of nanotechnology and AI. The core promise of nanocomputing is that it can greatly improve computing power for researchers and engineers.

As we are building even smaller computers, we encounter strange quantum effects that limit our ability to work at this scale. Moore's Law[44] – that the number of transistors on a computer chip doubles every two years – no longer holds true, but nanocomputing is one approach that can help overcome these problems. Nanocomputers use a variety of novel media to perform calculations, from organic chemical reactions to nano-MOSFETs.

Another example where nanotechnology and AI combine is chemical modelling, which stimulates how molecules will interact with each other. It is widely used in bioscience and drug development, and in the past decade scientists have been using chemical modelling techniques to better understand the behaviour of materials at the nanoscale, to improve their efficiency and efficacy.

AMF (atomic force microscopy microscopy) is yet another example; this combined technique is used for imaging objects at the nanoscale. There are many more examples besides, which all have a bearing on our consideration of ethics in extraterrestrial human life, and also regarding the use of AI.

Vallor (2024) has described AI with a metaphor that is now widely used in science: 'the AI mirror'. AI is nothing but our mirror; it has no soul or organic flexibility, and no matter how we train it, there are no organic cognitive functions. AI reflects human cognition and is backward-looking, constrained by the data we have already provided it with. It amplifies our biases and misunderstandings, giving back a shallow, unimpressive version of our presence. AI is not an independent force, but rather a reflection of our past. It might look like an impressive tool, but it is a system

[44] Moor's Law, in the context of computer ethics (not to be confused with Moore's Law about computer hardware), was introduced by philosopher James Moor. It suggests that ethical issues emerge because technology evolves more quickly than our ability to develop suitable laws and policies. This creates a "policy vacuum", where new technologies outpace our understanding of how they should be used responsibly, raising important ethical concerns around privacy, security, and fairness.

that doesn't know how to say: 'Stop, something is missing here, I do not understand', so it is a system of many misunderstandings. It is a recognition and replication machine that works by statistical guessing.

Vallor sees it as a "technomoral change" when technology uses human-generated data that can be manipulated to results that cannot fit our ends. She says that some of today's most advanced AI systems are constructed as immense mirrors of human intelligence. The reality is that they don't think for themselves, instead they generate complex reflections cast by our recorded thoughts, judgements, desires, needs, perceptions, expectations and imaginings. Therefore they open a gap for many ethically questionable practices, including racism.

From the virtue ethical perspective, as humans we want to flourish and have a good life, as we have throughout our history. Through the most important part of our social evolution we created great institutions that help us to live a good life and navigate our future: schools, courts, libraries, governments… and now, in our recent history, AI. One core problem of AI for Vallor is that it is created by humans and doesn't show the status quo but it mirrors back to us and strengthens the dominant cultural preference for whiteness. Technologies often develop quickly, without ethical pre-assessments, but this doesn't necessarily mean that we cannot predict unethical situations. Notable examples of racial bias in technology are observed in the paper 'The Whiteness of AI', where researchers Stephen Cave and Kanta Dihal cite numerous cases of search engines that are racially biased. AI has the ultimate function of gathering data from the Caucasian race; even in robotics, the main companies building humanoid robots make their images based on Caucasians or mixed white/Asians[45].

Many machines are anthropomorphised, with the look of humans, and their creators are making their image based on light skin. Vallor reminds us that computers do precisely what we tell them to do, but just not what we thought we told them to do. They mirror people's problems. The algorithms are often set to train based on data that has already been collected; when this data focuses on a particular social class or race, as has happened in many cases in the USA, then the AI becomes more

[45] Humanoid robots are one of the most advanced robots. Most of them have an image or prototype based on the Caucasian race, with fewer examples based on the Asian race. Some dominant examples are Sophia from Hanson Robotics, Kismet (blue eyes) and Cindy (blue eyes).

racially biased. It creates burdens and unprecedented situations for some, and privileged outcomes for others, whose data was widely available and whose data was used to train the algorithms.

The outcomes for racial bias are sometimes accidental, but not always. Vallor gives the example of a Silicon Valley startup, Sanas, which created an AI product for call centres that erases all kinds of accents and ethnic and regional variations of English into a so-called ‘Standard American English’ accent, colloquially known as ‘white voice’. To Vallor, this shows that we haven’t just created social bias against certain types of English speakers, but that the data gathered to train tomorrow’s AI systems will reflect even worse on human bias against speech that diverges from ‘white voice’. Meanwhile sociologist Ruha Benjamin has documented a ‘runway feedback loop’, taking the example of Instagram’s digital video ‘beauty filters’, which are designed with Eurocentric biases that make your skin whiter, your nose thinner and narrower, your eyelids bigger and eyes wider. These types of filters are harmful because they negatively affect young people and can damage their mental health, self-confidence and self-respect. They are particularly harmful for women who don't match the standard model of what white female beauty is supposed to look like.

Vallor reminds us that AI systems mirror our intelligence back to us; as we can see from media reports, books, analysis and TED-style talks, we are in a serious situation and there is evidence that these systems are transforming our economic and social order, even destroying it.

For the first time in our human history, we are giving power to imaginative technology that can process all our data in order to classify it into algorithms which are then used as humanity’s common voice and collective judgement. Judges have predictive algorithms to tell them who can be released from prison; HR software is used to choose from a large pool of applicants a much smaller pool of candidates for interview. Potential job candidates are picked up in the first phase by AI, without any ethical considerations on how it can be manipulated.

Some cases are even more dangerous and inhumane. When information data is already racially biased, it is not easy to eliminate unwanted bias. Vallor’s example from 2019 shows how a risk prediction algorithm used by hospitals in the USA was replicating the long history of racial bias in American health care. A special tool was

created to divert health care from Black patients; these were high-risk patients who were sicker than many of the white patients. Race had been excluded from the training data, and they used other data including how much money had been spent on a person's care.

It led to physicians regularly denying access to more expensive tests and treatments for Black patients, while white patients with similar symptoms and clinical findings were granted this. When the algorithm's designers naively chose healthcare cost as a good proxy for healthcare need, they unintentionally doomed Black patients to being rated as needing less care than white patients, who had already received better, costlier care from their doctors. In this example, Vallor shows us how a learning algorithm found and reproduced the pattern of racial discrimination without even being given a race label.

Vallor reminds us that the mirror does not reflect all of who we are. There is no sound, smell, depth, imagination or hope. Rather mirrors flatten and distort us, and our reflection is just our polished surface. The mathematical data used within AI does not know about our virtues and vices, our views and ethics. An AI mirror is machine learning, an optimisation algorithm that determines which feature of the 'incident light' that is the data the model is trained on will be forced and transmitted back to us in the forms of the model's outputs.

Does the AI mirror serve a virtue, and if so which virtue? The answer is far from straightforward. As Vallor explains in her previous book, virtues are at the core of human flourishing, and they are acquired by practice. They work almost like muscles; they must be actively cultivated, stretched and strengthened by activity. As Aristotle said, virtue is an excellence of a character, a trait that humans treasure and recognise not only as worthy of praise in an individual, but essential for shared human flourishing. There are moral and intellectual virtues: courage, honesty, generosity and wisdom, curiosity and open-mindedness.

Because some virtues like wisdom are virtually absent from a child, this particular virtue needs a whole-life practice; others are also complex and require many years of reinforcement by habitual, moral or intellectual practice and constant improvement by social learning and feedback. This delivers a good trait that

eventually shapes our character and creates the possibility of the best outcome and the best of ourselves.

Vallor considers the relationship between the AI mirror and virtues. She says our virtues can be powerfully shaped by our habit of using AI tools, because these tools alter how we perform the activities that build those virtues. As we enable more automation of social and intellectual tasks to AI tools, we can progressively evaluate these tools with perfect or imperfect images and information about us. AI has the potential to change our human character, to make it better or worse. The cases build on biases that prove that AI can even degrade what we think a ‘better’ character is.

In her book ‘The AI Mirror’, Vallor talks about the virtue of AI. She once again reminds us about practical wisdom, which is the English translation of Aristotle’s term ‘phronesis’. Practical wisdom, prudence or prudential wisdom is, she says, an über-virtue, it is the virtue that unites and refines our other virtues, calibrating their expressions in appropriate ways at a given place and time. She draws attention to how, in a time of rapidly-changing technologies, we lack the courage that is needed for the relationship between phronesis and other virtues.

AI technologies have the power to convince us that there is a mind, an intelligence, on the other side. Chat GPT and other AIs are not powerful bodies on the other side, nor mysterious machines that might save us or kill us, but just an illusion – the same illusion that killed Narcissus.

In ‘The AI Mirror’, Vallor invites us to rethink AI, not as a force that propels us to the future but as a reflection of our past. Some of the key areas where AI is applied to space are in autonomous spacecraft and rovers. AI helps to navigate unknown terrains, avoid obstacles and make real-time decisions without direct human input. On Mars, NASA's Perseverance rover uses AI for hazard avoidance and efficient route planning. In astronomy, AI processes vast amounts of data from telescopes, helping to identify exoplanets, classify galaxies, and detect phenomena like gravitational waves or supernovae. And in Earth observation, AI analyses satellite imagery to monitor climate change, natural disasters and environmental conditions. AI predicts and identifies potential hardware failures in spacecraft, satellites and other systems, ensuring timely interventions and extending operational lifespans.

AI-driven systems such as virtual assistants (e.g. CIMON on the ISS) provide astronauts with information, task reminders and problem-solving support. AI monitors astronaut health and predicts medical issues, aiding in diagnosis and treatment. It also optimises complex mission parameters, such as launch trajectories, orbital transfers and resource allocation, as well as being used for scheduling satellite constellations and communication relays.

In addition, AI analyses data from radio telescopes to identify potential signals of extraterrestrial origin for SETI (the Search for Extraterrestrial Intelligence). It also enables satellites to perform self-diagnostics, adjust to environmental changes, and adapt to mission requirements without human intervention. AI processes satellite data for urban planning, agriculture and disaster response; and it helps simulate and model cosmic phenomena, planetary formations, and potential future scenarios for space exploration and settlement.

It also has an important role in identifying and predicting the movement of space debris, facilitating collision avoidance and debris removal strategies. It assists in prospecting and extracting resources from celestial bodies like the Moon and asteroids, crucial for sustainable space exploration.

AI systems in space must be robust to radiation, extreme temperatures and long-duration missions. They must also operate with limited computational resources and intermittent communication with Earth. AI is expected to play a pivotal role in enabling human settlement on other planets, designing self-sustaining habitats and exploring distant exoplanets.

AI in space is revolutionising our capabilities and understanding, making ambitious space exploration missions more feasible and efficient. AI can successfully merge with different kinds of robotics and can begin to scaffold the development of cognition in the world. But Vallor doesn’t believe that we can build the necessary sensors and cognitions into robots for them to have the same cognitive experience as humans. There is also the question of whether consciousness is something biological that we do not have capacity to replicate in other kinds of matter – Vallor remains agnostic on this point.

Some of the scientists I spoke to made the assessment that no robotic research on Mars could be as successful as research done in person by humans (Kim Binsted

and Charles Cockell). Humans know how to navigate a situation, think and react. They can solve difficult tasks and equations of a nature that is not currently possible with advanced AI or any other technology.

Using AI in space, Vallor explained when talking about the 'AI mirror', is a lack of prudence and phronesis, and she said that there must be ethical considerations when implementing an AGI in our extraterrestrial human life. For the first time ever, we will have the chance to start not from the bottom of our social evolution, but from a place and time where we have already created moral standards, when issues such as the death penalty or public killings are not commonplace and we take a more ethical view. We are now consciously aiming for ethical standards and solutions.

Considering our social evolution, many sociologists consider the funeral as the first core movement when we can say that our civilisation started. Mourning is not unusual in developed species – we know that elephants, whales, dolphins and chimpanzees mourn – but the ritual of burying and understanding the burial place as somewhere special, did not just bring the awareness that we are mortal beings, but also created a fear of being mortal, a fear of death.

Developing techniques and tools eventually brought us from the agricultural to industrial age, and now into the technological age, as we created our great institutions such as schools, libraries, law courts and governments that help us live a good life and flourish. When we make another giant leap and leave behind our Earthen life, we should not surrender ourselves to the past, to those tools we created that are now used as mathematical algorithms to solve things that are already broken. Instead, we should give a chance to new extraterrestrial humans who can flourish because they understand science and technology. As much extraterrestrial technology is likely to be combined with nanotechnology and AI, I believe it will be very hard to separate them. It is impossible to imagine that building an object on Mars with nanotechnological material, which will be self-sustaining and self-replicable, will be done without the tools of AI; after all, AI will be able to store information for the 'nanotechnological DNA' that will make the construction work.

9.1. Superintelligence in Space

Nick Bostrom (2014) proposes the concept of superintelligence, which can help control the risks of nanotechnology, including fundamental collapse and wrongdoing by AI. He puts forward a very important time scale: to build the superintelligence first, and then the nanotechnology. We will achieve the best outcome, he says, if we can build a superintelligence only after we start using the bigger parts of our brain, so we can in a sense duplicate our cognitive functions and methods from our brain into the developing system of superintelligence.

The process to rise to this 'stage' of superintelligence is extremely complicated, and Bostrom offers a proper methodology of the process that could one day lead to the design of superintelligent machines. He explains it is important to acknowledge that we are not there yet, because we are not ready. We must start using more of our brain and stretch to the parts that are there but not in use yet; only then can we create a superintelligence that can copy all our cognitive functions as well as emotional functions.

Currently, machine cognition is vastly narrower than human cognition. We are not close enough yet to developing human-level general intelligence. Bostrom's core question is (2014,75): "If and when such a machine is developed, how long will it be from then until a machine becomes radically superintelligent?"

While it is widely accepted that current AI systems have no moral status, this will be changed if, in the future, humanity is able to design an intelligent supermachine. In their article 'The Ethics of Artificial Intelligence' (2011), Bostrom and Yudkowsky consider the ethical question of if or when thinking machines can be created. Machines have become incredibly advanced since 2011, but we can all agree that they still don't have a moral status (not including the robots from sci-fi movies, where their moral status is often granted inside the story, for example in 'Star Wars', 'Star Trek' or even the documentary film, 'Good Night Oppy'[46]).

[46] The documentary film 'Good Night Oppy' (released in 2022) is a real story based on two NASA rovers, Spirit and Opportunity ('Oppy'), which were sent on a mission to Mars to find traces of water and life. After they landed on the red planet in 2004, they were supposed to operate for 90 days, but the duration of the mission was extended, in the case of Opportunity to an amazing 15 years. The film shows how during this time scientists established very personal relationships with the rovers, playing them music and sending them messages, while the rovers sent back data and findings. The relationship between rovers and scientists from the perspective of the ground team became very personal and, in many situations, emotional. Finally, when Oppy reaches its end, the camera captures the distress, sadness and emotional reactions at ground control,

Bostrom and Yudkowsky propose two criteria that are commonly accepted to grant a moral status, either separately or in combination: sentience (the capacity for phenomenal experience or 'qualia', such as the capacity to feel pain and suffer) and/or sapience (a set of capacities associated with higher intelligence, such as self-awareness and being a reason-responsive agent). As mentioned earlier, most Western cultures now acknowledge that many animals do have qualia, therefore they do have some moral status. From an anthropocentric position, only human beings have sapience, which gives them higher moral status than non-human animals, although there is a suggestion that there are borderline cases. Humans with severe mental delays are, to Bostrom's and Yudkowsky's regret, sometimes called "marginal humans". Meanwhile, some non-human animals such as great apes pose at least some level of sapience.

Some may adopt another anthropocentric view, that some beings have more significant interests than others. They might consider it better to save humans rather than birds, not because humans have higher intelligence and a higher moral status, but because humans have a more significant interest in having his or her life saved than the bird.

Based on their assessment, Bostrom and Yudkowsky claim that an AI system has some moral status if it has a capacity of qualia, such as an ability to feel pain. A sentient AI system is more like a living animal. The underlying idea for this moral assessment is an expression in a stronger form as a principle of non-discrimination. Their suggestion has two principles.

1. Principle of Substrate Non-Discrimination: if two beings have the same functionality and the same conscious experience, and differ only in the substrate of their implementation, then they have the same moral status. The Principle of Substrate Non-Discrimination does not imply that a digital computer could be conscious or have human-like functions; the substrate makes a difference to sentience and functionality, therefore in this context is morally relevant.

2. Principle of Ontogeny Non-Discrimination: this is an additional principle proposed by Bostrom and Yudkowsky. Since AI systems are artificial products of deliberate

who knew all this time that the end would come. Because this story is based on real events, real people and stored in diaries as well as cinematographically, it does require a different analysis to sci-fi stories, yet the robotic probes are still not to be considered to have a moral status.

design, it is not fundamentally relevant to their moral status. So, if two beings have functionality and the same consciousness experience, and differ only in how they came into existence, they have the same moral status.

Bostrom and Yudkowsky make the point that the idea of moral status was differently absorbed in history; some people had a 'better' moral status if they came from a certain bloodline, a privileged family, a certain caste, etc. They don't believe that in cases where designs were used to deliver subjects of moral status – for instance fertilisation, family planning, assisted delivery – there is any necessary implication for the moral status of the progeny. They support this assessment with the example that even those who would oppose human cloning would treat the human-born clone with the same moral status as other humans.[47]

The Principle of Ontogeny Non-Discrimination would not apply in a case when, in their example, a procedure was carried out during conception or gestation that meant a human foetus developed without a brain. That anencephalic child would have the same moral status as any other anencephalic child. But compared to a normal newborn, an anencephalic child has different qualitative functions as it has no brain, so it does not have the same functionality and the same conscious experiences. Ethical views are consistently changing in parallel to human social evolution, and no data is available on the moral status of human clones as we officially do not have any yet.

Based on the of Principle of Ontogeny Non-Discrimination, a being's ontogeny has no essential bearing on its moral status. But it does not deny that facts about ontogeny can affect what duties particular moral agents have toward the being in question. Bostrom and Yudkowsky are referring here to duties, for example of parents towards children, which are consistent with the duties of those who created an artificial mind in an AI system. Based on the Principle of Ontogeny Non-Discrimination, they have a duty to the artificial mind they created and not to other artificial minds, even if the minds in question are qualitatively similar and have the same moral status.

[47] In the dystopian novel 'Never Let Me Go' by Kazuo Ishiguro, human clones are dehumanised and treated as subjects with no moral status. The central theme of the novel is an exploration of the ethical implications of cloning for organ donation.

Perhaps a better question is when does superintelligence become a subject of a moral status? Bostrom's suggestion is to build super machines, which will function similarly to, or the same as, our brains; they will be able to undo and use all our cognitive functions and it would be at some level a replica of our carbon-based intelligence, but much better because it will not be made of carbon therefore being more resistant and, most importantly, be able to upgrade its ability to become even better and smarter.

But, as mentioned earlier, the design and creation of superintelligence should not happen yet. Around million years ago, our ancestors left the rainforests and savannahs, and our development was based on efficient productive technologies. The rise of the human population began with the adoption of agricultural life. It took thousands of years for some individuals to develop special skills; our collaborative and social way of living increased the chances for the invention of better productivity, which resulted in the growth of human civilisation and eventually its spread to all the continents of globe.

Bostrom asks how long it will take for machines to become "radically superintelligent"; he thinks it will it take a long time for a machine to reach the human baseline, which represents the effective intellectual capabilities of a representative human adult with access to the information sources and technological support that is currently available in developed countries.

Bostrom's assessment is that the current AI system is below the human baseline on any reasonable metric of general intellectual ability. His positive view on the matter is that eventually machines will reach parity with the combined intellectual capability of all of humanity, which Bostrom calls the "civilisation baseline". Eventually, if the system's abilities increase in growth, it will reach the level of "strong superintelligence". This is a level of intelligence that is far greater than contemporary humanity's combined intellectual resources. This is the stage of a 'grand take-off', as Bostrom calls it, and the system may continue to gain in capacity thereafter.

It is important to acknowledge that the take-off phase is also an opportunity, as when the system passes this landmark, which Bostrom calls "the crossover", beyond this point the system's further improvement is manly driven by the system's own actions rather than by work performed upon it by others. Here Bostrom predicts three

scenarios in which systems progress from human-level intelligence to superintelligence. They are based on steepness: slow, fast and moderate (77-78, 2014).

Slow take-off would allow plenty of time for the news to get out. Meanwhile moderate take-off would most likely be held in a secret development in the hands of small groups, perhaps academics working incognito, for example under a military research programme. They would be under surveillance, and this monitored process would be undertaken by small companies or states, who would be able to shut down the project just before take-off. Moderate take-off scenarios could potentially create geopolitical tension and social and economic turbulence, because a small group of people or just one country who is a host would gain from the unfolding transformation. One example Bostrom mentions is how this scenario would lead to demonstrations of workers whose labour would be replaced by the superintelligence in a very short period. Fast take-offs would happen so quickly that no one could have any meaningful reaction to it.

Bostrom speculates how long it would take and how we could complete a whole human-brain emulation, if we want to design superintelligence based on our human neurocognitive functions. He acknowledges that it would be hard to attain roughly human levels of cognitive ability, and that it is hard is to get from there to superhuman levels, for instance designing high-level human concepts like virtue ethics for superhuman intelligence (227, 2014).

Our human brain is a complexity of emotions and understandings, and even with the improvement of algorithms, it is hard to predict when a programmer would be able to design a computer that would be a superintelligence. How could a programmer transfer values, or for instance virtue ethics, into superintelligence, and in this case would virtue ethics still be virtue? As explored in the second chapter, virtue also means the whole-life practice of learning, stretching and upgrading our virtues. Can superintelligence after all act as a virtue, and why would it, when the point is constant practice? Virtue does mean something that is the highest value, but also with the element that it is able to reach to the higher level of its virtue.

We are only speculating as to what extent superintelligence can evolve. As we can claim that so far humans are the only sophisticated intelligence evolved on Earth,

we can also predict that with our skills, tools and intelligence we are able to design superintelligence that can demonstrate higher intelligent domains and functions than we are capable of. And because of our weakness – we are, after all, made of organic and mortal cells – we can predict that superintelligent non-organic machines can live for many years, if not forever; depending on whether AI can be self-sustained, self-replicable and in constant demand for an upgrade to a better system. Bostrom indicates that it could be so intelligent that it could find the equation for black holes, or something that we are still not capable of understanding. It could go either way: to help us live a better life and support or even extend our mortal human life, or it could overpower us, perhaps enslaving or even destroying us, and if so, where then is the point of our human virtue and life?

The core question for Bostrom and Yudkowsky (2012) is: “How do you build an AI which, when it executes, becomes more ethical than you?” And this is the ultimate question in machine ethics. As an example, they ask a question: "What if Archimedes from Syracuse had been able to create a long-lasting artificial intellect with a fixed version of the moral code of Ancient Greece?” On this premise, we must accept that ethical views are changing as well as moral status within societies. What is ethical for our civilisation was not necessarily ethical for those before: Ancient Egyptians as well as Ancients Greeks and Romans had slaves, which is not acceptable now. Bostrom and Yudkowsky here consider our situation as analogous: that we should not invent a “super” version of what our own civilisation considers to be ethical.

The machines we create are in a position to be stronger, faster, more trusted and better overall than us; they will be designed to find results faster than the human mind, and if we are serious about developing AI, these are challenges that we must meet. Regardless, we must in this case commit ourselves to seeking human-superior, not just human-equivalent niceness. If machines can create internal processes, then machines have moral status.

To Vallor, AI is a tool, a mirror we created during our technological evolution, and not different to other tools such as bows and arrows; to Bostrom, AI is a potential agent. Bostrom suggests that a synthetic AI could be created de novo (2014,210), or that machine emulations of our brain could, through successive modifications and enchantments, increasingly depart from our original human form. One possible

scenario given by Bostrom is that after emulation technology is developed, progress in computer science and neuroscience continues. Digital minds now serve as researchers and test subjects. This makes it possible to isolate individual cognitive modules in an emulation and to hook up to modules isolated from other emulations. After a period of training and adjustment, different modules could collaborate effectively; modules that conform to common standards could more quickly interface with other standard modules. This results in two outcomes: it makes standardised modules more productive, and creates pressure for more standardisation. These emulations can now start outsourcing vast portions of their functionality.[48]

These discrete human-like intellects are combined, and optimal efficiency is achieved by grouping their capabilities in aggregates that roughly match the cognitive architecture of the human mind. Bostrom's scenario here opens up a possibility that by building these new architectures that cannot be well implemented on a human biological neural network, a new design space opens up, which does not need familiar types of mentality.

Considering humanity living an extraterrestrial life, AI together with nanotechnology will deliver a core support to their life. Humans will be able to flourish and live a good life based on the use of AI and nanotech.

Bostrom's suggestion is to study the human brain by slicing it, particularly those parts we are not using yet, to learn how neurons and cognitive functions work. He acknowledges that for the time being this is not possible, and that this kind of research would most likely kill the human during the research project. He thinks that sometime in the future this kind of research will be possible and we might develop new techniques and procedures to perform such experiments without harming subjects. Another important suggestion is that we do not rush to build a superintelligence before we use a bigger capacity of our brains. When we are able to do so, we will develop much better logical, neuroscience and cognitive functions, so our designed product of superintelligence will be more advanced.

[48] Bostrom comments: "Why be articulate when you can hire Coleridge Conversations to put your thoughts into words? Why make decisions about your personal life when there are certified executive modules that can scan your goal system and manage your resources to achieve your goals better than if you tried to do it yourself?" (2014, 211)

If we do create superintelligence, can algorithms of its design react to virtue as well? Can it through practice progress to better and better virtue? If virtue is achieved through constant training and practicing, how will this work in the case of a supercomputer?

There is a worry that in the current geopolitical situation, the regulatory changes made by Trump's administration will allow SpaceX, according to its owner Elon Musk, to land the first un-crewed Starship rockets at the first available orbital window[49]. This would be the end of 2026 or early 2027, meaning that the first crewed missions to Mars could happen as early as in two years after that. Humanity needs nanotechnology in order to survive on Mars, so Bostrom's plan at this point faces a great challenge, especially regarding his premise that nanotechnology should not develop before superintelligence, as mentioned in the previous chapters.

In the past few years, Bostrom (2024) has turned away from the pessimism and predictable dangers of AI and says there is a chance of a positive outcome if we as imperfect creatures develop a perfect system that can help us with practicing our virtues and achieving a better and happier life. It could also create something that can navigate our lives and also protect us, delivering a system that is a pure virtue itself. Bostrom admits that the introduction of machine superintelligence would create a substantial risk, but on the other hand it would reduce many other risks, such as the risk from volcanos, natural pandemics and asteroid impacts. In extraterrestrial human life too, superintelligence could help protect against sandstorms and earthquakes on Mars, deploying countermeasures against such hazards or minimising their power in order to protect and defend. Superintelligence could also eliminate or reduce many anthropogenic risks, such as accidental destructions and the risks related to the new technologies.

There is also a possibility that superintelligence could prevent many non-accidental anthropogenic existential risks that can result in global coordination problems: the risk of war, technology races, undesirable forms of competition, evolution, and 'tragedies of the commons' (2014,283). Bostrom here suggests an agreement that could deliver superintelligence earlier in order to prevent other hazardous situations: superintelligence could prevent the development of synthetic biology,

[49] Every 26 months, Earth and Mars align favourably, creating an orbital window. This is an opportunity to reach Mars from Earth with the shortest distance.

neurophysiological manipulation and molecular nanotechnology. Here Bostrom understands superintelligence as a positive, superior force of surveillance, and not as, for example, a designer of synthetic biology. Bostrom says the riskiness of creating superintelligence will decline in time, when humans are capable of learning more.

SpaceX's current plan is to potentially land the first crewed mission on Mars by 2029, but it is obvious that on a planet where no one can enforce any regulations, rules or laws, nanotechnology will kick in within the first moments of extraterrestrial life. It will help with the production of water, oxygen and other necessary elements to survive on the barren planet, as well as in the long run terraforming and possibly nuking Mars.

The second chapter of this thesis introduces our problematic relationship to potential alien life, with the great assumption that alien life is organic-based and perhaps even related to life on Earth. To stay open-minded, this life could well be silicon-based or based on AI. At this point we must consider two possibilities. The first is that silicon or boron-based life already exists either in our galaxy or galaxies nearby, which raises the question of whether we arrived early or late during the existence of the Universe. If we are late, 'others' may have already passed the organic evolution process and have been able to store their lives – thoughts, memories, feelings – into the longevity of a silicon-computer machine or other technologically advanced life. In that case we could assume that either we are just following a process of the Universe others have already advanced in, or we could go a separate way, as Bostrom is suggesting, developing a sophisticated AI, which can entirely change, take over and replace our organic human life. Based on this assumption, it is that "cosmic superintelligence" that can decide whether we organically vulnerable creators have moral status.

In any case, living in an extraterrestrial environment pushes the necessity of using AI. There are predictions that AI will develop much faster and broader in extraterrestrial economies than on Earth, with the assumption that extraterrestrial societies will be less regulated. Those environments will face a change of social roles; a good example is the labour market. It is hard to imagine that in lethal environments, with severe cosmic radiation and no oxygen outdoors, there will be human workers building a Martian village. For the next decade or so we will see

mostly machines doing that, operated by AI and nanotechnological designs. Rapid progress and demand in world economies will soon be driving AIs with sufficiently advanced mental states; some of these states will have moral status and some may count as people. Bostrom and Yudkowsky say there is a possibility of making an algorithm with super-ethical behaviour, though they do not deny the challenges of such a design.

Bostrom's assessment is that machine superintelligence is a type of technology that is ambivalent to creating existential risk. On one hand, it could create a substantial existential risk, but on the other hand it could reduce many other existential risks from nature: an asteroid impact, extreme volcanic eruption, a natural pandemic… Because superintelligence is more capable than humans, it could also reduce many anthropogenic risks including accidents that are related to new technologies.

As mentioned, Bostrom predicts a scenario when superintelligence forms a 'singleton'. This could eliminate non-accidental anthropogenic existential risks that are the result of a global coordination problem, such as wars, technology races, unfair trading and unfair forms of competition and evolution. Bostrom's worry is that the rapid development and growth of certain technologies – such as synthetic biology, molecular nanotechnology, climate engineering, neuropsychological manipulation, and tools for social control that could drive societies to unprecedented regime changes and tyranny – will create unforgivable mistakes with irreversible consequences.

Bostrom's preferred order of arrival is that superintelligence comes before potentially dangerous nanotechnology. This way, superintelligence can act as a surveillance above the "new technologies and new tools" (283, 2014). His core argument is that superintelligence will, if it comes first, reduce the existential risk, not vice versa. As he says (284, 2014): "If we create superintelligence first, we will face only those existential risks that are associated with superintelligence; whereas if we create nanotechnology first, we will face the risk of nanotechnology and then, additionally, the risk of superintelligence." Even if the existential risk of superintelligence is vast, and even if superintelligence becomes the most dangerous of technologies, we could still expedite its arrival.

Bostrom does not believe in “the sooner the better” argument; he is certain that if the development of the machine intelligence revolution goes wrong, there is always a chance to either slow it down or wait for it to get to the level of the right progress and then continue with the plan. One of the core problems where things could go wrong in developing a machine superintelligence is a problem of control. It is only in the past 10 years that the control problem has become recognised as the most important to discover and deal with. Bostrom believes that the longer it takes for superintelligence to arrive, the more research will be done and the result will be more sophisticated. Also, if it arrives later, this will allow various beneficial background trends of human civilisation to play out.

Thinking about the control problem regarding nanotechnology, we are not yet able to handle nanotechnology responsibly, and we have a poor track record in handling powerful new technologies safely. Some claim that the atomic bombs dropped on Japan saved the lives of millions of people, but at the same time they took the lives of thousands and had long-reaching environmental consequences. If we are to build superintelligence on this premise, which one will we choose as ethically justifiable?

Bostrom is thinking optimistically about our human future: there might be fewer wars, humans will live better lives, people and nations will get along better, political integration might increase, there will be less dysfunctionality, and so delivering a common project of superintelligence will be more successful via sharing data and research. But the question remains whether, in a century or so, societies will eventually be more altruistic and more open-minded to achieve common projects.

Bostrom considers molecular nanotechnology as dangerous, with the potential to be a civilisation-ending technology if misused. He is not the only one predicting the possibility of a ‘grey goo scenario’, where powerful nano weapons, self-replicating nanorobots, highly efficient surveillance and other control mechanisms could take over.

Nanotechnology could be developed without adequate safety measures by malicious actors, rogue states, and accident-prone human organisations. In contrast, Bostrom understands superintelligence as a safety regulator that can serve as a safeguard against the misuse of nanotechnology. He believes that

superintelligence would be better at designing safe and controlled nanotechnology, avoiding the risks of human error or intentional misuse.

Superintelligence as a wiser, more careful and rational overseer would be able to ensure that nanotechnology will be used for beneficial purposes; at the same time, superintelligence would be able to optimise nanotechnology research far beyond human capabilities.

But Bostrom's view clashes with Elon Musk's latest announcement. As mentioned before, on his social media platform X, Musk announced a plan to land a crewed mission on Mars by 2029 (Kojima, Spaceflight - March 2025). This indicates that the use of nanotechnology will – as predicted in this thesis – start on another planet, and it will be substantial. Even though the first several crewed missions are considered to be predominantly for the purpose of science and not yet colonisation, astronauts and space tourists will depend heavily on nanotechnology.

Oxygen production will be possible with the use of advanced nanomaterials that will electrolyse oxygen extraction from the Martian soil, ice and air. Nanomembranes could purify water extracted from underground ice; in self-sustaining habitats, nanomaterials could prevent solar radiation with nano-coating; and self-replicable materials could be used to build the Martian habitat. Nanosensors and nanofertilizers could enhance the controlled-environment agriculture important for food production on the planet. Nanomedicine could provide rapid diagnostics and targeted drug delivery in an environment where medical resources are limited, without hospitals and health centres. Then, in the future, when colonisation starts, nanotechnology will play an even greater part in building villages and protecting them from solar flares and solar storms. Nanotechnology, therefore, accelerates the feasibility of Mars colonisation and reduces the risks related to resource scarcity, potentially also the risk of the collapse of society on Mars.

Bostrom is not necessarily against nanotechnology as it is, but he considers it a dangerous technology on Earth if no one can control it. So how can nanotechnology be controlled on a barren planet far away from Earth? The controversy is that, while nanotechnology is crucial for humans living and working on Mars, developing it before superintelligence could pose dangers that outweigh its short-term advantages. Yet waiting for the development of superintelligence will delay the

human mission to Mars, which is equally important for our development of superintelligence. Mars is not just a potential source of energy, but is also a scientifically crucial place where we can learn about the consequences of planetary disasters that could well happen to us.

However, waiting for superintelligence before using nanotechnology for critical missions (such as the colonisation of Mars) may not be practical. A compromise approach – where we develop nanotechnology with strong ethical oversight and incremental AI safety measures – could align both perspectives. In essence, there should be some level of AI regulation before advanced nanotech, but we should not necessarily wait for full superintelligence before making progress.

9.2. Techno-optimism and Transhumanism

Techno-optimism is a belief that technology will soon replace all the burdens of today's society: much labour, including forced labour, will be replaced by robots and other technological tools including nanotechnology. We are already living in a time where robots are rapidly replacing labour in most Western countries. Techno-optimism validates that technology will make society "better", which means different things for different people. A crucial part of techno-optimism is longevity: some believe that advanced technological achievements will enable us to live healthier and longer lives.

This leads us to transhumanism, the belief that advanced technology will radically improve human life and will transition us to a 'post-human' state. Among numerous influential transhumanists are Nick Bostrom and Ray Kurzweil, who believe that technology will radically extend our lives. Transhumanism has been defended by some as the natural extension of humanist and Enlightenment thinking, and criticised by others for its ties to racism and eugenics.

Some scientists and philosophers think that eventually we could improve our bodies and mortality with technology to the extent that we could live forever or for at least several centuries. Some even believe there is a possibility that silicon-based life has already existed in our galaxy – meaning there are or were living beings who have realised technological achievements such as completely preserving their thoughts,

memories and emotions, transferring them from their fragile, organic bodies to a computer ‘avatar’, so they can live forever.

The biggest question I am repeating is that we do not know whether we came early or late to living in our galaxy. If we came early, then it could be that life is not after all spread in our galaxy, we could be alone or we could be alone as advanced in intelligence, although there might be forms of primitive or less advanced life in the galaxy. Alternatively it is quite possible that we came late to the galaxy, and that all the ‘others’ are already preserved in a computer-like immortal life.

If we are able to see our planet from the perspective of an advanced alien civilisation, which is also on a higher ethical level than us, then it is quite clear. If they exist, they probably wouldn’t want to have anything to do with us unsophisticated beings anyway. We are waging Illegal, unfinished wars, our planet has borders that are reserved for those who live behind them, and those who want to enter are usually refugees with low social status. Our human lives are too short, and we needed many knowledgeable people and thousands of years to figure out that the atom is actually not the smallest unit of matter.

9.3. Is AI Machine Superintelligence a New Human Condition?

Hannah Arendt and Nick Bostrom represent two vastly different perspectives on the nature of human labour and the implications of artificial superintelligence (ASI) for human existence. Arendt’s conception of labour, work and action, as outlined in The Human Condition, provides a fundamental framework for understanding the role of labour in human meaning. Bostrom’s work on Superintelligence, meanwhile, explores the transformative potential of AI, particularly its potential to surpass human capabilities.

For Arendt, labour belongs to the vita activa, which she differentiates into three categories: labour, work and action. Labour is cyclical and necessary, tied to biological survival (animal laborans), while work (homo faber) involves fabrication and making a stable world. Action is the highest form of human activity, representing political engagement, discourse and the ability to create something new.

If superintelligence were to replace human labour, Arendt might argue that this does not necessarily strip humanity of meaning – after all, true meaning is not found in

labour itself but rather in action, the uniquely human capacity to shape the world through speech and shared deeds. However, a world where AI fully assumes work (the shaping of the artificial world) and labour (sustaining life) could mean that humans risk losing engagement with the world itself. If humans no longer act in a public realm, no longer deliberate politically, no longer forge meaning through shared experience, humanity could slip into a post-human condition where its agency is atrophied.

Bostrom, by contrast, does not begin with the human condition but rather with the trajectory of intelligence itself. He argues that once AI surpasses human intelligence, it could lead to an existential shift – possibly a singleton AI governing humanity's fate or a post-human transformation where biological humanity is no longer the centre of intelligence.

From Bostrom's perspective, replacing human labour with AI does not just change work but shifts the fundamental structure of intelligence and decision-making. This is not merely an evolution of the human condition but rather an ontological rupture: humanity ceases to be the primary locus of intelligence. If meaning is tied to agency and the capacity to set goals, then losing control to ASI may render humans passive spectators rather than autonomous agents.

9.4. Comparative Analysis: Evolution or Annihilation of the Human Condition?

The crucial question is whether this transition is a continuation of the human condition or its fundamental dissolution. Arendt would probably warn that if superintelligence eliminates the space for action, then humanity dissolves into a passive existence, marking an end to the public realm where meaning is created. Bostrom would argue that this transition could lead either to unprecedented flourishing or catastrophic obsolescence, depending on whether ASI aligns with human values or not.

If AI simply replaces labour (as mechanisation and automation have done before), then perhaps the human condition has evolved. But if AI assumes the role of decision-making and world-building (homo faber) while rendering human political engagement obsolete (zoon politikon), then humanity is not just evolving – it is transforming into something unrecognisably different.

Thus, the question is not simply about labour but about agency. If AI takes over work but humans retain political and creative action, humanity may persist in an altered form. If AI governs all meaningful decisions, then humanity risks losing the vita activa entirely, marking the end of what Arendt calls a world fit for human habitation. In this scenario, meaning itself might become a vestige of a past, human-centered epoch, replaced by something we cannot yet conceive. The question remains how will our virtues play in these scenarios?

10. To Live Forever

For many of us this is an utopian question, but some people hope to shape technology to the extent that it will enable us to live forever. Many people on this planet would love to live forever, and humans have had all kinds of beliefs that are not unique to this civilisation but also applied to ones long before ours. The Ancient Egyptians, Greeks and Romans believed in life after death, as do most of today's Christians, Muslims, Jews and Hindus. But can we even imagine what living forever would be like?

Stephen Cave (2023) takes a vigilant stance on this. In a debate co-authored with John Martin Fisher they build their understanding of longevity on two criteria: prudential and ethical. The prudential view is more practical: the idea of living forever brings concerns that eventually people would get bored as they would have tried everything. Cave detects four problems with immortal lives: boredom (there are a limited number of pleasurable activities that a person can engage in); ennui (even before every possible pleasure becomes boring, the repetition involved in an endless life will lead to depression and staleness); meaninglessness (if person lives a long life, things will eventually repeat and contradict and counteract each other); and procrastination (we complete many things we do in a zone of time, so if time becomes infinite because we are immortal, many things lose value. It would make it impossible to make rational decisions about how to spend your time and would lead to a range of traps, conditions and ruts.)

The ethical questions related to living forever are also a concern for society. Would we prevent overpopulation because of the expansion of humanity by moving to other planets, moons in our solar system and beyond? The consequences of overpopulation could lead to political decisions like preventing people from having

children. Reproduction and looking after and bringing up our children is one of the core elements of life as we know, not just for humans but also for other animals and insects on this planet.

Cave doubts that it is even possible for humans to move permanently to other planets, but he also does not believe it would be a positive outcome for humanity, as it raises many questions about. But he is most likely wrong in this prediction, as the existing evidence from private companies suggests this scenario is not something that will happen in a distant future, it is happening now. The space market is one of the fastest-growing markets on this planet; in 2021, Statista recorded its annual turnover as approximately $496.3 billion. It recorded an annual growth of between 9-11% a year for the past 12 years, even during the pandemic. We should also not underestimate the fact that the life expectancy of people in Western societies is much longer than in Victorian England, and the predictions that the millennial generation will live on average for over 100 years.

I have another claim against Cave's arguments, and this is by the laws of physics. If you travel in a rocket close to the speed of light (these kinds of vessels exist only in theory for now), the distances between you (in the rocket) and for example the Andromeda Galaxy (the closest to the Milky Way, where we are) shrink from your perspective. Physicists like Brian Cox would support this claim with the example of the Large Hadron Collider (the world's largest and most powerful particle accelerator) [4]. So according to the laws of physics, if you can build a spacecraft that gets very close to the speed of light, you can shrink the distance to the Andromeda Galaxy and you could traverse that distance in principle in a minute. However, the downside is that if you came back to Earth at the speed of light to tell everybody what you found there, at least two and a half million years would have passed on Earth. In the LHC, protons travel around a 27km ring at 99.9999991% the speed of light. At that speed, distances shrink by a factor of 7,000. So we could, in principle, explore the galaxy and beyond, but to communicate what you found is forbidden by the structure of the Universe.

If we were to live forever, the benefit is that this time travel could become meaningless. If we can someday become a "traverse civilisation" and spread across the Universe, then Cave's arguments for not living forever become meaningless, and the importance of living forever would benefit the communication and wellbeing

of citizens across the whole Universe. There is a value to being able to travel vast distances in very little perceived biological time, which enables access to many rich experiences in different parts of the Universe: you can only do this if you live a very long life. So, Cave is missing the chance to preserve our virtues and to practice completely new, perhaps alien, virtues.

CONCLUSION

The space sector has undergone remarkable expansion over the past decade. Notable developments include NASA's Artemis programme, which aims for a permanent human presence on the Moon, and SpaceX's projected crewed and uncrewed missions to Mars, which could materialise as early as the end of this decade. Simultaneously, the proliferation of expired satellites has contributed to the significant accumulation of debris in Low Earth Orbit (LEO). These trends underscore the urgent need for rigorous ethical analysis in space exploration.

While several scholarly works – for example, "Ethical Issues of Human Enhancements for Space Missions to Mars and Beyond" – have sought to raise pertinent ethical questions, they often lack a sustained and systematic ethical debate or comprehensive review of ethical frameworks. Many ethicists who attempt to evaluate human life in extraterrestrial environments tend to favour utilitarian ethical theory, positing it as the most appropriate approach given the realities of long-duration missions in hazardous environments. Such missions frequently require strict hierarchies and chain-of-command structures akin to military organisations, with roles such as commander, deputy, and chief of staff defining operational conduct.

While this might indeed remain a dominant model, my perspective – shaped by active involvement as a member of the Mars Society and Fellow of the British Interplanetary Society – suggests that human expansion beyond Earth will not be limited to military-style missions. Instead, it is likely to include a diverse population comprising billionaires, philanthropic supporters of private or semi-private initiatives, and ordinary people. My own proposal for a "Panopticon on Mars" envisions even a small, initial settlement as the foundation of a society, rather than a purely militarised outpost.

In this research, I therefore advocate for an assessment grounded in virtue ethics. This approach is crucial for one important reason: the virtuous agent strives consistently for the best possible action, while recognising the inherent gap that leaves space for improvement and moral growth. In unpredictable and often lethal extraterrestrial environments, strict utilitarian reasoning can fail individuals in

complex or unforeseen situations. I analyse these challenges in detail in Chapter 3 of this thesis, drawing on both predictive scenarios and examples from popular cinema to illustrate the shortcomings of utilitarian ethics in such contexts.

While I appreciate existing scholarship that calls for serious ethical assessment of human life beyond Earth, I have yet to encounter any work that systematically applies an ethical theory to the most common questions faced in extraterrestrial settlement, while also justifying why the chosen theory is the most suitable.

Private space companies such as SpaceX, Blue Origin and Virgin Galactic – but also advanced space programmes in global economies such as the USA, China and India – have opened new horizons. The presence of private companies in the expanding universe is opening a political debate about the democratisation of space, as well as boosting the space market with an annual growth of 9-11% in the past decade. As a sustained human presence in space raises philosophical and ethical questions, I propose perhaps the most important one: are we venturing deeper into space as good citizens or as cosmic vandals?

The democratisation of space is taking us from our home planet towards barren, yet uninhabited, planets and moons, but it also reminds us that there is plenty of room in space not just for astronauts, but also for billionaires and space tourists and soon for normal citizens. The proposal of a Panopticon on Mars is an ethical concept, which is based on philosophical questions and ethical reviews, and where normal people like nurses and teachers, who cannot afford to buy an expensive ticket, could live and work on Mars. With the democratisation of space, the questions of why we should leave our home planet became irrelevant.

Advocates for extraterrestrial humanity and ambassadors of humans occupying Mars are trying to convince us that going deeper into space is our duty. We are running out of energy resources on Earth, and we must also learn about our past and our future. Mars will be the first destination where humans can live and work permanently and where our civilization will become extraterrestrial.

Some philosophers claim that leaving places and acquiring new habitats is in our DNA, as we have done it throughout our human history on Earth, and we are now taking further steps. With this giant leap towards extraterrestrial civilisation, our Earth-centric and anthropocentric character will leave gaps for moral judgement.

This thesis assesses several important cases where we can strive or fail on our moral judgment. It also foresees scenarios and predictions, some based on cases we know and some on the situations which we are yet to conceive. The questions we have about terraforming other planets and living in lethal environments in exchange for giving up things we consider ethical on our home planet such as freedom of movement, autonomy and bodily autonomy are hard to answer with the ethical presumptions we have now.

Another ethical view on extraterrestrial human life comes from the American philosopher Mary-Jane Rubenstein, who argues that the will and power of humanity to turn extraterrestrial is the dangerous religion of a corporate space race.

Rubenstein is convinced that all the scientific achievements and investments from private companies over the past few decades to conquer space are nothing more than another religion, which she names Astrotopia. She looks into parallel mythologies behind the colonisation of Earth and space, as well as how we can build a better future on Earth and in space.

She directly confronts the president and founder of The Mars Society, Robert Zubrin, on his plans to colonise Mars, stating that on Mars he wants to create “something new with clean hands” (Rubenstein, 2022,60). Although there is no evidence this is Zubrin’s intent, she reminds him that European settlers also thought they were creating something new when colonising the Americas, and they also believed that the new world was empty. She reminds us of the consequences of European colonialism on various ecosystems, as well as the treatment of indigenous First Nation people by settlers.

The concept of Astrotopia is that as crises multiply on Earth, including those in the environmental, political and public health spheres, there is the dawn of a new space race, where governments team up with celebrity billionaires to exploit the cosmos for human gain. In Rubenstein’s account, billionaires like Bezos and Musk share an elemental utopian enterprise, the salvation of humanity through the exploitation of space.

In his books ‘Sapiens’ (2011) and in particular ‘Homo Deus’ (2016), Yuval Noah Harari talks about a new concept of religion, which will unlikely emerge from the orthodox beliefs and practices that are rooted in places like Afghanistan and the

Middle East. His prediction is that this will come from research laboratories in somewhere like Silicon Valley, run by hi-tech gurus, who have nothing to do with God and everything to do with technology (Harari, 2016, 409).

Harari divides new techno-religion into two types: techno-humanism and data religion. The first example leads humanity to the creation of new superhumans. Techno-humanism is the acknowledgment that homo sapiens as we know them have run their historical course and will no longer be relevant in the future. The right path is to use technology to create something substantially better, perhaps immortal homo deus, a superior and upgraded human model.

Homo deus will still retain some essential human features, but will also enjoy upgraded physical and mental abilities. It is a new creation by science, philosophy and technology, which will enable homo sapiens to be capable of performing actions that are currently limited due to our biological and in some cases social boundaries. Broadly speaking, it is a superior human model, created by humans and supported by AI to the extent that even the most sophisticated nonconscious algorithms would not be able to win against its mind. As of 2025, AI remains unable to replicate our cognitive abilities. The thinking is that humans must actively upgrade their minds if they want to stay in the game, because our intelligence is decoupling from consciousness as non-conscious intelligence develops at a breakneck speed.

On the other hand, data religion argues that humans have completed their cosmic task and should now pass the torch onto entirely new kinds of entities.

To advance the arguments developed particularly in Chapters 8, 9, and 10 of this thesis, it is worth noting that both Rubenstein and Harari foresee humanity as standing at the threshold of a new, complex, and potentially unprecedented transformation: the creation of a new form of species. This transformation is grounded in emerging mythologies – such as the pursuit of immortality and the vision of a self-sustaining extraterrestrial existence. Rubenstein frames this within a religious paradigm intimately connected to space exploration, while Harari interprets such narratives as modern mythologies. In contrast to their primarily Earth-bound projections, this research remains firmly focused on the ethical and philosophical implications of extraterrestrial humanity – human life established and sustained beyond Earth.

In the case of Mars, ethical questions and dilemmas remain wide open until we discover if there is life on the red planet. If there is, this could change our view in two ways: regarding Mars itself, do we have the right to go to the planet and destroy its ecosystem? And, since finding life on Mars is proof that life is spread in the Universe, should we not go to other objects in our solar system and beyond where we think life could exist, even in a primitive form? Other objects in our solar system where we could potentially detect life as soon as in the next few decades are Jupiter's moon Europa, and Saturn's moons Enceladus and Titan.

The most acceptable theory claims we all evolved from the Kenyan valley, and with the help of our inventions and technological achievements we are now heading towards a very different form of human life. As Shannon Vallor would say, when we created the bow and arrow, our human family grew bigger; there were more people to seek happiness, to flourish and to live a good life. But what is the new frontier?

Religion asserts that all humans are subject to a system of moral laws that we did not invent and that we cannot change. Most Western religions promise a good life after death if, of course, you are capable of maintaining the practice of religious rituals and live according to the rules created by that religion. Spiritual journeys are different. In these cases, people can take mysterious journeys towards unknown destinations with many questions about their existence, for instance: Who am I? What is good? What is the meaning of life?

Harari thinks that, from an historical perspective, the spiritual journey is always tragic, for it is a lonely path fit only for the individual, rather than entire societies. Human cooperation requires firm answers, rather than just questions.

Mythology has always played a part in human life, throughout its evolution. Harari asks: who are the true believers and what do they believe in? It is a straightforward answer: you don't have to be religious or spiritual. As Harari points out, we all ought to believe in something. Thomas Jefferson in human rights; Hammurabi in the principle of hierarchy. The main danger of imagined orders is that they are always in danger of collapse, because they depend on myths, and myths vanish once people stop believing in them. Furthermore, France Veber concludes in his book Znanost in vera (Science and Religion, 1923) by challenging the then - prevailing view that factuality is a property inherent in objects. Instead, he argues that what

makes something truly factual stems from an unknown X, which he later associates with a divine ground. Over time, his position evolves so that factuality is not simply an attribute but is ultimately rooted in an act of God.

Some imagined orders are implemented in our everyday life to protect our wellbeing, to guide us through a good life, so we can be happy, we can flourish, and we can complement the virtue ethical perspectives. As a society we have established armies, police, courts and prisons that force people to act in accordance with the imagined order. Harari says that imagined orders cannot be sustained by violence alone; they do require some true believers as well. Imagined order can be maintained only if large segments of the population, and in particular large segments of the elite and security forces, truly believe in it, says Harari. His example for this is Christianity: this belief would not have existed for the past 2,000-plus years if the majority of bishops and priests didn't believe in Christ. And American democracy would not have lasted over 250 years if the majority of presidents and congressmen failed to believe in human rights. Also Harari points out that the modern economic system wouldn't have lasted for this long if the majority of investors and bankers failed to believe in capitalism. We cannot physically touch Christianity, capitalism, or human rights laws. Like a unicorn, we have no proof of their existence, but we know they all exist, so some call them religions.

However in Astrotopia, Rubenstein presents a sharp critique of the way space exploration is increasingly cast in religious terms. She argues that the vision of colonising other planets is often infused with narratives of salvation, transcendence, and cosmic destiny – echoing the very religious ideologies that such projects claim to leave behind. For Rubenstein, this spacefaring vision operates as a secular religion in disguise, masking techno-utopian ambitions in messianic language. Rather than viewing space exploration as a neutral scientific endeavour, she frames it as a dangerous myth that risks replicating colonial, extractive, and hierarchical logics – only this time beyond Earth.

Importantly, Harari does not dismiss these imagined orders as mere delusions; rather, he acknowledges that they are essential for collective functioning, cohesion, and progress. If space exploration begins to operate as a new form of belief – one that captures the imagination, commitment, and trust of individuals and institutions alike – then, according to Harari's logic, it may come to function as a constructive

social framework. In this case, it becomes necessary to develop ethical principles suited to this new frontier, such as space ethics or a moral code for extraterrestrial humanity.

Seen in this light, Rubenstein's critique begins to lose some of its force. If people genuinely believe in space science as a meaningful and shared human pursuit – not merely as elitist escapism – then they must be given the philosophical and ethical tools to engage with that belief responsibly. Just as religion has historically offered a framework for moral guidance and collective purpose, so too might space exploration, if approached with critical reflection and ethical foresight. Rather than dismissing it as a false utopia, we might ask instead: what kind of future are we imagining, and how can we ensure that belief in the stars is grounded in responsibility, equity, and care?

As history teaches us, with every new technological invention we changed as a society and at the same time our ethical credentials, assessments, and sometimes ethical norms changed as well.

With the invention of the bow and arrow, we became travellers, first in the local forests and ecosystems, and later elsewhere around the globe. With the discovery of copper, we became traders and started building structures in our societies. Later on came law, courts, governments, schools and temples. From the invention of Watt's steam engine industrial revolutions started and we slowly abandoned slavery; society gave greater importance to more of its members, women got the right to vote, and people of all races became members of society. The invention of the atomic bomb pushed the development of high technology and nanotechnology, which are fundamental to take us deeper into our solar system and beyond.

Each time we invented a new technology, we combined it with virtue. Virtues were pushing us to develop something new and better to have a better life, and to flourish. Arendt says we must have an idea first and then work hard towards this idea to make something new. What actually is an idea – isn't it stimulated and accompanied by virtue? The core question in this thesis is not about that, but to think how our virtues could play out in a predictable situation of our extraterrestrial human life, and how to deal with ethical dilemmas when living extraterrestrially. Some questions are related to environmental questions like terraforming, and whether we should change

Mars to fit our ends, regardless if life exists there or not. Or should we terraform it if we know life on Mars exists and that terraforming will change the development of that life or quite possibly kill it?

The human character is Earth-centric and anthropocentric, therefore our relationship towards alien life opens several ethical questions and dilemmas. If there is life on Mars in primitive forms, then we must take a step back and reconsider whether we should land on the planet. Benefactors of the Mars mission would not agree with this, since billions of dollars have already been spent. Nevertheless, scientists argue that we need complex scientific research that robots cannot perform, and this has led to many ethical concerns. If we ought to occupy Mars and turn it into a planet where it is possible to live, then we must terraform it. One suggestion for this process is to drop several atomic bombs on it to severely change the surface of the planet, but the ethical concerns are not only regarding potential life on Mars, but also insensitivity towards the beauty of the planet.

Part one of this thesis also considers ethical questions regarding our personal wellbeing, including what happens to our body in a physical and biological sense when living in lower gravity and being exposed to severe cosmic radiation, but also in a more philosophical sense – what does giving up our bodily autonomy mean? Those great nouns – freedom of movement, autonomy, bodily autonomy – cannot be exercised on Mars, which brings new ethical concerns. There are many other questions related to this: how do we feed people, and what happens to women, as society will fall if there is no reproduction? Mars could be a trial for the reproduction of babies developed and born from an artificial womb, outside their mothers, a subject for further independent research, and not subject of this research. More political questions bring the ethical concern of what will happen if a society on Mars becomes a tyranny, either self-imposed or forcedly implemented by an authority – perhaps the benefactor of the mission.

As predicted, tyranny can come from anyone. It could be the people who have control over the oxygen pump, but also the benefactors of the mission. Self-imposed tyranny is also a possibility, in order for the mission to be successful and to avoid conflict or dangerous situations. Tyranny is one of most unethical political structures on Earth, but on Mars, a planet that takes more than half a year to travel to from

Earth, where is no police, army, or sources for surveillance, in this very specific situation, if tyranny was self-imposed it could result in a positive.

Considering the core ethical dilemmas, including the relevant situation that as of now a mission to Mars is affordable only for a few rich people, I proposed the ethical concept of a ‘Panopticon on Mars’, as a possible solution. A dome with glass layers would create an artificial atmosphere and the structure would prevent contamination of the surrounding ecosystem; it would also serve as an access zone for research of the grounds (below the floor, holes can be created to take samples and analyse them). It is important to ‘balance’ ethical concerns regarding the freedom of movement, liberty, autonomy and tyranny. The Panopticon concept is based on Bentham’s utilitarian practice, and would be able to serve as a virtue. People would be able to live the best life possible, whereas all current proposals from NASA, ESA and JAXA for Martian dormitories suggest that people should live in underground tunnels in much more isolated, small and cramped habitats, with barely any daylight. Equally important, it would enable that ordinary people (nurses, school teachers…) who can not afford a $250,000 travel to Mars to endower their mission as well.

The first part of the thesis is more or less focused on the near future, when humanity starts living on Mars. Some people will go there on a one-way ticket and they will need much greater technological support; the Panopticon dome is limited and serves a smaller community better.

To build infrastructure and houses, to excavate water, source energy and protect human life, extraterrestrial environments will need nanotechnology. While some philosophers think nanotechnology is just part of technology, therefore it doesn’t require a new ethical branch as it has established and known ethics, others say that in fact we are talking about a completely new ethics, as it is in a new environment for humans and civilisation. Because nanotechnology is not fully developed and needs further considerations on how to implement ethical and legal frameworks - because for the time being it is a prediction of predictions - this thesis rests also in agnosticism.

When nanotechnology is accompanied by AI, we can see there is a great difference already. AI is a “nano” machine, which can also be built in a domino effect, mistake by mistake, as mentioned with the metaphor of a mirror. AI can be a completed

project, sometimes even successful if there are no mistakes, but on the other hand nanotechnology will never be close to completion. There will always be plenty of room for upgrades, new inventions, new lives on new planets, and with all of this comes new ethical considerations, dilemmas and assessments.

In centuries past, various philosophers opened ethical debates from different perspectives: Bentham from the utilitarian perspective, Kant from the deontological perspective. With technological achievements we get new ethical branches: applied ethics, techno ethics, etc. Keeping an agnostic position on ethics in extraterrestrial humanity gives the opportunity for further debates and research. Hence in conclusion, technology will always leave a gap for virtue, and techno - humans in nanotechnological extraterrestrial human life will always practice virtue ethics.

Virtue ethical theories are not going into reverse, but are parallel with technological achievements and our social development, which serves us well. We started in our history as cannibals, but if we maintained this practice we wouldn't be here anymore as we would have eaten ourselves to extinction. Ancient human societies would not have reached the Bronze Age. (Not long ago it was totally acceptable to burn criminals as a performance in a town square in a pot of oil, or amputate them until they died, and unfortunately in some countries punishment by stoning to death is still acceptable.) Exercising our virtues and using new technologies brought us to a morally better system of death penalty 100 years ago, first with electricity and then lethal injection. Not to mention that most Western states took a different moral approach and abolished the death penalty.

The virtue ethical approach is the most attractive for extraterrestrial humanity as it is deeply connected with our technological capability; it is difficult to consider technological achievement happening without virtue accomplishment.

Virtue ethics also proves there is no place for a U-turn. We will go, to satisfy our virtues and to achieve good for ourselves and our civilisation. We will exercise the same virtues we are familiar with from our human life on Earth, and with nanotechnology heavily implemented into our extraterrestrial lives there will soon be place for new virtues as well. For the time being, only in the theory of physics could individuals live for thousands of years hopping from galaxy to galaxy, sharing experiences between the new worlds. Also in the theory of physics this could be

fulfilled in a matter of seconds, except on an individual level, suggesting that time on each planet and star could last for millions of years. What would help this concept? The virtue ethical approach.

While people are determined that we should spend all our money on this planet and for this planet, virtue ethical theory teaches us that all the money spent on space on this planet remains on this planet – no one yet lives on the Moon or Mars, apart from a few astronauts working on the ISS. If we are ever to succeed in protecting our planet and surviving as a civilisation, we must go, to strive towards our future while flourishing in our past. It is almost certain that it will be virtue ethical theory that will accompany extraterrestrial humanity and their nanotechnological life.

When studying space, Mars, and other extraterritorial environments, we must consider which ethical perspective is the most adaptable for such challenging places. Virtue ethics is an attractive ethical perspective. The desirable qualities of the virtuous person include a keen sense of judgement, so that he or she can determine which principles are best suited to guiding actions depending on the case. In situations of great uncertainty, the virtuous person will fare a little better than the non-virtuous person because no one can reliably predict (in Aristotelian lingo) which virtues will be relevant and which courses of action will best accommodate those virtues.

What is needed is more knowledge about this still-uncertain situation – knowledge about what entities are in play, what relationships exist between those entities, and what perturbations will have what effects. Although our moon will be the first place for humans to work and live extraterrestrially, due to the fact that it is close to Earth (around three days travel away, which will most likely be reduced to a day or even less), it will never be understood as a proper settlement nor an extraterrestrial colony. On the other hand, Mars, with the assumption that travel there will remain over seven months, due to the orbital difference with Earth, will most certainly be the first human settlement.

The society on Mars will have to adapt to life in the most challenging circumstances. This life will not be possible without technology and science, which will create a completely new way of living. Human families will merge with nanotechnology. Here on Earth, individuals can still survive outside society and technology, but this is not

possible on Mars. Ahead of the formation of extraterrestrial humanity, we can acknowledge the ethical concerns raised in this paper, from environmental and biological, to social and political, but there are more too, including nanotechnological.

Our human family is evolving further, and new technologies are making extraterrestrial life possible. Ethical questions will always remain and, although there is the possibility that the first settlers will live their lives in a form of tyranny, eventually the human family will have to flourish again. Individuals must live happy lives, so nanotechnology and the ethical norms implemented accordingly will be the only possibility for enrichment and longtime survival as an extraterrestrial civilisation. Throughout the history of humans, people have evolved into a civilisation. The darkest side we can predict is that, if nanotechnology on a larger scale becomes part of artificial intelligence, this would gravely reduce the possibilities for humans to nourish virtue ethics.

Humanity becoming extraterrestrial may signal a shift to a new platform of existence – one heavily reliant on nanotechnology and advanced technologies, including AI. This could lead to a future in which traditional human challenges are overcome, prompting deep reflection on the meaning of life in such a transformed world. In such a scenario, one must ask: will humanity still be capable of practising the virtues? And if not, will these virtues be embedded into some form of ethically perfected AI, or will they simply become obsolete? In a world where everything is already virtuous, there is no longer a need to practise virtue. This could mark the graveyard of virtue ethics.

REFERENCES

Allhoff, F. and Lin, P. (2006) *'What's so special about nanotechnology and nanoethics?'*, International Journal of Applied Philosophy, 20(2), pp. 179–190. https://doi.org/10.5840/ijap200620220

Altmann, J. (2004) '*Military Nanotechnology: Potential Applications and Preventive Arms Control'*, London: Routledge.

Altmann, J. (2006) '*Military uses of nanotechnology: Perspectives and concerns'*, Security Dialogue, 37(1), pp. 123–141. https://doi.org/10.1177/0967010606064130

Altmann, J. and Gubrud, M. (2004) '*Anticipating military nanotechnology'*, IEEE Technology and Society Magazine, 23(4), pp. 27–36. https://doi.org/10.1109/MTAS.2004.1374005

Annas, J. (2011) *'Intelligent Virtue'*, Oxford: Oxford University Press.

Anscombe, G. E. M. (1958) '*Modern Moral Philosophy*', Philosophy, 33(124), pp. 1–19.

Aristotle. (2020) *'Nicomachean Ethics',* Milton Keynes: Penguin Random House UK.

Arendt, H. (1958) '*The Human Condition'*, Chicago: The University of Chicago Press.

Bacchini, F. (2006) '*Is nanotechnology giving rise to new ethical problems?',* Science and Engineering Ethics, 12(4), pp. 607–620. https://doi.org/10.1007/s11948-006-0067-3

Bacchini, F. (2013) '*Ethics and New Technologies: The Case of Nanotechnologies'*, Rome: Aracne Editrice.

Bentham, J. (2017) '*The Correspondence with Jeremy Bentham'*, London: UCL Press, University College London.

Bostrom, N. (2014) '*Superintelligence: Paths, Dangers, Strategies'*, Oxford: Oxford University Press.

Bostrom, N. and Yudkowsky, E. (2014) '*The ethics of artificial intelligence'*, in K. Frankish and W. Ramsey (eds.) The Cambridge Handbook of Artificial Intelligence. Cambridge: Cambridge University Press, pp. 316–334. https://doi.org/10.1017/CBO9781139046855.020

Cave, S. and Dihal, K. (2020) '*The Whiteness of AI',* Philosophy & Technology, 33(4), pp. 685–703. https://doi.org/10.1007/s13347-020-00415-6

Cave, S. and Fischer, J. M. (2023) Should You Choose to Live Forever? A Debate. Abingdon: Routledge. https://doi.org/10.4324/9781003261136

Christman, J. (2009) The Politics of Persons: Individual Autonomy and Socio-historical Selves. Cambridge: Cambridge University Press. https://doi.org/10.1017/CBO9780511630200

Cleland, C. E. and Wilson, E. M. (2013) '*Towards the ethics of astrobiology'*, International Journal of Astrobiology, 12(1), pp. 61–65. https://doi.org/10.1017/S1473550412000413

Cockell, C. S. (2022) '*Interplanetary Liberty: Building Free Societies in the Cosmos'*, Oxford: Oxford University Press.

Cockell, C. S. (ed.) (2022) '*The Meaning of Liberty Beyond Earth'*, New York, Dordrecht, London: Springer.

Cockell, C. S. (2014) '*The Meaning of Liberty Beyond Earth'*, New York, Dordrecht, London: Springer.

Cockell, C. S. (2022) '*Essay on the causes and consequences of extraterrestrial tyranny'*, International Journal of Astrobiology, 21(2), pp. 75–85. https://doi.org/10.1017/S1473550421000414

Colburn, B. (ed.). 2023. '*The Routledge Handbook on Autonomy'*, London and New York, Routledge.

Colburn, B. (2010) '*Autonomy and Liberalism'*, New York: Routledge.

Crandall, B. C. (1997) '*Nanotechnology: Molecular Speculations on Global Abundance'*, Cambridge, MA: MIT Press.

Drexler, K. E. (1986) '*Engines of Creation: The Coming Era of Nanotechnology',* New York: Anchor Books.

Drexler, K. E. (1991) '*Nanosystems: Molecular Machinery, Manufacturing, and Computation'*, New York: Wiley.

Ekirch, R. A. (2001) 'Transported convicts and British colonies', in Winks, R. W. (ed.) The Oxford History of the British Empire: Volume II – The Eighteenth Century. Oxford: Oxford University Press, pp. 101–117.

Marx, K. and Engels, F. (2002) '*The Communist Manifesto'*, Edited with an introduction by G. Stedman Jones. London: Penguin Classics.

Feinberg, J. (1989) '*The idea of autonomy'*, in Christman, J. (ed.) The Inner Citadel: Essays on Individual Autonomy. Oxford: Oxford University Press, pp. 27–53.

Feynman, R. P. (1959) '*There's Plenty of Room at the Bottom'*, lecture delivered at the annual meeting of the American Physical Society, California Institute of Technology, Pasadena, California, 29 December. Reprinted in Engineering and Science, 23(5), pp. 22–36 (1960).

Foot, P. (1977). Euthanasia. Jstor, Vol.6, No2 (Winter, 1977) pp. 85-112 (28 pages) https://www.jstor.org/stable/2264937

Foucault, M. (1975) '*Discipline and Punish: The Birth of the Prison'*, UK: Penguin Random House.

Godfrey-Smith, P. (2013) '*Cephalopods and the evolution of the mind'*, Pacific Conservation Biology, 19(1), pp. 4–9. https://doi.org/10.1071/PC130004

Goodall, J. (1986): '*The Chimpanzees of Gombe'*, Cambridge: Harvard University Press.

Goodall, J. (2000): '*In the Shadow of Man',* New York: Houghton Mifflin Co.

Guyer, P. (2003) *'Kant on the Theory and Practice of Autonomy'*, Social Philosophy and Policy, 20(2), pp. 70–98. https://doi.org/10.1017/S0265052503202040

Harari, Y. N. (2011) '*Sapiens: A Brief History of Humankind'*, London: Penguin Random House.

Harari, Y. N. (2016) '*Homo Deus: A Brief History of Tomorrow'*, London: Harvill Secker.

Haqq-Misra, J. (2016). The Transformative Value of Liberating Mars. New Space, Vol.4, No 2. https://www.liebertpub.com/doi/10.1089/space.2015.0030

Hyman, W. A. (1966) '*Magna Carta of Space*', New York: Amherst Press.

Hughes, R. T. (2003) '*Fetal Shore'*, London: Vintage Books.

Hursthouse, R. (1999) '*On Virtue Ethics'*, Oxford: Oxford University Press

Hursthouse, R. (2010) '*Virtue Ethics'*, in Zalta, E. N. (ed.) The Stanford Encyclopedia of Philosophy (Fall 2010 Edition). Available at: https://plato.stanford.edu/entries/ethics-virtue/ (Accessed: [insert date]).

Hursthouse, R. and Pettigrove, G. (2016) '*Virtue Ethics'*, in Zalta, E. N. (ed.) The Stanford Encyclopedia of Philosophy (Winter 2016 Edition). Available at: https://plato.stanford.edu/entries/ethics-virtue/ (Accessed: [insert date]).

Joyce, G. F. (1994) '*Foreword: The antiquity of RNA-based evolution',* in The RNA World, edited by R. F. Gesteland and J. F. **Atkins**. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press, pp. xi–xv.

Kardashev, N. (1964) *'Transmission of Information by Extraterrestrial Civilizations'*. SAO/NASA Astrophysics Data System (ADS), Harvard University.

Kojima, N. (2024) *'Panopticon on Mars'*, Journal of the British Interplanetary Society, 77(3), pp. 115–123.

Kojima, N. (2023) *'Is Terraforming Mars Bad?*', Spaceflight, 65(5), pp. 180–185.

Kurzweil, R. (2005) '*The Singularity is Near: When Humans Transcend Biology'*. New York: Viking Press

Loeb, A. (2023) Interstellar: The Search for Extraterrestrial Life and Our Future in the Stars. New York: Mariner Books. https://doi.org/10.006325087X

Mehta, M. D. (2002) '*Nanotechnology: The next big thing or much ado about nothing?',* Bulletin of Science, Technology & Society, 22(9), pp. 34–42. https://doi.org/10.1177/0270467602022001005

Merker, B. (2005) *'The liabilities of mobility: A selection pressure for the transition to consciousness in animal evolution'*, Consciousness and Cognition, 14(1), pp. 89–114. https://doi.org/10.1016/S1053-8100(03)00002-3

Mill, J. S. (1863) Utilitarianism. London: Parker, Son, and Bourn.

Milligan, T. (2015) Nobody Owns the Moon: The Ethics of Space Exploration. Jefferson: McFarland & Company Inc., Publishers.

Milligan, T. (2015) Animal Ethics: The Basics. Oxon: Routledge.

Pettigrove, G. and Swanton, C. (eds) (2022) Neglected Virtues. Oxon: Routledge.

Popper, K. (1959) The Logic of Scientific Discovery. London: Hutchinson.

Rabineau, J. (2022) The Cardiovascular System in Microgravity: Wearable Monitoring, Countermeasures, and Numerical Models. PhD thesis. Université libre de Bruxelles. Available at: https://dipot.ulb.ac.be/dspace/bitstream/2013/351122/3/PhD_Thesis_Jeremy_Rabineau.pdf.

Rachels, J. (1975) '*Active and passive euthanasia'*, The New England Journal of Medicine, 292(2), pp. 78–80. https://doi.org/10.1056/NEJM197501092920206

Ratner, M. and Ratner, D. (2003) Nanotechnology: A Gentle Introduction to the Next Big Idea. Upper Saddle River, NJ: Prentice Hall.

Regan, T. (2004) '*The Case for Animal Rights'*, Berkeley and Los Angeles: University of California Press.

Regan, T. (1985) '*The Case for Animal Rights'*, in Singer, P. (ed.) In Defence of Animals. Oxford: Basil Blackwell, pp. 13–26.

Rubenstein, M. J. (2022) Astrotopia: The Dangerous Religion of the Corporate Space Race. Chicago: University of Chicago Press. https://doi.org/10.7208/chicago/9780226821122.001.0001

Szocik, K., Wójtowicz, T., Rappaport, M. B. and Corbally, C. (2020) 'Ethical Issues of Human Enhancements for Space Missions to Mars and Beyond', Futures, 115, p. 102489. Elsevier.

Sandler, R. L. (2017) '*Character and Environment'*, Chichester: Columbia University Press.

Schwartz, S.J. (2020). '*The Value of Science in Space Exploration'*, New York, Oxford University Press.

Singer, P. (2016) '*Ethics in the Real World*', New Jersey: Princeton University Press.

Smith, A. (1982) '*The Wealth of Nations*', London: Penguin Classics.

Sophocles. (2011) '*Antigone',* Translated by Diane Rayor. Cambridge: Cambridge University Press.

Sparrow, R. (1999) '*The Ethics in Terraforming'*, PhilPapers. Available at: https://philpapers.org/rec/SPATEI (Accessed: [insert date]).

Sparrow, R. (2009) '*The social impacts of nanotechnology'*, Ethics and Information Technology, 11(1), pp. 5–15. https://doi.org/10.1007/s10676-008-9184-1

Swanton, C. (2003) '*Virtue Ethics: A Pluralistic View'*, New York: Oxford University Press.

Taylor, P. W. (2011) '*Respect for Nature',* Woodstock: Princeton University Press.

van de Poel, I. (2008) '*How should we do nanoethics?*, NanoEthics, 2(3), pp. 257–267. https://doi.org/10.1007/s11569-008-0030-2

Vallor, S. (2016) '*Technology and the Virtues: A Philosophical Guide to a Future Worth Wanting',* Oxford: Oxford University Press.

Vallor, S. (2024) '*The AI Mirror: How to Reclaim Our Humanity in an Age of Machine Thinking',* Oxford: Oxford University Press.

Veber, F. (1923) *'Znanost in vera: vedoslovna študija'*, Ljubljana: Tiskovna zadruga.

Zubrin, R. (2022) '*The Case for Mars*: *The Plan to Settle the Red Planet and Why We Must',* New York: Free Press.

Zubrin, R. (2021) '*The Case for Space: How the Revolution in Space Flight Opens up a Future of Limitless Possibility*', Maryland: Prometheus Books.

Zubrin, R. (2024) '*The New World on Mars: What We Can Create on a New Planet',* USA: Diversion Books.

Walker, R. L. and Ivanhoe, P. J. (eds) (2010) '*Working Virtue',* Oxford: Oxford University Press.

Walzer, M. (1983) '*Spheres of Justice',* USA: Library of Congress Cataloguing in Publication Data.

National Library of Australia (n.d.) Convicts in Australia. Available at: https://www.nla.gov.au/research-guides/convicts-in-australia (Accessed: [insert date you accessed the site]).

[1] https://www.nasa.gov/headquarters/library/find/bibliographies/space-debris/

[2] https://x.com/elonmusk/status/1094796246613516289?lang=en

[3] https://www.youtube.com/watch?v=agvkfUihgCg

[4] https://www.youtube.com/watch?v=I98TvuVucGA

