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**SNAP, PAN, ZOOM, CLICK, GRAB, AND THE
EMBODIED ARCHIVE OF GEOGRAPHIC INFORMATION
SYSTEMS**

Philip John Nicholson

**Submitted for the requirements for the Degree of Doctor of
Philosophy (PhD)**

**School of Geographical and Earth Sciences, College of Science and
Engineering, University of Glasgow**

ABSTRACT

The aim of this thesis is to critically interrogate the question of ‘what is’ Geographical Information Systems (GIS) from an arts and humanities perspective, and to contribute to the emergence of what scholars have called a ‘third stage’, or ‘creative’ GIS. A significant element of this thesis is a practice-based research component that allowed for unpredictable avenues to emerge as the research unfolded, and the cultivation of an experimental approach that ‘tinkered’ with objects of inquiry regardless of preconceived outcomes. I begin with a critical assessment of the conceptual heritage of GIS, and related debates that situate GIS in the context of digital technologies and objects, structuralist, humanist and post-humanist geographic literatures on practice, and creativity as a productive geographic practice, before offering the notion of the ‘archive’ as a productive means of framing and interrogating GIS. In order to understand the doing of GIS, field studies were conducted to investigate what it means to learn and become immersed in GIS. I deployed more established social science methods at several sites, such as interviewing and participant observation, supplemented with auto-ethnographic accounts. From here, I sought to investigate how my own creative practice brought something new to the study of GIS, working through an abundance of materials, insights, and feelings amassed over the course of the PhD. Several artworks were created to tease-out, distil, and probe the aesthetic qualities of GIS that had become known to me throughout the PhD. This was a matter of ‘interfacing’, between GIS as broad discipline and my creative and aesthetic sensibilities and determining how my singular approach could recast our understanding of what GIS indeed is.

This thesis renders GIS not only as a tool, as a means of producing geographic knowledge according ontologies past and present, but as a set of practices that the user takes part in, and asserts his or her agency, but also must surrender themselves (at least in part) to the agency manifest through GIS as a historically, socially, and technologically produced mechanism. The practices involved in GIS are not just productive to particular ends, such as map making. The emotional dispositions, frustrations, anxieties, affective atmospheres of GIS practice produce a material and embodied residue that must be taken into consideration when we consider what GIS is. The thesis thus concludes with a proposal for a curated exhibition to ‘open up’ the dissemination of the thesis beyond the page and provide some sense of the what of GIS via other mediums. This curated installation offers a moment of closure for the project, as a culmination, a coming together of many of the materials built up and collected during the project.

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AUTHOR'S DECLARATION

I hereby declare that, except where explicit reference is made to the contributions of others, this dissertation is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution.

Signature:

Printed Name: Philip John Nicholson

ABBREVIATIONS

AHRC	Arts and Humanities Research Council
CSV	Comma Separated Values
FOSGSS	Free and Open Source GIS Summer School
FOSGIS	Free and Open Source GIS
GIS	Geographic Information Systems
GPS	Global Positioning System
GT	Geospatial Technologies
ICT	Information Communication Technology
IGR	Institute for Gravitational Research
NLS	National Library of Scotland
NLW	National Library of Wales
NRT	Non-representational Theory
OBD	Object-based Database
OSGeo	Open Source Geospatial Organisation
PDF	Postscript Document Format
PIP	Picture in Picture
QGIS	Quantum GIS
RDS	Relational Database System
SIGTE	Geographical Information Systems and Remote Sensing Service
VGI	Volunteered Geographic Information
WBGA	Web Based GIS Application

CHAPTER ONE: INTRODUCING THE ‘WHAT’ OF GEOGRAPHIC INFORMATION SCIENCE

In March 2016, I attended a panel session entitled *Algorithmic Governance* at the American Association of Geographers (AAG) Annual Meeting in San Francisco. In this session, panellists discussed how everyday life is affected by the ubiquity of digital technologies that act according to a programmed repertoire of computerised functions; these functions, whilst ‘hidden’ from view, nevertheless allow for all manner of activities to take place. One question that emerged time and again from these discussions was: how do we as researchers come to understand how these technologies work, in terms of producing the spaces that we inhabit, and affecting our everyday experiences, whether that be a matter of behaviour or felt emotion? One audience member, sitting a few rows behind me, suggested that one avenue to explore was to have a look at the actual code that underpinned these technologies to understand how the algorithms were constructed, and the opportunities and constraints that emerged from this. A panel member, Louise Amoore, challenged this method of enquiry, responding that we, as researchers, needed to resist the notion that by “opening the black box” we could get at some underlying truth concerning the nature of digital technology. Such a manoeuvre suggested, she argued (and here I am paraphrasing), not that we cannot deploy other methods, such as interviewing or observation, but that these did not sufficiently locate and interrogate the fundamental nature of our objects of inquiry.

Clearly, I am interpreting the above events in a manner that befits my own preoccupations brought to the event; indeed, these preoccupations have engaged me for four years. What struck me about this exchange was the refusal to regard code as foundational to the nature of digital technologies. On the one hand, I can appreciate the interrogative search for a key object of analysis that ‘unlocks’ explanations as to what a technology can and cannot do, and upon which a research design can be built. I can also understand the frustrations that ensue from engaging with a ‘black box’ that we cannot peer into because most are protected, proprietary mechanisms unavailable to us, or because we do not have the disciplinary expertise to map out the contents. On the other hand, I appreciate that such concerns can reinforce the idea that such a ‘black box’ is the epicentre that defines all other objects as belonging or not to digital technology, as well as from which all causality and affect emanates. There is an idealism to the idea that if we can understand the supposed core (the code) of these digitally mediated agents, then we might be able extrapolate and understand any possible consequence.

To expand on this issue further, the risk in looking to code as *the* crucial object of analysis pertaining to such technologies is that gives far too much credit to the programmer, implying that the author of these coded responses, or algorithmically controlled behaviours has, in some way, pre-empted all the ways in which they may affect the world. Such a position does not take into consideration how such ‘algorithmically governed’ spaces may give rise to unexpected or unintended behaviours. For instance, in the same AAG session Agnieszka Leszczynski raised the case of *Girls Around You*, a ‘hook-up’ app that scrapes data from social media platforms to visualise nearby, and potentially available women (Leszczynski and Elwood, 2015; Leszczynski, 2016). This is just one example of where the affordances of digital technologies - in this case social media platforms like *Facebook* and *Foursquare* – have been exploited in ways not necessarily intended by the creators. What is more, the existence of these affordances suggests that the affective qualities produced by these digitally mediated actors are dependent upon their interaction with others. Therefore, how digital technologies produce affect can neither be traced to one distinct entity, nor determined by gaining access to some privileged space. If we take this line of critique further, what it undercuts is the notion that to research technology is to search for clear lines of cause and effect and, from their exposition, to draw up a summative explanation of what that technology indeed is.

I use this vignette from the AAG as an introduction to the thesis overall because I think the concerns it raises neatly reiterate those I have wrestled with over the course of the last four years in my research project into the ‘what’ of Geographic Information Systems (GIS). Funded as part of an Arts and Humanities Research Council (AHRC) Collaborative Doctoral Award that addressed the rapidly unfolding engagement of geography with art/science debates and practices, the PhD was conceived of as an opportunity to build a creative and experimental approach to a subfield that, despite its emergence within the discipline of Geography, and its shaping by the rigours of spatial science, has nonetheless been appropriated by artists as a means of disturbing what has become for many our usual means of ‘wayfinding’ in the world, and of interrogating the ‘view from nowhere’ that our social media has increasingly integrated as lives are lived via geolocated Instagram pictures and so on. As a collaborative award, the PhD benefitted from the advice of a GIS consultancy firm, Environment Systems, which is a small to medium sized enterprise based in Aberystwyth, Wales, with very strong links to the School of Geographical and Earth Sciences at the university there. Environment Systems had experience of working with master’s students wanting to undertake a ‘hands on’ project in GIS and had also worked with faculty on diverse land mapping projects. This was to be the first time, however, that they would work with someone with an arts and humanities background.

The stated aim of the PhD project, as proposed to and approved by the AHRC, was to critically interrogate the question of ‘what is’ GIS from an arts and humanities perspective, and to contribute to the emergence of what scholars have called a ‘third stage’, or ‘creative GIS’. This emergence of the term ‘creative GIS’ is commonly attributed to GIS scholar Daniel Sui and his 2004 article entitled *GIS, Cartography, and the “Third Culture”: Geographic Imaginations in the Computer Age*. In that article, Sui calls for the “cross- fertilization of creative ideas from the arts and sciences via state-of-the-art technology” (2004, p. 63) so that we can, “ask more innovative and socially relevant questions about the evolving character of the Earth’s surface under conditions of global environmental change and the global economy”(2004, p. 63). Key to this effort was to be the development of an arts-based, practice as research component that not only gave space for unpredictable lines of inquiry to emerge as the research unfolded but saw the value in an experimental approach that ‘tinkered’ with objects of inquiry regardless of preconceived outcomes. By practice-based research here I am referring to the deployment of my own creative practice as a tool for enquiry. It is about taking creative practice as knowledge producing in of itself. Not really formalised, and often highly individualised, it essentially uses those same processes that would be mobilised to create an artwork and applying them to a specific research subject. Here I am talking about the interrogative, attentive, and interventionary activities that an artist mobilises to understand and imagine. It is about paying attention to, “what can be learned in the processes of creative doings” (Hawkins, 2015, p. 247). For me, this may involve rearranging images, amassing snapshot photographs, video-clips, and doodles. Furthermore, this is an approach that is often playful, sometimes quick and sketchy, sometimes very slow and meandering. It is about an interfacing of my learned aesthetic inclinations with the research topic to produce images that resonate and say something new about the subject that would be difficult using other forms of representation.

Given my own arts-based research background -- I have a BA honours in contemporary fine art, and a MA from Central Saint Martin’s College of Art and Design in ‘Creative Practice for Narrative Environments’ -- this practice-based element had a degree of familiarity to it. What was challenging, however, was the need to not only become familiar with the subfield of GIS, and its professional cohorts, but to also think simultaneously and critically about how that familiarity was being constructed. I could not simply train to ‘become’ a GIS scholar and then undertake a GIS project. Rather, I had to think through how GIS was a field that I apprehended in diverse ways, such that I could reflect upon how the ‘what’ of GIS was produced via my own efforts and initiatives working in concert with a host of others.

The session and subsequent discussion at the AAG resonated with me, then, because I began this research project with a similar set of concerns. That is, how was I, as an artist, a designer, meant to open the ‘black box’ of GIS? To a large degree, this question resonated with me due to my own insecurities. For instance, how could I contribute to the study of GIS with no practical experience of this area? As I began to move forward, what gradually reassured me was the realisation that that my creative practice had a lot to contribute to an understanding of the interrogation of the ‘what’ of the question not via a familiarity with software and code, but via a desire to come to grips with GIS via a practice-based research that eschewed ordinary centres and simple cause-effect explanations. I would turn instead to the manner in which I myself apprehended GIS -- tracing the myriad of objects, actors, ideas and anxieties, peripherals and practicalities that I came across and actively engaged with – and build up a knowledge of GIS as simultaneously socialised (talking with others about GIS and observing their efforts), individuated (reflecting on my efforts and experimenting with GIS) and materially mediated (working with software and peripherals). Indeed, what became interesting was a growing apprehension of how these spheres intertwined in practice, even as they were disambiguated not only by myself but also by GIS scholars and practitioners, as I go on to describe in Chapter Two. My objects of analysis decomposed and recomposed time and again as my research unfolded, a process enabled not only by my creative experimentation, but also the capacities of the medium itself, as I go on to describe in Chapter Three.

For a number of years preceding the PhD, my creative practice had involved a strong science dimension in terms of its subject matter, as I, for example, made short films about scientists as they talked about their work. The primary concern in my practice had been to tease out and re-narrate how scientists are affected by the work that they do, and how they articulate their work as a way of living in, as well as observing, the world. This meant interrogating the embodied practice of science; and, in how scientists, as individuals with access to a privileged (requiring specific knowledge and skill to access), and somewhat ‘mystical’ (to me at least) realm of understanding, narrativise – via metaphor, analogy, and performance – their understanding to others. Prior projects that I worked on had culminated in a type of creative installation called a ‘narrative environment’. Narrative environments are designed, physical and/or digital, spaces in which stories unfold, such as a museum exhibition. I became familiar with this approach to designing installations during my master’s in creative *Practice for Narrative Environments*. For my final project, I designed a narrative environment entitled *Singularity*, which looked at the science of black holes. In the first year of my PhD, I worked on a similar project, *Touching Space-Time*, about gravitational waves. For *Touching Space-Time*, I collaborated with a sound designer and researchers at the Institute for Gravitational Research (IGR) at the University of Glasgow to

create a narrative environment that unfolded at three sites across the university campus, each providing for the audience a different encounter with an artwork relating to gravitational waves. Working on this project in the first year of my PhD was a good opportunity for me to get to grips with the university environment as a creative reservoir, as well as an opportunity to experiment with the narrativising of what became a world famous scientific success story. As an avid user of digital technologies to create narrative environments that depended on image and setting for the production of affect as well as content, I had a well-developed understanding of how graphical user interfaces employ visual language (to direct, instruct, help, anger the user), as well as training in how to 'read' an image as the work of affect, as opposed to a neutral conveyor of information. In a broad sense, what I was thus able to bring to the PhD was a practiced sensitivity to various visual literacies and a reflective understanding of creative practice.

As noted above, a primary focus of this PhD project was to investigate how creative practice might contribute to my enquiry as to the 'what' of GIS. And, my creative practice served as a way of thinking through my observations, expressing, and performing this embodied archive as a method of data production and analysis. As I go on to describe in Chapter Three, I worked through a series of what might be termed more 'established' data collection techniques. I sought to understand what it means to practice GIS via structured and unstructured interviews with individuals who used GIS as part of their job. These interviews focused on what is involved in their daily practices working with GIS: more specifically, I was interested in how they organised themselves, configured their workflows, arranged their workspaces, moved around their offices, and so on, in the pursuit of *doing* GIS. Inspired by work on an ethnomethodology, I paid particular attention to how they spoke about working with large amounts of data, the way in which they utilised many different components (hardware, software, skills, bodies, furniture), and how their work was reliant upon various skills and proficiencies. At the same time, a significant line of research involved critically reflecting upon how I myself was learning to use GIS in my office, in conversations with various GIS experts, by formally undertaking a class, and by teaching GIS to others. Here, I was interested in how GIS as a pedagogy was constituted. I paid attention to how issues such as exploration and experimentation -- or testing the limits of the technology -- plays a part in this learning process, as well as how the bodies of participants come to move in particular ways (in mimicry, for example, of the instructor's actions). I was also concerned with how learning GIS gave rise to certain emotional dispositions, such as anxiety (relating to pressure to perform), but also how the coming together, and reliance upon disparate and existing knowledges, imbued participants with confidence or reinforced insecurities.

In carrying out these lines of inquiry, and learning to *do* GIS, I found myself to have become a kind of embodied repository, or living archive, of knowledge, skills, and feelings. Taken together, these techniques facilitated a critical reflection on how certain practices ‘worked’ through an embodied knowledge, how they made me feel, how they influenced the way I was thinking, and, moreover, how reflections on practice are a means of archiving the ‘doing’ of research. They also provided me with a dense reservoir of ideas, images, objects, feelings and so on that could be worked into what might be termed ‘creative outputs,’ including films and photos, as well as installation pieces, that captured something of what was for me the ‘what’ of GIS.

The Remit of this PhD

As briefly noted above, the remit of the PhD was set to a degree by the nature of its funding. The PhD is funded as part of an AHRC Collaborative Doctoral Award and is supported by the GIS consultancy Environment Systems. The stated aim of the project, as approved by the AHRC, was to critically interrogate the question of ‘what is’ GIS from an arts and humanities perspective, and to contribute to the emergence of what scholars have called a ‘third stage’, or ‘creative’ GIS. An explicitly stated element of this project was thus a *practice-based* research component that allowed for unpredictable avenues to emerge as the research unfolded, and the cultivation of an experimental approach that ‘tinkered’ with objects of inquiry regardless of preconceived outcomes.

Coming into this project as an artist, rather than a geographer, meant that while I was comfortable with some elements – such as the practice-based research approach – I found other elements, such as a familiarity with the history and philosophy of geography, to be a challenge. Indeed, a great deal of my first and second years was spent engaging with some of these literatures, but also with the methodological approaches developed within the discipline. At the same time, while I found the notion of practice provided something of a ‘comfort zone’, there was also a need to critically reflect upon my prior training such that I could gauge how it impacted my PhD work. Taking into account this project aim, as well as my own expertise, what I developed was a thesis that undertook a series of steps, integrating more established social science methodologies alongside disciplinary literatures, and a more experimental, practice-based approach that both draws on and responds to these. The written thesis that follows has been composed around these steps -- though of course there was, in practice, considerable overlap – and thus takes the form of a ‘journeying’ narrative as I apprehend GIS in various ways, gradually building in the process a GIS world that centres on my efforts and anxieties,

knowledges and capabilities, all facilitated through my interactions with others, both human and inhuman. Specifically, the PhD project was to become composed of:

Step One: Developing an understanding of GIS via a consideration of various literatures relating to GIS.

I set myself the task of thinking through how and why scholars have framed debates around GIS, such that a current concern has become the emergence of potential of a ‘creative GIS.’ This included a review of the conceptual heritage of GIS, and debates as to the nature of a ‘critical GIS’. Over time, it also involved drawing from other, related debates that situate GIS in the context of digital technologies and objects, structuralist, humanist and post-human geographic literatures on practice, creativity as a productive geographic practice, and post-structural renderings of the archive.

Chapter Two thus takes the form of a literature review. I begin by tracing a disciplinary history of GIS, noting its significant reliance on spatial science. I acknowledge the hagiographic rendering of GIS as a field of inquiry that emerged as a confluence of spatial science and advances in machine computing, a societal need to capture, store and analyse various types of geographical data (Goodchild, 1992), and as a result of the proliferation of personal computers. As spatial science was concerned with the quantification, representation, and subsequent analysis, of ‘real’ world objects, GIS allowed for the processing of this quantitative spatial data with greater speed and efficiency. This section also deals with what scholars have termed the ‘first wave’ of critical GIS, which considered GIS’s appropriateness as a method of geographical knowledge gathering. I discuss claims from critics, for example, that GIS relied too heavily on an ontology reliant upon positivistic approaches to scientific research, and the Boolean logic of computer systems. I then undertook a comprehensive review of progress reports on GIS and Cartography in the journal *Progress in Human Geography* over the last 35 years. The aim here was to complicate the narrative so far outlined by turning in more detail to debates and concerns in the GIS literature as these unfolded. To complement these reports I also interviewed Mike Goodchild, Matt Zook, and Sarah Elwood asking them to sketch out some of the theoretical and technological innovations and milestones in GIS from their perspective.

I then move on to a more in-depth discussion of how GIS deals with ‘ontology’; that is, how it structures geographic information to model reality. In GIS literatures, ontology refers to how scientific observations become objects within a GIS. In that, in a similar way to spatial science, and specifically relating to Berry’s geographic matrix (Berry, 1964), what GIS refers to are ultimately simulated, knowable objects. I discuss recent debates on the rise of the citizen

scientist, or neogeographer and the consequences this has for organising and structuring spatial data. Furthermore, taking a lead from Ash et al (Ash, Kitchin and Leszczynski, 2018) I briefly discuss how one might broaden the scope for considering how GIS is constituted outwith the confines of specific software applications. This section thinks through assemblage theory to imagine GIS as collection of hardware components, software, people, emotions, skills, legal and commercial interests, and so on.

The fifth section of the literature review chapter sketches a slightly different path for GIS, thinking through how GIS has been configured as a type of technologically mediated set of *practices*. I begin by outlining Jerome Dobson's (1983) notion of an automated geography, and framing this idea of GIS as a thoroughly technologically mediated type of praxis. I trace the development of this idea through to the efforts of the second wave critical GIS scholars to humanise GIS. I return to the subject of citizen science, but this time discuss specifically how Web 2.0 made GIS more user friendly, allowing non-expert citizens to gather, contribute and structure their own spatial data in open databases and repositories, and to deploy GIS for various cultural as well as political and economic ends. I then move on to how post-humanist approaches to geography have opened up discussion around 'practice' and how this, as a rejection of the structural ontologies seen in earlier GIS practice, has been used to configure GIS as an assemblage of interoperable parts mediated by themes such as affect, embodiment, performativity and doing. Furthermore, and attendant to the broad focus of this thesis, I look to literatures on creativity, play, curiosity and experiment in an effort to think through how a creative GIS might be composed. The next section looks to more directly address GIS as a series of practices. Therefore, I discuss literatures of sociality, collaboration, technological mediation, agency, digital work, emotions, and affect

Finally, this chapter turns to assess GIS as a kind of digital *archive*. I consider how GIS, understood as an information storage and retrieval system, might work as an agent of authority. To do this, I discuss the work of post-structural thinkers on the nature of the archive. Here I note how Derrida sees the archive as a system for deadening knowledge, but also as a kind of patriarchal control over the act of inscription, or textual or embodied record. This contrasts with Foucault, for example, who sees the archive as the repository of all possible statements, governing what can be said. I discuss GIS as a kind of digitally mediated archive that structures the files and data it holds to construct certain narratives or re-present knowledge according to its own ontologies. However, I also note how certain types of knowledge resist the conscription of the textual analogue archive (DeSilvey, 2007; Cresswell, 2012). I conclude by turning to the question of what might be left outside of the archive. For performance studies scholar Diana



Figure 1 - Environment Systems Office Building, Aberystwyth



Figure 2 - Workspace at Environment Systems



Figure 3 - Participant's Workspace at Environment Systems



Figure 4 - Workspace at Environment Systems



Figure 5 - My office at the University of Glasgow

Taylor (2003) what cannot be inscribed in the textual archive are the lived, embodied traces of performance, that instead reside in bodies of those who encounter it.

Step Two: Developing an understanding of social science data collection techniques and applying these to GIS practitioners and practices.

Here, I researched and put into practice semi-structured interviewing and participant observation and ethnomethodology, with the intention of coming to understand what the practice of GIS involves for those doing it, including myself. Using semi-structured *in situ* with individuals who use GIS as part of their job, the aim was to capture something of the ‘what’ of GIS as participants were immersed in the *doing* of their daily GIS practices. I also wanted to further interrogate some assumptions taken from my literature review, as well as some informal discussions that I had had with GIS practitioners, that GIS is ‘digital work’, technologically mediated, and assembled.

My fieldwork studies focused on five sites. These were the offices of GIS and remote sensing consultancy, Environment Systems; my office at the University of Glasgow; The National Library of Wales (NLW); the Map Reading Room at the National Library of Scotland (NLS); and the University of Girona. The first of these – Environment Systems – housed one of my co-supervisors, Seb Hudson, with whom I developed a sustained relationship around learning how to practice GIS as a consultant, but also how to treat GIS from a ludic perspective, toying with different software, and exploring their potentialities. Environment Systems consists of a suite of offices on a science park on the outskirts of Aberystwyth in Wales. During my fieldwork with the company I observed approximately 20 people working with GIS software and related technologies. The Environment Systems site consisted of six offices, separated into project centred teams (for instance one office was dedicated to agricultural remote sensing, another housed the IT support manager and GIS support manager). There was also a meeting room, and an administrative office where the company directors worked.

I observed and interviewed the staff at Environment Systems as they worked with GIS as part of their everyday job. Most of this work was done at a computer workstation that had been assigned to them, and from which they manage their workflow, operate their computer, and collaborate with other members of their team. The staff at Environment Systems was made up of people with various academic and non-academic training. There were marine biologists, ecologists, geographers, computer science graduates, data entry clerks, and so on. Amongst other tasks, staff worked to produce maps and reports for farmers, for local authorities, and for government and non-government agencies. They also worked on improving their technology,

improving workflows, data collection protocols, working on quality assurances tasks, assisting other team members, writing plugins, and updating software.

Aside from our formal relationship via the collaborative award, this site gave me the opportunity to talk with GIS practitioners as they were engaged with GIS software, and related technology, as part of their job. It allowed me to get a sense of the skills and proficiencies at work, and what it is to be immersed in the practice of GIS at a professional level. I could gain a sense of how GIS is constituted in a small company, experience first-hand the ebbs and flow of activity in such an environment, observe how work is distributed and allocated, and how different knowledge and skills are spatially distributed throughout the workspace.

A great deal of my efforts to learn about and learn to *do* GIS has taken place in my office at the University of Glasgow. This office is in the Geography department, in a rabbit warren-like modernised Gothic revival building at the centre of the university campus. It is hidden behind a turret, and in amongst teaching rooms, computer labs, lecture halls, seminar rooms, and the offices of other academic and administrative staff. Mine is the only occupied desk in an office meant for four. The office contains four miss-matched, and rather old writing desks facing the walls with a desktop PC atop each one. Above each workspace is either a pin board or bookshelf mounted to the wall.

From this modest office space, I managed my PhD project and the various other activities that go along with being a PhD candidate. This is where I planned the logistics of my field work, transcribed my field interviews, read, ate my lunch (when deadlines would not allow me to make the trip to the departmental lunch room), wrote essays, literature reviews, and thesis chapters, meditated, took naps, procrastinated, made coffee, drank coffee, and met with undergraduate students (in my role as a graduate teaching assistant) and other PhD students. But mostly I would just write, and most of this writing was centred around the desktop PC given to me when I started my PhD. This was the computer on which I taught myself to use GIS, sometimes requiring technical assistance but mostly I worked alone.

This was the environment in which I taught myself to use various GIS software packages. In my previous experience of learning new software packages, I have found I made the most progress when self-directed. Moreover, this is where I analysed my fieldwork data, a significant element of which was to involve archiving it using Quantum GIS (*QGIS*). Although GIS software is used on laptops by many users, I found that it was far more effective to use my university desktop computer to do this because it has superior hardware specification to my *MacBook* (including greater storage facilitated by an external HDD, and an additional monitor (better for multitasking)).

Figure 6 - Project Manager David's Office at the National Library of Wales



Figure 7 - Scanning Studio at the National Library of Wales

Figure 8 - Scanning Technician working to stitch scanned images in Scanning Studio at the National Library of Wales





Figure 9- Veranda at University of Girona (SIGTE, 2014)



Figure 10 - GIS Teaching Lab at University of Girona (SIGTE, 2014)

One of the main concerns reflected in my literature review was the potential of crowd sourcing, or neogeography, to shift the way GIS is practiced. For this reason, two projects, one at the NLW, and one at the NLS were of interest to me. At these sites staff were involved in preparing materials for projects to crowd source the georeferencing of historical maps. I wanted to address, therefore, how individuals at these sites had and were preparing materials for the georeferencing projects - how the software was configured to allow users to contribute, the kinds of activities involved in contributing, how the staff prepared materials for the projects, and who was involved, and what kinds of skills they had.

NLW in Aberystwyth, is housed in a building close to Aberystwyth University and overlooking the town. Here, and after some time spent conversing through email, I spent time with staff working on the *Cynefin* project. Upon my arrival, I had to produce identification, have my photograph taken, and was given a library card to allow me access to the reading rooms. Aside from the individuals I was there to see, the space was open to the public. There was a gift shop, a canteen, various exhibition galleries, and reading rooms. It was a busy place. My time at NLW was mostly spent in the office of the project leader, the bespoke scanning studio, and the corridors in between. The project leader's office was away from the public corridors, behind two sets of coded entry doors. His was a small office with a simple desk with a PC. In my time moving to and from his office I would pass other people working in the library, and in the public corridors members of the public, including students from the university, come to use the reading rooms. I also spent time at the scanning studio where two recent graduates from Aberystwyth University -- one history graduate, and one graphic design graduate -- worked scanning the large historical maps of Wales.

Again, after conversations over email I met with the map curator at the Maps Reading Room at NLS, Chris Fleet, in order to follow up on a project he had been leading to georeference historical maps of Scotland. The Maps Reading Room had quite a different configuration to that of NLW. Here, the georeferencing project, that I had come to learn more about, was managed by the map curator from the Maps Reading Room, at a separate site from the main NLS. Here, there was no receptionist to greet me; instead I wandered in off the street into a large open space, where shelves lined the walls, and the floor was gridded in blocks of map chests and tables set up for the viewing of the maps stored on the shelves and chests. In amongst the shelves, maps, chests, and tables, perhaps two or three members of the public shuffled through the collection or leant over tables peering at the maps. Towards the front of the space were a bank of approximately six computer workstations, where Chris Fleet and two of his colleague sit working at their computers workstations.

In July 2014, I attended the Free and Open Source GIS Summer School at the University of Girona (FOSGSS). I chose this site so that I could observe individuals learning how to use GIS in a particular way. That is, at this site individuals enrolled to learn new skills as part of a group. Also, this training course accepted applicants with range of skill levels. Taking part in this summer school allowed me to observe others learning and get a sense of what it is like to become immersed in learning with others. This summer school was hosted by Geographical Information Systems and Remote Sensing Service (SIGTE), which is a research support service based in the University of Girona, and specialising in GIS, web GIS, augmented reality, spatial analysis, and so on. I was one of approximately 20 attendees, which included post graduate students, academics, civil servants, and GIS practitioners from various industries. These individuals came to the university to learn new skills, some were sent by their respective companies, and some by university departments.

The other summer school students and I spent most of our time in a teaching lab, within SIGTE, on the second floor of the main university building. We were treated like conference delegates, directed from the teaching lab, to a veranda mid-morning for coffee, and then to the university canteen for lunch. Being the summer holidays, there were few university students on the campus. During workshops, attendees sat at four rows of desks, at four computers workstations to a row, facing the front of the room, where the workshop leaders and SIGTE staff would direct the summer school students. The workshop leaders were academics and developers specialising in GIS and were from other institutions, such as, Jeremy Morley a geospatial scientist from Nottingham University, and Jorge Gaspar Sanz and Alberto Romeu from *Prodevelop*, a software development company in Valencia.

I discuss the more practical aspects of my data collection in Chapter Three but would simply note here the diverse mediums brought to bear. I recorded with a sound recorder and observations were recorded in my field book; and made note via word and sketch of corporeal dispositions involved in the 'doing' of GIS, such as the movements of hands, how individuals sat in their chair, and what was happening on screen. I also took photographs, focusing on small spaces (encapsulating the interaction of hands, keyboard and mouse) and the participant's workspace. I made lists of materials mentioned by participants and made orientation sketch maps of the site. These observations allowed me to gain a sense of how individuals managed their time and effort, how their practices became routinized, and an overview of the day-to-day working of the site. Most of my interviews were conducted sitting at the participant's computer workstation as they talked me through their activities.

In Chapter Four, my intent is to provide a sense of how GIS emerges as a socialised activity, insofar as my interviews with others allowed me to not only gain a sense of how people imagine and practice GIS as an activity that takes place alongside others, but how this activity is rationalised through dialogue with others. That is, using this established social science method of data collection, I was able to note how GIS practice became visible in a particular way; as an ‘active reflection’ that is prompted in various ways, such as the asking of a question as to *what* is happening. In response, GIS users narrated their activities as an exercise of agency, such that there was a ‘taking ownership’ of the doing of GIS.

As I discuss in Chapter Four, in talking with my participants, and subsequently thinking through these conversations, I noticed that most of our discussions resonated with literature on sociality, collaboration, ‘digital work’, technological mediation, and assemblage. Furthermore, most of our discussion tended to focus on the three thematics, namely: accounts of individuated doing within a cohort of individuated users, repetitive decision-making, and accounts of components that were being deployed. In writing up this chapter, I thus deliberately adopted a complementary narrative tone that maintains the agency of the ‘I’ – the individuated doer of GIS – as central to the unfolding of activities and events across time and in situ.

Chapter Five performs something of a contrast with Chapter Four, insofar as I follow the narrativisation of my interviews with a collection of autoethnographic accounts of my own experiences of working with, and learning to use GIS, and my observations of others doing the same. The research activities covered here include taking part (observing and learning as part of a group) in the Free and Open Source GIS Summer School at the University of Girona; observing technicians at the National Library of Wales as they prepared materials for a public crowd sourcing GIS project; and my efforts to teach and familiarise myself with GIS software in my university office.

Here, I also draw on established data collection techniques, though mine is now a more explicit voice as I detail my experiences of becoming invested in the practice of GIS. I discuss my learning to *do* GIS either alone or in concert with others and note the various approaches I took to learning GIS, and the different pedagogic methods used at different sites. Nevertheless, this ostensibly ‘I’ centred accounting of GIS is undercut by a sense of myself as a kind of flaneur of the digital world. Where the flaneur of Walter Benjamin discombobulated the systematising, cohering work of modern, organised urban spaces and timings by insisting on the ephemera of memory and the siren call of the marginal, my slow-dragging gaze was caught in the hyper-mediated spaces of GIS practice. Like the flaneur, my perspective – as an outsider – allowed me to take on a critical eye, and to continuously question as I was drawn in to GIS. I paid particular

attention to the disjunctures, miscommunications and moments of awkwardness of the practices that I observed, looking for breakages, or when things did not run according to plan. In paying attention to these breakages, I sought to ground my observations in literature on embodiment, affect and emotion. I tried to imagine the spaces of GIS learning according to the concept of affective atmospheres. That is, thinking through how these spaces were configured – either by design or by contingency - to prime people to act in a particular way. Making observations according in relation to these ideas, I identified five key thematic threads that ran through these encounters: testing limits of the technology, anxiety, reliance on disparate and existing knowledge, aggregation of bodies, and spheres of attention.

Step Three: Employing my creative practice as an apparatus of enquiry to imagine what a ‘creative GIS’ might be.

A crucial manoeuvre in addressing step three was to set myself the task of working for a period of two weeks on a series of creative experiments. To do this, I drew from my insights, observations, fieldwork data, memories, and feelings from the previous two steps, figuring them as a kind of creative reservoir. The primary concern of this step was to try to understand what might GIS have to do with creativity. Moreover, what might happen at the interface of my creative practice and the material and embodied residue of GIS practice?

The brief I set myself was quite open, with the relatively loose objective of creating at least one kind of creative response per day. At the beginning of the two weeks, I reconfigured my office at the university and collated research data, found images, computer equipment, cameras, and various art materials, such as coloured paper, glue, scissors, and so on. I revisited themes and materials from previous chapters, so that this material served as a creative reservoir for experimentation and exploration. I took a charrette-like approach (a method of creative practice often used by architects and designers that involves working intensively and rapidly) to working in the makeshift studio space, creating doodles, sketches, video clips, and staging small re-enactments of practices I had observed in previous research activities. The intention here was to think through my research findings via the lens of my own creative practice. I detail some, and certainly not all, of the ‘outputs’ of this creative practice in Chapter Six. These address themes of collage (and layering of information), zoom and resolution, the characteristics of the visual language of GIS, and futile labour.

A continuation of this process, however, was the archiving of the PhD itself, with a view to an exegesis of ‘what happened.’ This process was a thinking through of how to summarise doings and findings of this PhD project in a manner that conveyed critical thinking and substantive

information yet retained a creative element that allowed the viewer to ponder other associations and possibilities. I thus set about creating a series of ‘infographics’ that narrated the research design process as it unfolded over space and time, and which would themselves have a spatiality that roved beyond the linearity of the written sentence. My Chapter Three, then, which outlines my methodology, can itself be considered an ‘output’ of the thesis.

What is more, my Chapter Seven takes forward the research process even as it ‘marks’ the conclusion to the written thesis. The intent is to have this chapter read in concert with an installation piece that takes the content of the PhD back out of the page and into the hardware and software of GIS. In this chapter, I work through my summative thoughts on what a creative GIS is, and correspondingly, the installation – a material analogue if you will -- works to expand these ideas into a creative work that imagines what creative GIS could be, or what it might look like. I discuss how the aesthetic experience of working with GIS might be progressed, or evolve, with a more explicit working through and with a range of visual literacies, and a more explicit reflection on the performative aspects of scientific practice. These provide a project that is more attuned to emotional and affective experiences of learning to *do* GIS. What I hope is that this chapter, and accompanying installation, will address how one becomes immersed in the practices corresponding to this technologically mediated set of practice. How have I become an embodied archive of GIS? What does it mean to become an embodied archive? And, what does it matter how he/she feels, how he/she empathises, the relationship he/she has with the materials around him/her?

CHAPTER TWO: Locating GIS

SECTION ONE – Introduction

The intent of this chapter is gain an understanding of the ‘what’ of GIS via, primarily, a critical consideration of relevant literatures, and the emphases and distinctions these lend to GIS as an academic field of inquiry. There are two narratives I want to draw out here. On the one hand, there is a body of work that looks to draw out a chronological accounting of GIS, affording it a specific context, and set of concerns, out of which GIS emerges. On the other hand, delving into the details of reports, as well as discussions with key figures in the GIS community, another narrative appears that is characterised by multiple origin points for GIS, and a series of concerns and inspirations that do not square up into a smooth, linear chronology. Where the first narrative deals with ‘turns’ and even ‘revolutions’ in a collective field of inquiry, the second highlights difference and even a ludic element in the unfolding of GIS and, moreover, takes account of the imaginaries, practices and materials that assemble to allow for GIS itself to emerge.

In what follows, I begin by emphasising the role played by a spatial science epistemology – an approach often cited as affording GIS its core framework as a way of knowing and representing the world (Pickles, 1993, 1997; Schuurman, 2000; D. Z. Sui, 2004; Sheppard, 2005; Sui and DeLyser, 2011). Thus, Section Two is concerned with critically assessing the emergence of spatial science in the mid-20th century and how this provided a reservoir of epistemic concepts and modes of imagining and visualising data for GIS in the late 20th Century. The core of spatial science, as the name implies, is the location and understanding of spatial laws; an effort that relies on methodically testing for correlations across objectively measured and collected, geo-located data sets. As its advocates observed, this was a ‘revolutionary’ turn, insofar as it cut against a prevalent regional geography. Richard Hartshorne’s *The Nature of Geography: A Critical Survey of Current Thought in the Light of the Past* (1939) in particular was subject to critique on the basis that it was deemed to be both “exceptional” and “idiographic” (Schaefer, 1953). “Exceptional” referred to the fact that geography (alongside history) was a non-systematic discipline, in that it engaged with a wealth of different phenomena rather than with a particular group of similar objects. “Idiographic”, Schaefer (1953) argued, indicated that geography dealt with specific, unique events rather than groups of data that could be used to test hypotheses and identify generalisations. For Schaefer (1953), regional geography was thus non-scientific, according to the criteria associated with a logical positivism predicated on the philosophy that only statements verifiable through empirical observation are meaningful in the sense that they

contribute to the accumulation of useful knowledge of future (predictable) events and patterns. As an alternative, Schaefer offered a “spatial science” based on the formulating of geographical hypotheses that could be tested using observable, measurable data produced under controlled conditions. This data could be analysed using statistical techniques and theoretical models imported from other disciplines such as economics, sociology and physics. This emphasis on administrative and statistical data production and analysis was often referred to as geography’s “quantitative revolution” (Burton, 1963; Gould, 1979).

From here, I go on to outline how the emergence of GIS in the late 20th century has been explained as a confluence of spatial science, the evolution of computer technology and proliferation of personal computers, and a societal need to capture, store and analyse various types of geographical data (eg., Goodchild, 1992). From the late 1960s onwards, GIS’s primary function became concerned with the representation of “real” world objects in digital form. A number of concerns, however, about GIS’s appropriateness for gathering and analysing geographic information began to emerge within and outwith the field. GIS’s origins in spatial science and resultant reliance on positivist constructions of reality, for example, therein privileging scientifically controlled observations as the only appropriate method of knowledge gathering, troubled a number of human geographers (Sui, 1994; J Pickles, 1995a; Kitchin, 2006). Further criticism focused on its emergence as a digital, computerised process reliant on limited Boolean logic to represent and process geographic information (Sheppard, 1995; Schuurman, 2000).

In Section Three I complicate the narrative so far outlined by turning in more detail to debates and concerns in the GIS literature as these unfolded. Here, I look to the annual reports produced in the journal *Progress in Human Geography*. Starting with some of the earliest progress reports on Cartography (within which GIS was discussed) and GIS *per se* in the journal, I read most of the reports from the last 35 years. I note the main concerns, ambitions, and achievements in both fields, distilling out the key points raised in each report so that I might trace the emergence of broader trends and identify some of the multiple trajectories at work in the development of GIS and Cartography. In this section, I discuss some of these broader themes as they cut across both disciplines but also moments of convergence and divergence between reports from each field.

I go on to augment these reports with the comments of key practitioners in GIS. I conducted interviews by Skype with Mike Goodchild Matt Zook, and Sarah Elwood. I asked them to give me an overview of how they came to GIS as geography scholars, and how they became invested in related practices and debates. I then asked them to sketch out some of the theoretical and

technological innovations and milestones in GIS from their perspective. This allowed me to get a more nuanced sense of the different ways in which GIS is apprehended and invested in, leading to the deployment of varied theoretical and methodological perspectives on GIS and related technologies.

In Section Four, I provide a more in-depth discussion of the ontology upon which a GIS is predicated, and to which it contributes. What I emphasise is how, on the one hand, the geographic matrix conceived by Berry (1964) is arguably at the heart of contemporary GIS. This model was formulated to define a version of reality by interpreting observations of the real world through the lens of logical positivism – this being the assumption that these observations allow one to know certain things about the real world. By plotting observations on a matrix, the spatial scientist can establish a geographical fact, something that is known about geographical reality. Furthermore, according to Fonseca *et al* (2002) in order to define this geographical space or reality one must define geographical objects. Once defined – usually by quantitative methods – these entities in geographical space can become objects within a GIS.

On the other hand, there is a much more expansive notion of ontology that can be brought to bear, one that encompasses the imaginaries, practices and materials that assemble to allow for GIS itself to emerge. In other words, what human geographers refer to as ontology, as relating to the nature of being with and outwith our individual or social experience, is quite different to what GIS practitioners refer to as ontology, as the nature of known objects within a computerised system. For example, ontology understood by critical human geographers arguing for an ‘object-orientated ontology’ accepts that there are unknowable qualities of objects; as Shaw and Meehan observe, what GIS refers to are categorised, knowable objects,

...geographers in GIScience are advancing object-oriented thought in spatial modelling to simulate insect outbreaks and tree mortality (e.g. Bone et al. 2005 2007). Modellers code ‘swarms’ of objects – bugs, ponderosa pine, clearcut tree stumps – in an explanatory framework that uses objects (and their relations) as the fundamental unit of inquiry. Agent-based modelling, increasingly prominent in geography, and the ontological questions that modellers raise about objects – including their power to affect worlds – is a bridge to philosophical discussions. (Shaw and Meehan, 2013)

In this section, I begin by discussing the key issues relating to discussions on ontology in GIS, noting what is meant by ontology in GIS and what the implicit assumptions of this definition are, focusing on categories and boundaries, scale and granularity, object-related databases, relational databases, linking databases and validity. I then go on, however, to outline current debates as to the nature of digital objects; debates that have broad relevance for the question of

‘what’ is GIS? Here, I draw attention to debates in geography on cloud computing (Amoore, 2018), the technical stack (Ash, Kitchin and Leszczynski, 2018), and the *Digital Despositif* put forward by Ash et al (2018), that address how such digital technologies are part of a broader constituted or assembled system. I also discuss how geographers have approached emotional dispositions (Kwan, 2007), and have argued for the affective qualities of screen-based technologies to be taken into account (Ash, 2013a, 2015b). Importantly, what such an expanded notion of ontology allows for is a much more nuanced account of not just of the ‘what’ of GIS, but also of its multiple origin points within the materiality of the world, including corporeal bodies, as well as stated ideas and imaginaries.

In Section Five, I turn to what it means to ‘practice’ geographical information science (GIS) within contemporary academic geography. Here, I use Jerome Dobson’s (1983) article entitled “Automated Geography”, as an entry point for discussion, which predicted a coming age where computerised machines superseded humans in the practice of quantitative analysis, allowing for greater efficiency and speed. This, amongst other commentaries, helped to prompt what was termed a ‘second wave’ of GIS that emphasized a critical analysis of its production and practice in various contexts and the explicit ‘humanising’ of GIS. In conceptual terms, geographers such as Pickles (1993) and Sheppard (1993) criticised Dobson’s “Automated Geography” on the grounds that it relied upon a false ‘objectivising’ of the GIS practitioner and prioritized authoritarian and top-down orderings of space. Throughout the 1990s debates continued, promoting a concern for the development of a ‘progressive’ GIS open to the needs of various vulnerable communities especially (Sui, 1994; John Pickles, 1995; Sheppard, 1995; Openshaw, 1997). At the beginning of the 21st Century, as computer technology advanced and the internet emerged as a profoundly important mode of analysis and communication, a social media-focused ‘Web 2.0’ made GIS more user friendly, allowing non-expert citizens to gather, contribute and structure their own spatial data in open databases and repositories and to deploy GIS for various cultural as well as political and economic ends. These technologies also encouraged other disciplines, such as literary studies and history, to begin to think about their research spatially, particularly in the interrogation of ‘big data.’

I then turn to the bulk of the section, which opens up discussion around ‘practice’. What we might call a ‘post-humanist’ approach to GIS practice is a rejection of the structural ontologies seen in earlier GIS practice. Structural ontology refers to a way of viewing the world that is governed by specific rules that dictate how phenomena relate to one another. The two main structural ontologies rejected by post-humanist practice are those of Marxist Geography and the Cartesian perspective on space. Post humanists instead view GIS as an assemblage of

interoperable parts mediated by themes such as affect, embodiment, performativity and doing. Furthermore, post-humanistic Geography includes non-human actors in this ontology and grants them agency also mediated via these themes. Post-humanist Geography thus understands practice as being situated, socially, emotionally, physically, psychologically, culturally etc. within the world, as well as a way of world-making. A broad-based turn to 'doing' in cultural Geography has led geographers, including some working with GIS, to turn to creative practice as a way of gathering and sharing knowledge about the world. Here, I offer arguments as to what a creative GIS could be composed of, looking to literatures on, curiosity and play. I outline how geographers have looked to understand experimentation as the adoption of artistic modes of representation and undertaking risky research, and by paying attention to sites of experiment. Curiosity is often cast as a relatively naïve apprehension of the unknown. Here, I discuss how geographers have looked to understand curiosity as productive, how it is evoked, focused and becomes useful in the academy. Relatedly, play too is often cast as a childish pursuit: I discuss how it has been critically interrogated in relation to affect and desire to unshackle play from such notions of childishness.

In Section Six, I outline some key issues in considering how GIS as a series of practices can be more specifically addressed. I note how geographers understand how sociality is constituted across physical and social layers of the environment. I consider collaboration as the facilitation of decision making, shared understanding, and establish common goals. Furthermore, I look to work on technological mediation as a means of understanding the materiality of spatial media, as well as unpacking relations between human and technology, and note how knowledge becomes constituted across both bodies and technology. Relatedly, I note work by geographers who look to understand work and agency in relation to digital technology, efforts to foreground the critical agency of GIS users, and how digital skill is co-produced between body and technology. Furthermore, I discuss theories of emotion and affect from geography, in relation to embodiment and attunement to affect, the situatedness of emotions, and the affective atmospheres that encapsulate both human and non-humans.

In Section Seven, I reflect on some issues that have *not* been systematically applied to GIS; that is, as a distinct node of archiving data that manifests deeper modes of knowledge production and reproduction. In doing so I begin to intimate some of my activities in using GIS as both an object of study and a data storage and retrieval system to archive my fieldwork data. I also intimate some of my activities as a 'flaneur' of this archive. In doing so I shift the content of the chapter away from the ostensible content of articles and books and towards their material form as virtual objects. This section thus addresses how archives 'work' as agents of authority,

and then turns to how archives structure the documents and knowledge they hold, in some instances to construct narratives, as a mode of remembering the past, but also the different ways in which they can be read. Further to this, I will discuss what might be termed an “embodied archive”; paying particular attention to literature from performance studies I will address the concepts of re-enactment, repertoire (Taylor, 2003) and how these ideas relate to the traditional textual archive. That is, according to Taylor, there are things that resist conscription in textual form in the traditional archive. What Taylor refers to as the repertoire are the materials remains that resist conscription; the trace of these types of knowledge morph through the bodies of those that experience it.

SECTION TWO – Spatial Science and GIS

From the Exceptional to the Nomothetic

The rise of spatial science is inextricably linked to critiques of regional geography, which prioritised the cataloguing of phenomena of a specific place. In regional geography, each aspect in an area -- for example the climatology, geology and hydrology -- is understood and articulated in terms relative to that defined region. In other words, regional geography assumes that any phenomena observed of a specific cannot be assumed typical of any set of contextual factors. Thus, general scientific laws cannot be formulated to explain a given phenomenon when translated from one area to another. In the mid-20th century, several critiques of this regional approach emerged in both physical and Human Geography, more often than not focusing on the political and economic geographer Richard Hartshorne’s (1939) normative tome *The Nature of Geography: A Critical Survey of Current Thought in the Light of the Past*. One of the most vocal critics of Hartshorne’s work was Fred Schaefer. Schaefer (1953), who argued that Hartshorne’s position was buttressed by his reliance on the philosopher Kant’s claim that Geography, like History, is an exceptionalist discipline. That is, exceptionalism holds that these disciplines deal with such a diverse range of observations that they cannot produce systematised findings; instead, such approaches seek to integrate these phenomena into a holistic understanding of a place (Geography) or time (History). As Hartshorne wrote,

To know and understand fully the character of the unique is to know it completely; no universals need be evolved, other than the general law of geography that all its areas are unique. (1939, p. 644)

For Schaefer, by contrast, in order for Geography to be considered a rigorous scientific discipline, classifications made by regional geographers must be empirically tested to generate

laws. Lacking such a philosophy, regional geographers, instead of building a discipline to compare with the natural or ‘hard’ sciences, employed some kind of insight or “artistic feeling” (Schaefer, 1953, p. 229).

In light of his dissatisfaction with Hartshorne’s supposedly unscientific geography, Schaefer went on to articulate his own version of a “nomothetic” geography based on objective observation and repeated experimentation to develop rules that could be applied to a repeating situation or phenomena if the same conditions were present. Where the systematic sciences such as physics, chemistry and biology, addressed the properties of energy and matter according to extant understandings of the laws of thermodynamics and so on, a spatial science, Schaefer argued, should be concerned purely with the spatial distribution of phenomena and not the substance of the phenomena themselves. Schaefer describes this as a matter of the division of labour among the sciences so that, for instance, the spatial was to Geography as the movement of water is to hydrology,

Hence geography had to be conceived as the science concerned with the formulation of the laws governing the spatial distribution of certain features of the surface of the earth. (Schaefer, 1953, p. 227)

The concerns highlighted by this debate were to lay a fertile ground for the ambitious new geographers of the 1950s and 1960s, as discussed by Gould (1979). This delineation of a new geography – a spatial science – was to strike a chord with other academics (Burton, 1963; Nystuen, 1963; Berry, 1964; Taaffe, 1974; Gould, 1979) who collectively placed space at the heart of geographic inquiry.

Methodologically, statistics were a crucial means of scoping data sets for significant correlations, while modelling allowed for diverse data manipulations and presentations. In this “quantitative revolution”, as Gould (1979) reflects, geographers explored new techniques, many having to learn approaches from other disciplines, such as statistics and engineering. The processing power needed here was substantially augmented by the proliferation of mainframe computers (in part brought about by the continuing Cold War) in research institutes and universities allowing researchers to test their data sets. And, this dynamism did allow geography to reclaim its significance within the academy, with the promise of tested and verified findings that could form the basis for future predictions (Gould, 1979, p. 139). Indeed, geography’s new methods could be applied at the regional level to model land use and urban and rural economies, such that even the old-fashioned regional geography could be transformed into a “regional science”.

Matrices and Plains

As spatial science took form via the quantitative revolution, a distinct ontological perspective was also to become manifest. That is, spatial science works on the assumption that there is a ‘real world’ that is made up of both objects and events that are observable and measurable via techniques that are independent of the observer’s singular identity or capacity. These objects can include individuals and groups of individuals or in fact any element of the world such as buildings, organisms, plants, machines, anything. Events are occurrences, actions, or anything that can happen such as a street festival or a volcanic eruption. To be specific, it is assumed that these objects and events -- this world -- are ‘real’ precisely because they can be observed: they can be measured and from these measurements one can infer a “geographic fact” (Berry, 1964, p. 5). A geographic fact combines three variables or dimensions (Table 1). These three dimensions are spatial, systematic and temporal. The spatial relates to the absolute spatial positioning of objects and events; the temporal to the absolute or relative time in which these events or objects occur or are positioned; and the systematic deals with the qualities or composition of these events or objects. Each column in a “geographic matrix” represents the accumulated data across various categories for a given location (Corbett, 2011).

	Colour	Shape	Temperature
Long/Lat = x	Brown	Square	Hot
Long/Lat = y	Yellow	Circle	Warm
Long/Lat = z	Brown	Circle	Hot

Table 1 - Table to illustrate the systematic and spatial axis of the geographic matrix

The geographic matrix described by Berry (1964) operationalised specific ontology, wherein phenomena are laid out across a ‘flat’ or Euclidean geography. Yet, it must be noted this was not the only ontological foundation proffered for spatial science. For Nystuen (1963), by contrast, this approach was predicated not on universal coordinates but on the body of the observer and their apprehensions of their environs. The system and set of conceptual spatial descriptors, or “fundamental spatial concepts” (1963, p. 35), defined by Nystuen systematised the language used to describe spatial qualities. To do this Nystuen put forward the idea of the isotropic plain (Figure 13), an abstract, conceptual sandpit in which the qualities of spatial phenomena could be imagined. In his scenario, Nystuen asks the reader to consider a room in a mosque. The floor is completely flat, and the room is without furniture. In this scenario, a teacher invites children to sit around him to hear a lesson. As he paints a picture of this scenario, he illustrates his three spatial concepts – direction or orientation, distance and connectedness –

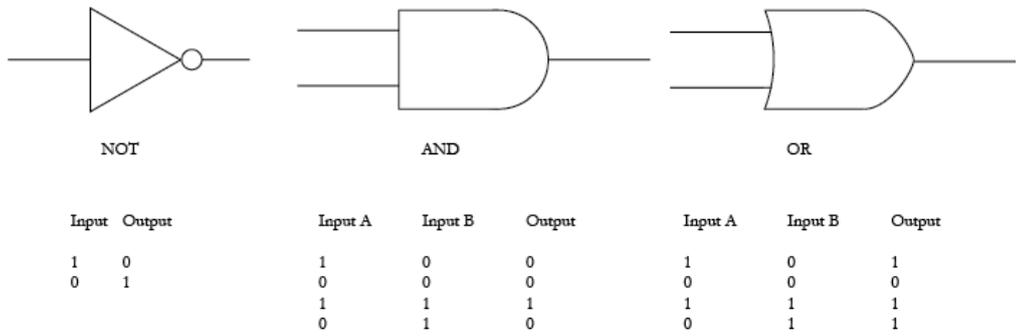


Figure 11 - Diagram to explain Boolean Logic

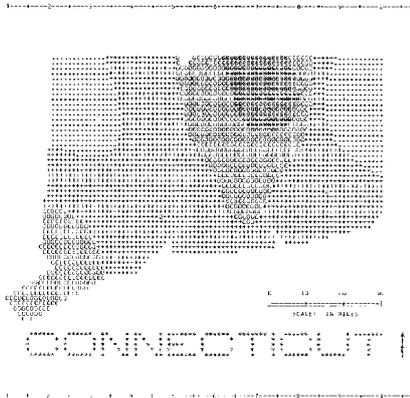


Figure 12 – Unknown (1965): Map produced with SYMAP and printed with a line printer
 (<http://www.casa.ucl.ac.uk/gistimeline/symapss.gif>, 2016)

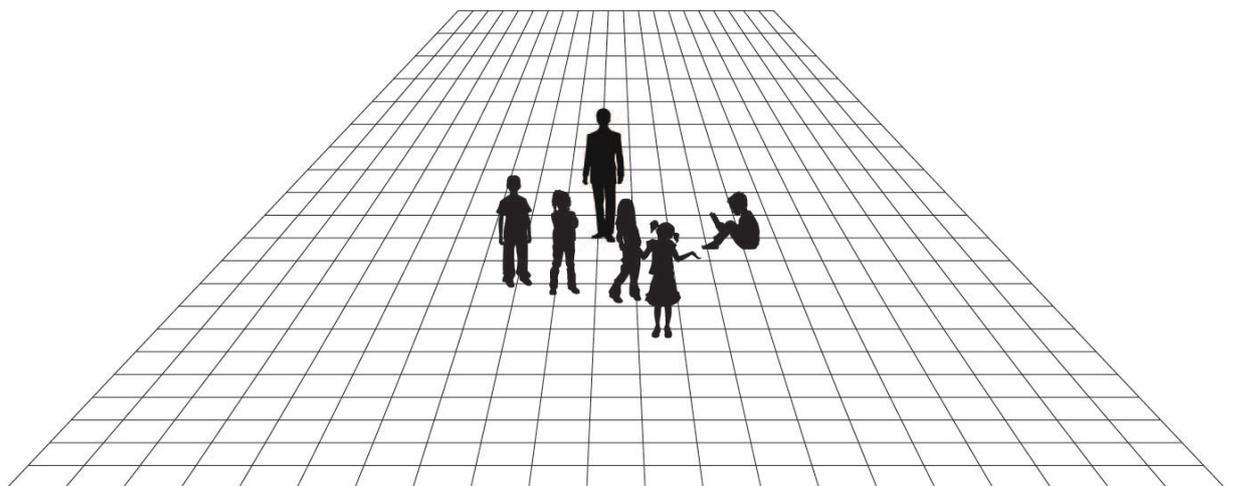


Figure 13- Illustration to explain Nystuen's (1963) Isotropic Plain

and discusses briefly their significance and irreducibility in this neutral space. Whilst Berry (1964) described an ultimately passive space across which events occur, and which exists apart from the observer, Nystuen asks the reader to consider what might be described as a relational, or phenomenological, kind of space, which is apprehended and made sense of by individuals.

Processing with Computers

As intimated above, the interrogation of data sets was enhanced considerably via computers, such that,

When used in conjunction with a computer, for example, the generation and printing directly on a map of such data as index numbers, sales figures, and average rainfall could become almost one operation. (Tobler, 1959, p. 531)

At the time Tobler was writing, computers were very large pieces of equipment requiring dedicated human operators and occupying entire rooms in universities and research facilities. For Tobler, there were clear parallels between the data-storage abilities of this new computer machinery and maps. Looking to the future, he speculated on the digitisation of cartography, reducing maps to data-storage devices through a computerised system.

During the quantitative revolution in the 1950s and 1960s, geographers began to use computers to analyse and process spatial data using the mainframe computers of the time. Though, it must be noted, their outputs were not in map form these mainframe computers could nevertheless be used for the analysis of geographic facts as described by Berry above and so have been denoted as GIS (Coppock and Rhind 1991). Calculations could be made on large datasets via computer processing even though there were no direct graphical interfaces or cathode ray tubes, and data would be loaded into the computer via punch cards. Rudimentary computer programmes were designed, and the data analysed as an input/output method. Input-output refers to information entered into the machine (input) and the resulting data coming out of the machine (output). The results of the programme were usually delivered to the operator through a line printer.

As these systems evolved during the 1960s and 1970s, their most significant achievements were more in response to societal needs than academic 'blue skies' theorising (Goodchild, 1992; Sui, 1994). In the 1960s, for example, the Canada Geographic Information System (CGIS), now recognised as the first GIS (Coppock and Rhind, 1991), was created to assist in the management of agricultural land use. This system, now iconic, allowed the capture, storage, manipulation and analysis of various types of geographical data for the first time in one unified system. During the following two decades, various GIS packages were developed, in some cases independently,

by a number of state and research funding councils. In the UK, GIS packages were developed by utility companies to manage systems such as water pipes, gas lines and telecoms. In the USA, The Harvard Laboratory for Computer Graphics did much work to create a computerised mapping package called SYMAP (later ODYSSEY). These GIS were vector-based; meaning objects on the map were made up of points, lines and areas. Maps were produced using these software packages via a line printer connected to the computer (Figure 12).

Critiquing GIS

In the mid-1990s, several critiques of GIS emerged in geography. Some focused on its positivist, technological structure and the assumptions used to model geographic reality (Lake, 1993; Sui, 1994); as Sheppard (1995, p. 5) observed, "...the ghost of positivism returned to haunt the discipline". As noted above, spatial scientists sought to employ the scientific method of logical positivism, with a new methodology involving the formulating of hypotheses that could be tested using observable, measurable data produced under controlled conditions. This positivist approach assumes that the findings of these observations are the ultimate authority for defining reality.

Critics of GIS maintain that GIS still embodies these positivist ideas even as a Human Geography refashioned by Marxism, feminist theory and post-structuralism no longer expects such absolute models of geographic reality as those espoused by logical positivism. As Sui notes, "Most post-positivist geographers believe that geographical reality is a socially and culturally produced puzzle that is infinitely complex and cannot be unproblematically represented in a GIS" (1994, p. 264). Goodchild (1992) has similar concerns, but discerns a difference between pure and applied research, as opposed to epistemic diversity. For Goodchild, insofar as GIS is generally created to fulfil a human need, "Many GIS are a response to human needs for information management and analysis, and in that sense one might expect GIS research to be more applied than pure" (1992, p. 34). For example, in resource management or the collection of census data it is more than likely that a GIS user will be an applied rather than a pure scientist (*ibid.*) and perhaps not so concerned with critical geographical debates. Perhaps, it has been suggested, the users of GIS are more often applied rather than pure scientists, thus preventing them from entering into the debate of why positivism is an ineffective position from which to model geographic information (Sui, 1994; Sheppard, 1995). For Openshaw (1997), such differences are augmented by what he sees as a form of conceptual navel-gazing, wherein the sophisticated language of theoretical debate is "...strongly encoded in linguistic jargon that while still English, [are] incomprehensible to virtually all GIS practitioners" (1997, p. 8).

Leaving aside the specialised languages used by Geographers, Sui (1994) points rather more productively to what he calls an “epistemological inflexibility” (1994, p. 226) inherent in GIS. Because it is a computer-based technology, he argues, GIS relies on Boolean logic. Boolean logic is the logic of digital computers. In a computerised digital process, information is processed according to varying arrangements of logic gates (Figure 11). In the digital machine results are delivered via NOT, AND and OR logic gates. All logical queries asked of a Boolean system are thus considered via these, and conjunctions of these three logic gates. The NOT gate inverts the signal entering; the AND gate requires both inputs to receive a signal for a positive response; and the OR gate requires only one of the inputs to receive a signal for a positive response. Therefore, any computer language or code is written to sequence a specific arrangement of these logic gates. It is argued, therefore, that even a theoretically imbued GIS is still just a “transformation of theory into a set of operation rules.” (Sui, 1994, p. 266). Because of this, there is a danger that GIS is “dominated by the structure of the technology, rather than by the structure of the problems facing modern society” (Sui, 1994, p. 265). Sheppard (1995) shares Sui’s concerns about GIS’s connection to Boolean logic, noting, “the direction taken by GIS is constrained by the structure and logic of Turing machines” (1995, p. 8).

Sui (1994) goes further with his critique of the Boolean underpinnings of GIS (again echoed by Sheppard, 1995), and suggests that the structural and epistemological limitation of the programming of GIS is also an ethical concern. “GIS analyses have promoted a technocratic geography serving the interests of existing power structures,” Sui continues: “Who can access this technology and enjoy the benefits of it will depend on who is willing to pay, not on who really needs it” (1994, p. 267). Similarly, Coppock and Rhind (1991) express disappointment that geographic information in the UK is not in the public domain. The Ordnance Survey (OS) in the early 1990s was still majority funded by cost recovery from access to their databases and maps. Summing up such criticism, then, there are two conditions here working against the democratisation of geographic knowledge. Firstly, access to GIS is primarily controlled by commercial enterprises; and secondly, even if access was open to anyone with a personal computer the system is still reliant on a limited interpretation of the world (Sheppard, 1995; Schuurman, 2000).

In 1997 Stan Openshaw wrote a paper reacting to the growing criticism of GIS, generally by human geographers and specifically relating to chapters in the book edited by economic geographer John Pickles, *Ground Truth: The Social Implications of Geographic Information Systems*. In his paper, Openshaw defends GIS, at the outset labelling Pickles *et al’s* criticism as a misinformed, and ultimately a “nihilistic” (1997, p. 8) deconstruction of GIS. Openshaw

specifically challenges the political and ethical issues that critics of GIS have highlighted and the assertion that most GIS applications,

... are concerned with the management of the physical infrastructure such as those involving drains, wires, pipes, parcels of land, and roads. Indeed, the vast majority of all GIS applications involve little more than a digital replacement for the well-established paper mapmaking, recording, and handling industries. (1997, p. 8)

Openshaw mocks the non-GIS human geographers' "nihilistic destruction by seemingly endless and rampant deconstruction of anything for which there is a publication opportunity" (Openshaw, 1997, p. 8). From an angle that is reminiscent of Schaefer's criticism of Hartshorne's regional geography, Openshaw calls into question the practice of these geographers, suggesting that what they are doing is not actually geography. In a similar vein to Schaefer (1953), Openshaw invites critics of GIS, if so repulsed by "map-related geography", to find another discipline. He notes that,

There is an alternative and less charitable interpretation here: to ask whether or not critical human geography has moved so far away from the world of GIS and any kind of map-related geography that it has in fact become so non-geographical that its advocates may well feel more comfortable in some other discipline (1997, p. 7).

While the fundamental reliance of a map-based GIS on absolute location necessarily remains, it must be noted that in recent decades the use of relative location information has considerably shaped the debate around GIS and ethics. As Mei Po Kwan explains, such relational information – echoing the phenomenological inquiry of Nystuen – can be used to integrate locative media with "self-expression and the articulation of emotional geographies" (2007, p. 23). What Kwan has in mind here is how a recording of the multi-dimensional world can be made, and then re-narrated within a GIS framework, such that Kwan better articulates, "the complex realities of gendered, classed, raced, and sexualised spaces and experiences of individuals" (2007, p. 24).

What is more, while the screen may reveal,

many physical elements that are considered to be parts of the objective reality and scientifically visible 'facts' of the study area (e.g., buildings and roads) ...they are rendered from the GIS database with symbolic and artistic techniques, which helped to create an expressive visual narrative that was produced collaboratively with the informant." (2007, p. 27).

In this vein, the self-expressivity of the research, as well as a co-production of knowledge, can be accomplished. Hence, for Kwan certainly, the positivism underpinning GIS is by no means

the only episteme that can be brought to bear by GIS practitioners a hybrid mode, informed by a feminist inquiry into emotional conditions and relational forms of knowledge can be actualised.

In similar vein, it is this capacity for GIS – despite the need for a geo-locatedness - to express particular visions of the world that is of importance insofar as it allows for alternative renderings of the world and our place within it. Indeed, GIS can even, as Amoore's discussion of the artists Terry Paglen's photographs of the US' surveillance infrastructure makes clear, be used to turn the critical gaze back upon the same confluence of data organisation and computing that helped GIS itself develop. Amoore writes,

Among the critical geographical accounts of cloud computing, the desire to wrest the cloud into an intelligible form similarly finds expression in methods of visualization. The geographer and artist Trevor Paglen seeks to 'make the invisible visible', reflecting that 'the cloud is a metaphor that obfuscates and obscures' the material geographies of the 'surveillance state' (2016, p. 6)

Going one step further, Leszczynski and Elwood (2015) discuss the notion of affordances, that is, the potential ways in which a technology can be used apart from (and including) the 'design features' of the technology. They give an example of the way in which software like *Girls around me* – a 'hook up' application designed to scrape location data from check-ins on *Foursquare* for female sounding names -- renders that information to a smartphone screen, so that the user will be able to locate venues with a high concentration of women. Such knowledge, they argue, can afford a sense of security in women users as to the use of space. This app exemplifies for them how the 'affordances' in the design of the *Foursquare* app and other 'open' social networking apps and how they manage the 'data flow' can be used for means not intended by the creators. This particular affordance allowed for as Leszczynski (2016) terms it, "the rendering of vulnerable bodies" through 'affordances' of a masculinist heteronormativity.

Summing Up

From Schaefer's (1953) concerns that geography was not scientific enough, and his criticism of the regional geography advocated by Hartshorne (1939) geography has indeed changed since the mid-20th century. Schaefer's desire for Geography to become more nomothetic, to strive towards the formulation of scientific laws describing spatial phenomena rather than what he termed "ideographic" studies, taxonomies, fact gathering and cataloguing, led to a significant change in geographic methodology. In the following two decades, geography adopted a more scientific method in line with the logical positivistic approaches of the scientific method. Spatial

science was born out of this so-called quantitative revolution. With the application of mathematics, statistics and sophisticated spatial modelling techniques researchers had to work with great precision. As Gould (1979) reflects, it was a time when geographers explored new methodological territory. Geographers working during the quantitative revolution, such as Berry (1964), with his geographic matrix which operationalised spatial analysis into three dimensions; and Nystuen (1963), with his isotropic plain, which described a conceptual model describing interconnecting spatial relationships, established a rich framework for future scholars.

Later, with the increasing speed and efficiency of mainframe computers, spatial science soon found countless practical applications in society with the emergence of GIS. However, some geographers (Lake, 1993; Sui, 1994; Sheppard, 1995; Pickles, 2006) found problematic the overly positivistic and inherently Boolean underpinnings of GIS, pointing to the privileging of such a mode of knowledge production. Certainly, access to GIS is still relatively limited despite the exponential increases in computer speed and access, contrary to the hopes of Dobson (1983); his anticipated “joystick generation” (1983, p. 141) -- meaning those born after the 1980s, and maturing through the 1990s with a familiarity with computers beyond the generation before – remains skewed by location, gender and ethnicity. Certainly, GIS software packages such as those produced by ESRI remain expensive and are only accessible to those in higher education. Even with the proliferation of Google Earth, the doors are still closed to most computer owners. Google Earth, although downloadable for free, is for most users little more than a “digital peep box” (Lammeren and Bergsma, 2006; Kingsbury and Jones, 2009) with the full potential of its geographical analysis tools still on the periphery. Aside from Google Earth, there are a number of open source GIS projects, but these still require much technical expertise. It is disconcerting that those debates in the mid-1990s, albeit heated, mostly concluded by noting a real desire for dialogue and continuing debate to bridge the gap, and yet nevertheless the divide still exists.

SECTION THREE: Complicating Narratives of the Emergence of GIS

Progress Reports

In order to complicate the narrative outlined so far, I delved into the detail of reports appearing in the journal *Progress in Human Geography* (the reports are listed in Table 2). The journal itself is concerned with theoretical and philosophical matters pertaining to Human Geography, and so these reports strive to situate GIS within broader disciplinary concerns and issues.

Table 2 - Progress in Human Geography Reports

Year	Author	Title	Subject	Issues addressed
1986	Blakemore	Cartography and geographic information systems	Cartography & GIS	<ul style="list-style-type: none"> • Innovation held back by cold war • Global differences in data practices • First GIS textbook • Distributed computer systems • Use of GIS and digital cartography in military, navigation and TV news graphics
1988	Goodchild	Geographic information systems	GIS	<ul style="list-style-type: none"> • The formation of the National centre for geographic information and analysis by the NSA. • Investments by the academy in staff, courses and research funding in GIS. • Innovation in GIS as being mainly tech driven.
1990	Blakemore	Cartography	Cartography	<ul style="list-style-type: none"> • GIS development driven by demands of North America – mostly forestry and resource management. • Call for increased availability of cartographic datasets, capacity for dealing with massive datasets

				<ul style="list-style-type: none"> • Critical of significance of time-saving improvements to software
1991	Goodchild	Geographic information systems	GIS	<ul style="list-style-type: none"> • Challenges in standardising terminology. • Disconnect between the concerns inherent in cartographic representation and GIS. • Critiques limitations of vector and raster representations of space.
1992	Smith	History and philosophy of Geography real wars theory wars	GIS	<ul style="list-style-type: none"> • Discussion of GIS and relationship to first Gulf War
1992	Blakemore	Cartography	Cartography	<ul style="list-style-type: none"> • Calls for more attention to design of symbolism, contours, and line enhancement. • In GIS software, more efforts should be made to meet social need rather than market demand – more attention to vulnerable people.
1993	Lake	Planning and applied Geography positivism ethics and geographic information systems	GIS	<ul style="list-style-type: none"> • Concerns relating to an apparent unchecked positivism. • Lake claims positivistic categorisation in GIS fails to account for the complex nature of power

				relations such as those relative race, class, and gender.
1994	Curry	Image practice and the hidden impacts of geographic information systems	GIS	<ul style="list-style-type: none"> • Discussion of distinction between chronological and narrative structures of time in terms of representation for GIS.
1994	Unwin	Cartography, ViSC and GIS	Cartography	<ul style="list-style-type: none"> • Reflects that the expertise in visualisation encompassed by cartography and its relationship to the larger field of scientific visualisation. • Discusses the work of Bertin to establish cartographic 'graphic variables'
1995	Unwin	Geographical information systems and the problem of ' error and uncertainty '	GIS	<ul style="list-style-type: none"> • Discussion of issues relating to error and uncertainty in GIS. • Concerns about reliability and validity of data, and practices of data capture and analysis. • The differences between, and the historical benefits of, both raster and vector data
1996	Unwin	GIS, spatial analysis and spatial statistics	GIS	<ul style="list-style-type: none"> • GIS as a tool for spatial statistics

				<ul style="list-style-type: none"> • Proposes recommendations for the creation of GISable techniques for spatial statistics.
1998	MacEachren	Cartography, GIS and the World Wide Web	GIS & Cartography	<ul style="list-style-type: none"> • Discussion of early mapping websites. • Distribution of digital mapping • Spatial referencing • Web user interactivity • 3D virtual environments
2000	MacEachren	Cartography and GIS: facilitating collaboration	GIS & Cartography	<ul style="list-style-type: none"> • Collaboration in PPGIS • Empowerment of disenfranchised participants in policy decisions • Encoding non-metric information
2000	Schuurman	Trouble in the heartland GIS and its critics in the 1990s	GIS	<ul style="list-style-type: none"> • Science wars and relationship to critical GIS debates. • Overview of first and second wave critical GIS. • Calls for attention to GIS in relation to literature on the cyborg.
2001	MacEachren	Cartography and GIS: extending tools to support virtual teams	GIS & Cartography	<ul style="list-style-type: none"> • Identifies GIS as predominantly a solitary practice • Distributed computer systems

				<ul style="list-style-type: none"> • PPGIS and decision making • Disaster management applications
2002	Longley	Geographical Information Systems will developments in urban remote sensing and GIS lead to 'better' urban Geography?	GIS	<ul style="list-style-type: none"> • Methods for classification in urban remote sensing • Neural networks • Ancillary data
2003	Perkins	Cartography: mapping theory	Cartography	<ul style="list-style-type: none"> • Discusses rejection of maps by humanist and Marxist geographers. • Mapping as performance • Efforts from artists to confront power relationships in maps.
2003	Longley	Geographical Information Systems: developments in socio-economic data infrastructures	GIS	<ul style="list-style-type: none"> • Inadequacies in census data for urban geographers. • Increase in availability of commercial data.
2004	Perkins	Cartography - cultures of mapping: power in practice	Cartography	<ul style="list-style-type: none"> • Reluctance of cultural geographers to engage with maps
2004	Longley	Geographical Information Systems: on	GIS	<ul style="list-style-type: none"> • Advancements in networked

		modelling and representation		communication systems and visualisation
2005	Monmonier	Cartography: distortions world views and creative solutions	Cartography	<ul style="list-style-type: none"> • Advancements in map projection systems • Data access policy in post 9/11 USA • Geopolitics and Iraq war in relation to cartography
2005	Longley	Geographical Information Systems: a renaissance of geodemographics for public service delivery	GIS	<ul style="list-style-type: none"> • Aggregation of census and demographic data in economic urban Geography.
2005	O'Sullivan	Geographical information science: time changes everything	GIS	<ul style="list-style-type: none"> • Discusses attempts to more appropriately represent time in GIS, particularly pertaining to human geography applications • Notes the implications and foundational influence of Berry's geographical matrix.
2006	Monmonier	Cartography: Uncertainty, Interventions, and Dynamic Display	Cartography	<ul style="list-style-type: none"> • Uses of interactive cartography by local and national crime agencies • Use of new technologies such as GPS and PDA devices. • Uncertainty in cartography -ethic, modelling, file formats.

2006	O'Sullivan	Geographical information science: critical GIS	GIS	<ul style="list-style-type: none"> • Themes emerging from initiative 9 - PPGIS, gender (feminist GIS), and privacy
2007	Monmonier	Cartography: the multidisciplinary pluralism of cartographic art, geospatial technology, and empirical scholarship	Cartography	<ul style="list-style-type: none"> • Web mapping as confluence of GIS and telecoms • <i>Google Maps Mashups</i>
2007	Dunn	Participatory GIS – a people's GIS	GIS	<ul style="list-style-type: none"> • The objectives for Public Participatory GIS (PPGIS) • Widening participation, to marginalised groups. • How to deal with information that has never been written down, has been handed down in oral traditions
2009	Elwood	Geographic Information Science: new geovisualization technologies – emerging questions and linkages with GIScience research	GIS	<ul style="list-style-type: none"> • Geoweb and reliance on web 2.0 • Geoweb as originating from public technologies • Allowing for integration of various forms of digital media • Representation, reproduction and (user) modification of imagery.

				<ul style="list-style-type: none"> • Issues of surveillance, exclusion and erosions of privacy.
2009	Crampton	Cartography: performative, participatory, political	Cartography	<ul style="list-style-type: none"> • Maps as practice • Map art • NRT • Artistic elements of Cartography
2009	Crampton	Cartography: maps 2.0	Cartography	<ul style="list-style-type: none"> • Web 2.0 mapping platforms • Virtual globes – <i>Google Earth</i> • Free and Open Source GIS (FOSSGIS) challenging the dominance of proprietary developed software. • Crowd sourcing • De-professionalisation
2010	Elwood	Geographic information science: emerging research on the societal implications of the geospatial web	GIS	<ul style="list-style-type: none"> • VGI and neogeography • Politics of spatial data – copyright, privacy, inequalities, data standards, etc. • Curation of datasets • The geocoded citizen
2010	Elwood	Geographic Information Science Visualization: visual methods and the Geoweb	GIS	<ul style="list-style-type: none"> • Use of Geoweb applications by activists, NGOs etc.

2011	Caquard	Cartography I: Mapping Narrative Cartography	Cartography	<ul style="list-style-type: none"> • Storymaps • Locative Media • Geo-referencing
2014	Caquard	Cartography II: Collective Cartographies in the social media era	Cartography	<ul style="list-style-type: none"> • Collective and community mapping practices • Indigenous cartographies • VGI • Crisis mapping • Reliability of crowd sourced cartography • Decreased role of the state in mapping
2014	Caquard	Cartography III A post representational perspective on cognitive cartography	Cartography	<ul style="list-style-type: none"> • Participatory mapping platforms – <i>Google Maps, Street view</i>
2017	Dodge	Cartography I: Mapping deeply, mapping the past	GIS	<ul style="list-style-type: none"> • GeoHumanities contributions to cartography • Geo-referencing of Historical Maps

What appears, from the mid-1980s to the early 1990s, is a focus on the foundational formalising of strategies for GIS in academia and government. Questions such as ‘what is GIS for?’ and ‘how should universities and national governments invest?’ were common. Debates are focused around differences in global data practices (Blakemore, 1986), national priorities for geographic research (Blakemore, 1990), the availability of geographic datasets, and issues of cartographic representation (Goodchild, 1991).

The impression that emerges from these early reports is a concern to situate, and give authority to, GIS as an academic field (epistemologically connected to but distinct from Cartography) as well as a technological apparatus that had political utility and was attracting increased levels of

investment as such. In this vein, Goodchild distils the benefit of GIS as a, “computer system for input, storage, analysis, and output of spatially referenced data” (1988, p. 560). They allow the user to efficiently analyse, inventory, overlay, and do measurements of geographical data. Blakemore (reporting on Cartography, 1986) refers to some notable accomplishments in the application of GIS and digital cartographic visualisation in the military for weapon systems, battlefield displays and automated vehicle navigation, map graphics for TV news and election coverage, and disaster response planning. However, Blakemore (1990) does reflect that GIS development was predominantly driven in the 1980s by particular demands; that is, mostly in the development of applications for forestry and resource management. By the late eighties, it is noted, interest in GIS was gathering momentum and greater investments were being made in GIS from both universities and national governments. In 1985 the first GIS textbook was published (Blakemore, 1986), and in 1987 the first dedicated GIS journal was launched (Goodchild, 1988). In the USA, the National Science Foundation (NSF) formed the National Centre for Geographic Information and Analysis, formalising a national commitment to the technology. Similar commitments were also made in the UK in the formation of the Regional Research Laboratories. Furthermore research funding was being directed towards using GIS, notably relating to its application to and with statistics, the development of database ontologies, visualisation technologies, and thinking about applications for social science (Goodchild, 1988). As a result of Cold War sanction upon Eastern Bloc countries, Blakemore (1986) observes, innovations in GIS were being ‘held back; for instance, it was not possible to export 32 bit computer systems to the eastern bloc and India (Blakemore, 1986). There were differences in data practices globally, especially regarding socio-economic data. For example, the USA and UK having different policies on who has access (Blakemore, 1986).

Goodchild (1991) notes that as problems of cartographic representation were being resolved to various extents, the practice and research of GIS was concerned with the standardisation of terminology. Furthermore, the task of creating appropriate ontologies for GIS databases was still somewhat unresolved, as databases were still centred around cartographic standards rather than the modelling geographic reality. According to Goodchild (1991) there is a disconnect between the concerns inherent in cartographic representation – proper communication and representation using lines on paper - and those of appropriately modelling geographic reality. At a more conceptual level, however, Goodchild (1991) also discusses the appropriateness of GIS beyond a ‘container conception’ of space: at the lower levels of planning this can be reasonably effective and adequate for representing space, however at higher more abstract levels of abstraction an understanding of other spatial imaginaries is missing. Similarly, Goodchild notes the limitations of vector and raster representations of space, as these fall short of

modelling the dynamism of geographical reality. That is, GIS should strive to manage changing, temporally dependent phenomena. For Goodchild (1991), the vector model sees the world as a collection of point, line and area objects, and defines their locations and attributes, while the raster model defines what is present in every one of an array of finite elements. Both have abundant analogues in vision and graphics, but, according to Goodchild (1991),

both models are seriously deficient as bases for describing real geographical variation, as distinct from the contents of maps. And they fail to deal with the human propensity for giving objects identities that are independent of their physical manifestation at any particular scale (1991, p. 197).

Whilst these systems can be configured to visualise appearances and disappearances of geographic phenomena, for a geographer this too does not go far enough to model the nuances of geographical reality. To put this another way, Goodchild (1991) is arguing that GIS systems, built upon systems designed to deal with digital mapping – essentially digitising cartography – favour a visual impression of variation over an inventory of geographic phenomena over and against a precise analysis (Goodchild, 1991). Relatedly, though focused on the integration of cartography, Blakemore (1992) calls for more attention to issues in cartography such as those around symbolism, contour, design and line enhancement.

Reports from early 1990s are concerned with epistemological questions relating to positivism (Lake, 1993), precision and accuracy and error and uncertainty (Unwin, 1995), representation, algorithms and statistics. According to Lake (1993), for example, despite the retreat from positivism in geography and Planning theory towards post structural ontologies, GIS heralded a resurgence of positivist problem solving in research. His concern lies in what might be termed an ‘epistemic lock-in’, as larger investment in the technology gathers momentum it will be far more difficult to undo, or retrofit, GIS positivistic ontological foundations:

Breaching the divide at the core of planning and geography will be possible only to the extent that developers of geographic information systems are willing to relinquish their positivist assumptions.

Lake frames his concern with positivism from an ethical standpoint. He notes how ethical protocols in the practice of information technology can go some way to alleviating issues relating to information technology reinforcing existing power structures but that these cannot fully account for the harm that might be done. Whilst individuals and groups of users can operate practices that ensure privacy rights are adhered to, wider access and participation is advocated and stronger safeguards are designed into GIS databases, such codes of practice, do

little to address underlying positivistic assumptions, or as Lake (1993) explains, “Equal access is ethically insufficient if it provides access to an ethically flawed project” (1993, p. 407). The problem lies in GIS’ ‘othering’ of research participants in a positivistic subject object relationship. Furthermore, Lake (1993) claims positivistic categorisation in GIS fails to account for the complex nature of power relations such as those relative race, class, gender which are not adequately represented in GIS. He warns, the answer is not more data, but whether GIS is able to integrate, “fundamentally different categories of data that extend considerably beyond the ethical, political, and epistemological limitations of positivism”(Lake, 1993, p. 411). This querying of the epistemic framing of GIS is echoed by Curry (1994), who makes a distinction between chronological and narrative structures of time. Where chronology allows different events to exist in the same sequence in a mutually or analogous relationship, narrative allows for the entirely necessary (according to post-structuralism, Curry argues) inclusion of point of view, but prevents congruency across multiple events. Thus:

while it is possible to take a number of chronologies and put them together, when narratives are put together one gets not a single more complete story but rather a series of juxtapositions (Curry, 1994, p. 447).

In counterpoint to Lake’s broad conceptual querying of GIS, Unwin (1995) expresses concern relating to the issue of error and uncertainty in GIScience. Unwin notes that errors often occur because the researcher does not have the same understanding of the results had he or she done the analysis by hand: “You have an answer, but you do not know how good it is” (1995, p. 549). These errors have a tendency to propagate through the GIS workflow and processes. To an extent, this is a response to critical GIS debates questioning GIS’ suitability to adequately represent the world. Here, these questions about appropriate representation push beyond concerns about technical accuracy into uncertainty around the reliability and validity of data, and practices of data capture and analysis. Though computer processing benefits from increased precision, frequently used algorithms have been shown to frequently yield erroneous results (Unwin, 1995). Unwin explains that a better understanding of the data (in terms of what it is supposed to represent and its potential shortcomings in digital form) allows us to mitigate for errors in processing. Essentially, what underlies this is an inherent incongruence between imagined (real) and modelled reality (Unwin, 1995). Unwin suggests a few methods that might be used mitigate for these kinds of errors in geo-processing:

- Using the visualisation functions in GIS software to identify errors in interpolation.
- The creation of software tools that would GIS users to see how errors propagate through GIS operations and processes.

- Using a different database structure, “based on object-orientated technology... within this framework the objects would have to be allowed to be fuzzy, have uncertain boundaries, and evolve on both database and modelled real time”(1995, p. 555).

By the mid-1990s much of the practical expertise of cartography could be done by computer systems such as GIS (Unwin, 1994). In his 1994 progress report on cartography, Unwin reflects that the expertise in visualisation encompassed by cartography and its relationship to the larger field of scientific visualisation. Indeed, the report reads a little like a swan song for cartography as a skillset once of particular significance in geographic scholarship. As such, Unwin argues the case for the continuing significance of the field of scientific visualisation (VISC) (of which cartography is part) as a sub-field of expertise with geographic research. He argues for the lasting significance of VISC (and cartographic methods of visualisation) to geography because its attention to visualisation, as not purely as a method of communication and display, but as a legitimate form of analysis. Unwin (1994) gives the examples of the work of Bertin to establish cartographic ‘graphic variables’ demonstrating the wealth of knowledge within cartography in regards to how such data is visualised and the visual capacities of maps.

Also important to the growth of GIS as a tool for geographic research was the development and integration of spatial statistics. According to Unwin (1996), the key drivers of the uptake of GIS in terms of statistics were an evolved body of theory in spatial statistics that did not exist during the quantitative revolution, including density estimation, kriging and K-function which were developed during the 1980s, and greater access to large datasets and affordability of computer systems. However, he notes that work is still to be done in developing ‘GISable’ techniques for statistical analysis, which he asserts must fulfil the following criteria: an ability to process large datasets; be study region independent; they must be mappable; and be useful in an applied sense.

Around the turn of the century, a marked attentiveness to issues of participation - only hinted at before - is apparent. This theme of participation can be further broken down into subthemes relating to reassessment of GIS as practice (solitary or collaborative) (MacEachren, 2000), interactivity (online), how to design hardware/network architectures to facilitate greater participation. MacEachren’s first report on cartography and GIS in 1998 takes up the emergence and growth of online mapping platforms to potentially facilitate greater participation. This report, however, focuses more on the technical achievements and areas for improvement in the early web mapping services. MacEachren outlines the potential for such mapping websites to allow for: increased user interactivity; development of 3D Virtual worlds and environments; hyperlinking and spatial referencing to any other www object (webpages, images, text

documents). For MacEachren (1998) decisions needed to be made about how these systems are distributed, this includes considering options for storing data on a server, to be accessed on-the-fly (i.e. as and when the user requires it) or stored locally on the client machine. These are issues relating to system architecture, about the physical and digital arrangements of things like data storage, graphic display, interface controls. MacEachren (1998) recognises the potential to use maps as an underlying structure to order all kinds of information, so that maps become the underlying structure on top of which all other data is organised - in the same way the html is used to order and structure webpages.

Furthering this move to broadening the participatory potential of GIS, MacEachren (2000) takes up the issue of collaboration in working with GIS. His entry point here is same place synchronous working practices, and specifically those that have been tested with public participatory GIS (PPGIS) applications. He notes that the PPGIS project is an attempt to address calls for a more socially inclusive GIS. According to MacEachren PPGIS aims to:

- Empower disenfranchised participant in policy decisions
- Involve researchers who focus on socio-spatial issues, development and implementation of technology to those ends
- Address the perceived failure of traditional GIS to encode much of what matters about place to stakeholders.
- Encoding non-metric information.

MacEachren (2000) outlines the contribution that PPGIS has made to thinking about collaboration in GIS. To this end, MacEachren discusses:

- The types of display technologies that are useful in same place GIS collaboration
- How group work in GIS can integrate and visualise different viewpoints.
- How consensus is built in group work.

Furthermore, as if to confront the notion that GIS is often seen as solitary practice, and thus, “developed for use by individuals”, MacEachren (2001, p. 431) provides an overview of some efforts to enable GIS to be applied in a context where users are working in a different place at the same time. For MacEachren, what is important here are developments in distributed information systems and contributions from work on PPGIS that allow users to resolve decision making issues, formulate and code arguments, and facilitate discussion about geographic objects to incorporate multiple viewpoints into shared perspectives.

At the turn of the century, Schuurman (2000) provides a sustained overview of the critical GIS debates that took place during the 1990s, giving these a broad academic context but also providing a 'legacy' for future work. She refers to these debates as the 'GIS wars', after similar debates going on between Science and Technology Studies and the hard sciences. She notes some points of distinction between the two debates, in that:

- The 'science wars' were concerned with one discipline critiquing another, whereas critical GIS involved geographers critiquing the use and relevance of technology within their own discipline.
- The critical GIS debates were overt discussions opposed to the under-handedness of Sokals hoax paper, for example.
- The idea of GIS being socially constructed was never really the focus of debates in critical GIS.

Looking back over a range of literature, Schuurman (2000) proceeds to position these as 'waves'. As such, debates in the 'first wave' were centred around epistemological concerns that apprehended GIS as troublingly positivistic and at the risk of indulging in "naive empiricism" (Taylor quoted in Schuurman, 2000, p. 572), where GIS is good for storing data but offers little for meaningful analysis. Others warned that, "technology *can* wound and kill, and it is essential that geography reflect upon it's culpability" (Schuurman, 2000, p. 575). Schuurman notes that by the mid-nineties engagement in these debates from proponents of GIS had somewhat waned – most probably due to the demands of the increasing popularity and demand for their expertise. Nevertheless, in the late 1990s workshops and panel discussions brought practitioners from both sides of the debate together, "[f]ollowing the admonitions of Donna Haraway to engage with the cyborg rather than critique it from afar (1991), these critics initiated practical means to democratize the technology as well as increase public participation in its use (Schuurman, 2000, p. 587).

The progress reports on GIS written under the tenure of Paul Longley are more focused around the uses and increased availability of economic datasets moving towards big data. Longley (2002) is concerned with methods for classification in urban remote sensing. Longley attributes recent progress on the field of urban remote sensing to advancement in technical areas, such as improvements in hardware devices, and increased resolution of data. However, he notes concern about the "operational usefulness" (2002, p. 233) of urban remote sensing to urban geographers. Longley describes the difficulty in translating Land-*cover* (as remote sensing interprets imagery) into Land-*use* (as of interest to urban studies). One solution is to use ancillary

data and neural networks to do this work - requiring training of such systems. Instead of using ancillary data to complement, train, or calibrate neural networks work on interpreting land use from land cover, better measurements are what we need to provide better insights from remote sensed imagery in an urban studies context. Furthermore, Longley (2003) outlines how some urban geographers are finding census data inadequate for their work, and how social area analysis in human geography and geodemographics might benefit from GIS applications. In his last report Longley (2004) focuses specifically on issues pertaining to GIS as a system for modelling reality, and the advancements in networked communication systems and visualisation that allow this. He asks how census and demographic data from the public and private sectors might be aggregated in GIS for value in economic urban geography.

In reports following, there is now a marked divergence between the reports in cartography and those focused on GIS. Perkins' (2003) cartography report, for example, looks to reconcile disciplinary differences within geography in relation to maps with the import of artistic and performative notions of mapping. Perkins (2003) discusses an apparent rejection of maps by humanist and Marxist geographers. According to Perkins, "quantitative geography and cartography have been devalued within human geography following the cultural turn" (2003, p. 341). He identifies two camps engaged in mapping debates as those who research mapping as a practical form of applied knowledge and, "those who seek to critique the map and the mapping process" (Perkins, 2003, p. 341). For Perkins, most work in map design is thus focused on usability, communication, thinking through comparative analysis of map design and usability studies underpinned by cognitive and, semiotic approaches. For scholars influenced by critical social theory such research in applied mapping works from the assumption or an a-theoretical view of the map as a 'Mirror of the world', apprehend maps as a social construction. For Perkins (2003), the difficulties in resolving these two perspectives are both the lack of strategy potential to "reconcile modernist science and postmodern critique" (Perkins, 2003, p. 347), and a lack of cross citation.

However, quite aside from this discrepancy between applied and critical mapping discourse are the debates that frame mapping as performance (Perkins, 2003). Here the map - as performance - has been figured in relation to cultural theorists such as Foucault and Deleuze and Guatarri so that the process of mapping becomes the telling of a story. Furthermore, Perkins notes the contributions from artists who, "emphasise the complex and nuanced ways in which the power relationship in mapping practices is exercised" (Perkins, 2003, p. 346). For Perkins, what is also relevant is Ingold's conception of the relationship between map and mapping - where the map is an inscribed mapping and mappings are the narrativisation of a journey.

Monmonier's first report (2005), is a more technical and pragmatic detailing of advancements in projection systems, data practices in the US post 9/11, and cartographic developments resulting from the Iraq war. His subsequent report (Monmonier, 2006) discusses the uses of cartography by national and local crime prevention agencies and, and beginning to speak to my theme of growing momentum in participation in and interactivity, noting how the police, as non-cartographers utilise interactive mapping. He briefly notes the significance of new technologies such as GPS and PDAs have in the practice of collaborative mapping for the facilitation of decision making, dialogue enabling, and the prototyping of new collaborative mapping platforms. Monmonier (2006) also discusses impact policy, dynamic mapping, and uncertainty noting how cartographers introduce uncertainty into maps, for instance in digitising lines or saving to different file formats. Monmonier (2006) explains that any form of modelling will introduce uncertainty, such that in translation of file formats, adjustments in resolution, and so on, the user is translating data into a less complex system with different or coarser ontologies, increasing the level of uncertainty in any real world application of the outputs.

In counterpoint, GIS reports from 2006 and 2007 see greater attention paid to participation and interactivity in PPGIS. O'Sullivan (2006) discusses the lasting significance of those concerns from the mid-nineties making an assessment of their significance for contemporary GIS debates, most notably those that lead to the development of PPGIS. O'Sullivan cites 3 of 7 themes that emerged from initiative 19. Initiative 19 was organised by the US National Center for Geographic Information and Analysis (NCGIA) to bring critics and users of GIS together and set a research agenda to promote a more socially appropriate GIS. Advancements in relation to this research agenda discussed were PPGIS, gender (feminist GIS), and privacy. According to Dunn (2007) the PPGIS effort looked for a way to create GIS that were more representative of groups other than the predominantly white males employed by academic and governmental institutions in north America. Dunn refers to Kwan who proposes that we might think what else a GIS might be, and or "break the positivist/masculine connection that was historically constituted"(Dunn, 2007, p. 648). According to Dunn the aim of PPGIS was to widen participation, particularly to marginalised groups, to develop a methodological approach with public participation at its heart, and to encourage thinking outside of the conventional GIS, and to utilise alternative methods and media for data capture and processing. As such, PPGIS is cast as more than a technology, rather, as an attempt to import socially responsible and more representative practices into the doing of GIS research. The ambition of PPGIS was to make GIS driven research in human geography more inclusive and participatory to, "integrate local and indigenous knowledge with expert data" (Dunn, 2007, p. 619). Furthermore, according to Dunn (2007), PPGIS, in its various different forms, essentially, looks to address two issues with

GIS: that the type of information that GIS uses represents an overly simple world view, and the sources of this information are similarly limited. Dunn talks about problem of bringing indigenous knowledge into GIS. This is knowledge that has often never been written down, has been handed down in oral traditions, and is performed. To aid with these kinds of issues, efforts have been made to allow for imprecision in participatory mappings, using fuzzy boundaries, softening, and multi-user transparent boundaries.

Key to the practice of PPGIS is to allow communities to exercise ownership over the knowledge that they produce and share. To do this Dunn calls for a “closer coupling of users and software design” (Dunn, 2007, p. 623). Dunn (2007) notes concerns about the capacity of geographers to drive innovation in this field given the technical knowledge and expertise required to develop software, and the reliance upon propriety software in GIS that is for the most part driven by market demand. For which this kind of research attracts relatively little demand. Nevertheless, Dunn (2007) is enthused by the momentum gathering in cultural and feminist geography in terms of increasing use of digital media in that it has the potential for increased engagement between feminist and participatory GIS

From 2009 onwards, a creative trend re-emerges, seeming to gain momentum from advances in web mapping technology. Here, technologies and practices of data coalesce around themes of crowd-sourcing, web 2.0 and interactivity, communications technology, and narrativisation. Furthermore, deeper concerns relating to the efficacy of big data were also addressed. Elwood (2009) suggests that there has been a change of tone in relation to debates about GIS and spatial technologies. Rather than a debate framed by opposition versus proponents for GIS, instead current debates are focused more on research need. Elwood focuses on the Geoweb and notes how they differ slightly from GIS, in that:

- Hardware and software systems, here, have originated as public technologies rather than expert.
- Relying heavily upon web 2.0, or the online interactivity that web 2.0 allows users - most notably allowing users to produce and contribute their own knowledge.

In this sense Web 2.0 has allowed for a different kind of digital mapping - here web mapping services are more configured towards “user specification” over traditional GIS software. For instance, mashups tend to focus on the integration of various forms of digital media. So here, quite separate from the concerns of critical GIS literature, the discussion is more concerned with representation, reproduction, and (user) modification of imagery. The politics here are not necessarily concerned with the top-down power relations regarding how the software is built

and who has the power or knowledge or skill to wield it; rather, the question becomes one of interactivity, sharing, and crowd sourcing. Far from being a departure of top-down state surveillance, these new technologies represent a new forms of “surveillance, exclusion and erosions of privacy” (Elwood, 2009).

Elwood (2010) notes changes in processes and relationships through which geographic information is produced (e.g. neogeography and VGI) and understandings of what constitutes a GIS (i.e. wikification of GIS, GIS 2.0). As such, previous critical geographic scholarship pertaining to theorizations of information technologies fall short of conceptualising the social and political construction of the Geoweb (Elwood, 2010). The politics of spatial data is shaped by copyright and privacy laws, reinforcing existing inequalities (race, gender, and class), legislative structures, data standards, social contracts, and local political traditions. For Elwood, the Geoweb represents a paradigmatic shift, “producing ‘patchwork’ datasets that bring together curated and volunteered information” (Elwood, 2010, p. 351). Elwood (2010) notes changing relationships between user and producers, the presence of advertisers, open source software, and activism. Nevertheless, the digital divide is present in re-inscribing political inequalities and advantaging those with coding skills. She claims that there is a clear shift with the Geoweb in terms of how power is distributed, relating to the blurring of user and producer and the consequences therein of how knowledge is produced. Elwood points to Heidegger and his claim that technology produces the world as something to be ordered. Thus, the web is, “a technology whose power is derived in part through accumulating, ordering, and storing multitudes of entities.”(Elwood, 2010, p. 353). On the question of whether VGI is truly volunteered Elwood refers to Schuurman (2002) who claims that the cyborg is constituted of data, not electronics, and becomes ordered, structured, networked, part of the system as a data point (whether volunteered or scraped, or mined and everything in-between) conscripted as The “geocoded citizen”(2010a, p. 354).

Crampton (2009a) too focuses on the emerging field of web 2.0 enabled mapping applications. He notes that these practices mark a departure from a trajectory in map making that he believes would see GIS make obsolete or subsumed. Crampton (2009a) pays homage to the contributions made by virtual globe platforms (most notably Google Earth) bringing forth visualisations of Earth that are naturalistic, interactive, allowing integration of all kinds of data, integrating temporalities, and opening up opportunities for the public to contribute spatial knowledge. Crampton also notes that, for the most part, developments in the Geoweb have been made outside of academia. Innovations in the Geoweb seem to be mostly driven by practitioners, citing increased online participation as a key driving factor in this ongoing

innovation. He recognises the utilisation of Free and open source software (FOSS), and more importantly the approach and culture in respect to software development that for him is challenging the dominance of propriety developed software. For Crampton (2009a) one notable consequence of growing participation from non-experts is that of de-professionalisation. That is, there are two opposing forces in regard to issues of de-professionalisation on GIS. On the one hand there is the GIS FOSS project, encouraging open access and wider participation, and those pushing for accreditation through professional certification. According to Crampton, the need for expert knowledge is always vital. For quality assurance (for example) spatial expertise is still valued in creating useful data. Crampton asserts that in order to recognise the Geoweb, as a distinct professional field, it must correctly acknowledge (and not overreach) in what it is professional. For Crampton this is in crowd sourcing, FOSS, and participation and syndication. Crampton (2009b), following Perkins (2003), continues a trend that looks to pay more attention to mapping as practice. Crampton (2009b) discusses understanding maps as practice rather than fixed objects and points towards the work of Kitchin and Dodge (2007) on the ontogenic nature of maps – that is, there is no map, only mapping. And similarly points to the work of Laurier and Brown who note, “Reading maps... is much more than mental cognition” (Laurier & Brown quoted by J Crampton, 2009b, p. 841). Crampton notes how artists have used maps (as map art), and artists groups such as the Situationists used maps to subvert politics and power. For the Situationists mapping was performative - a type of socially engage praxis (J Crampton, 2009b). Crampton offers a reassessment of how history of cartography figures artistic elements of cartography.

Caquard (2011) explains how storymaps – as opposed to grid maps – have the potential to bring more personalised narratives to the fore. He explores the relationship between art and the spatiality they describe or produce. He points to how painters, writers, and filmmakers use maps to locate narratives. Caquard (2011) takes the lead from MacFarlane who describes story maps as a way of spatialising personal and embodied experience to create emotionally charged maps. He sets the ‘story map’ apart from the ‘grid map’ – where the grid map makes the landscape “dream proof” the story map encourages “wonder” (Caquard, 2011, p. 136). Caquard (2011) discusses how mapping practices are being used to frame cyberspace – for instance where digital media becomes georeferenced and searchable according to location. Similarly, there are many research efforts, particularly in the humanities, such that textual and literary material is being scraped for place names.

Caquard’s (2014) second report covers practices of volunteered geographic information that have been described as collective mapping, community mappings, indigenous cartographies,

and crisis mapping. He notes how indigenous groups have used geospatial technologies to further their own political agenda, where, “hybrid cartographic forms of expressions do not reverse colonial social relations, but rather rework them” (2014, p. 143). He notes how VGI projects such as OSM have developed developing systems and approaches to measure the reliability of VGI or crowd sourced data using ebay style rating systems. Caquard (2014) explains how the decreased role of the state in the production of cartographic information has been mirrored by increased participation from the private sector. Furthermore, although receding influence from the state in cartographic information production, state owned institutions such as us USGS and OS are still held as standard. As such OSM etc. are held against the same standards and ontologies where state ontologies are reproduced to “perform the state”(Wood quoted in Caquard, 2014, p. 145).

Dodge's (2017) first cartography review focuses on the potential of the new and emerging field of spatial or GeoHumanities as providing interesting new perspectives and creative approaches to maps. He recognises the efforts of creative geographers (specifically Hawkins and Straughan, and Knowles) for igniting this trend for new map forms. Dodge also discusses how historical maps are being used in this field. He notes the opportunities for many users to engage with scanned, geo-referenced, and overlaid (recognising the efforts of Chris Fleet and his colleagues at the national library of Wales) historical maps. But also, how this resurgence in the interest in historical maps was led to many printed reproductions. In light of the trend in digitising historical maps Dodge does note the importance of physical engagement with the originals.

Talking with GIS Scholars

In order to pick out some of the themes noted above for more detailed discussion, I took the opportunity to interview some key members of the GIS community (see Table 3).

Table 3 - GIS expert interviews

Interviewee	Position	Date of Interview	
Sarah Elwood	Professor in the Department of Geography at the University of Washington	24/09/2017	<ul style="list-style-type: none"> • Digital competency • GIS as encompassed by critical digital geographies • The importance of the critical GIS debates in the early to mid-nineties focusing on epistemology

			<p>and then sociological critiques – These debates are a useful resource when thinking about big data today.</p> <ul style="list-style-type: none"> • Key touchpoints in geospatial: <ul style="list-style-type: none"> ○ Critical GIS ○ Mashup ○ FOSS • Knowledge making assemblages – how do you do affective geographies? • Fascinated by the digital
Mike Goodchild	Emeritus Professor of Geography at the University of California	20/09/2017	<ul style="list-style-type: none"> • Origins of GIS (1970s) – from CGIS, ESRI at Harvard Labs, experimental cartography unit at RCA, IGU. • GIS as originally for landscape architecture • Reflected upon his initial scepticism, that for him, computers were for calculating, cryptography decrypting messages. • Teaching notes in 1975 – slow shift from spatial data analysis to include modelling • Today's challenge of big data

			<ul style="list-style-type: none"> • Geoweb is essentially GIS – reluctance is down to academic conservatism
Matt Zook	Professor in Geography, University of Kentucky	04/10/2017	<ul style="list-style-type: none"> • Key touchpoints in geospatial media: <ul style="list-style-type: none"> ○ 2005 – <i>Google Maps</i> ○ Crisis mapping for Katrina and Haitian earthquake • Dissatisfaction with engagement with big data in geography. • From a cohort of geographers interested in the possibilities afforded by geo-information and internet geographies: <ul style="list-style-type: none"> ○ Fascination emerged from ludic approach. ○ little investment in ESRI or critical GIS • Coalescence of digital and cultural geographies

For Goodchild, GIS began with the Canada GIS, he notes contributions from the experimental cartography unit at the Royal College of Art but attributes the greatest contribution to the formation of GIS as we know it today to the work of Roger Tomlinson. According to Goodchild, “one person had the vision of an incorporated technology, and that was Roger Tomlinson” (2017). Further contributions were made at workshops organised by the International Geographical Union (IGU) in 1970 and 1972 with the ambition of bringing experts together to create something that would bring these technologies together into a single technology. According to Goodchild it was never obvious that GIS would exist, “that is, an alternative system may have been built around integrating remote sensing around image-

processing or around CAD.” (2017) By the 1980s ESRI at Harvard created a commercially viable integrated technology. Goodchild reflects upon his initial scepticism, that for him, computers were for calculating, cryptography, and decrypting messages. Goodchild notes that his teaching notes from 1975 show a shift from spatial data analysis to modelling.

According to Goodchild (2017) the challenge of today is around big data. For Goodchild, there is no such thing as a geographic fact – “all geographic data is uncertain”. Therefore, geographers are well positioned to understand big data, just as they were to contribute to the inception of the GIS as a multidisciplinary project. According to Goodchild, GIS is a science because it encompasses practices, outside of the software, that are critical, and allow the scientist to comprehend and negotiate a practiced resolution between data and geographic reality. For Goodchild, “coordinates are never the truth, what are the implications of that?”

Sarah Elwood explained to me how she came to GIS as an undergraduate. She was trained in what was then termed digital cartography and a very nascent analytic style GIS. She notes her interests lay at an intersection of feminist geography, political economy, and a deep fascination with the digital. Elwood, “found digital practices limited and unsatisfactory, but there’s something to this, perhaps something different” (Elwood, 2017). For Elwood, a key touchpoint in GIS relating to academic geography were the critical GIS debates of the early to mid-1990s, focusing on epistemology and then the sociological critiques on politics of knowledge. This signalled the importance of broadening the project. According to Elwood there is much to be learnt from the debates from the so called ‘GIS wars’; that is, much that can be applied to current concerns relating to the ethics of big data. However, “computing as a whole went from being creative in terms that everything was quite open in that everything was done through command line interface (CLI), to things becoming more packaged and, in a way, black boxed. But with rise of open source and APIs they opened it back up again”. She explains the significance of the map mashup and *Google Maps*, wherein “you could do geovisualisation [with your own data] outside the ESRI world and other for-profit packages, that was a big deal”.

When I asked Sarah Elwood how she would position the Geoweb in relation to the trajectories of GIS, she explained, “the Geoweb is a boundary object, GIS no longer has tight boundaries, in fact it’s more porous than it’s ever been”. Elwood prefers to encompass this all under ‘critical digital geographies’, to include: interactive online geo visualisation, big data analysis, conventional GIS, Geoweb. She reflects that this is all to do with analysis, manipulation and storage of spatial data; “this is more or less what a GIS is” (Elwood, 2017). What is interesting for Elwood, is that there is more of a cultural perspective coming from within geography as we (geographers), focus more attention on new digital worlds which brings involvement from

various arenas, such as, information science, artists, historians and archaeologists working in humanistic tradition. She remarks, “a growing public mass of digital artefacts, and growing publicness has opened this stuff up and has loosened the strictures of old style geographic information science”. For Elwood the project of a creative GIS is really about rethinking the knowledge making assemblages, and hence framing GIS in terms of performance or affective ways of knowing, and thinking through the methodological challenges of performative work – “for instance, how do you do affective geographies?” For Elwood, this is fertile ground for contributions from cultural geographers. She recognises the contributions of economic geographers in breaching the void between critical GIS and studies of emotion, embodiment, affect, and performativity; but, what this area needs, according to Elwood, are more practitioners accustomed to particular modes of making. She sees, “more room in UK geography for creative, edgy cultural geography” (Elwood, 2017). However, she is concerned about a new wave of militarism, and the restructuring of funding of research and education (even in science). How can we preserve the right to do this kind of edgy work in the face of a growing rejection of climate change science, and increased protectionism across the world? And yet, there is political potential for coalition and solidarity, for Elwood (2017) and this is why the performative, affective, artistic matters.

For Matt Zook, (and perhaps a wider cohort of geographers interested in the geospatial media in the 90s – Zook mentions Martin Dodge, Rob Kitchin, and Anthony Townsend) -- his way-in to the field was not tied to any previous participation in the debates of critical GIS, nor investment in ESRI products. Rather, Zook’s point of departure was an interest in the possibilities afforded by geo-information and internet geographies and serviced by an ability to programme and write computer script to scrape social media data. Moreover, Zook’s fascination with geospatial media emerged from his interests as an economic geographer, and a somewhat ludic approach of experimenting with *GoogleMap* searches with a student. He notes, “Because the internet is weird, we were not afraid to be experimental and play with the data – It was about playing with the technology... and it’s about wrecking up the gears.” But, for Zook, it is important to be cautious: of course, research that takes a more curiosity led, experimental, and playful approach can be insightful (and feel liberating), and we can use this to subvert some of the more malicious aspects of things such as big data, state and corporate surveillance, and so on, but, as Zook emphasises, “creativity is important but can have negative effects, where does play end and trolling and doxing begin?”

Zook reflects that when *Google Maps* was launched in 2005 that “this was a watershed, a changing event, of how mapping happened and how geospatial data was used” (Zook, 2017). That is,

previously there were many barriers involved in accessing maps, requiring access to ESRI products, getting these installed, getting license USB keys and so on. He remarks, “It was a pain in the ass, and suddenly you had this functionality that everyone could access” (2017) According to Zook, recently geographers interested in what have been termed digital geographies have begun to coalesce, surveying the broader implications of contemporary digital life. Zook is enthused that this interest has led to the formation of digital geographies research groups at both the AAG and RGS-IBG conferences. For Zook (2017) growing support and engagement from cultural geography is encouraging, particularly in contributions to the new *GeoHumanities* journal.

SECTION FOUR: GIS and Ontology

Key Issues in GIS Discussions of Ontology

At this point, and bearing in mind the diversity of issues raised, and points of resonance and difference noted above, I want to look more closely at the issue of ontology in GIS thinking and practice. In GIS discussions, for the most part, ontology refers to the way in which geographic entities are organized and recognized within a simulated world or model. This model presents certain constraints as well as possibilities as to how objects are represented, manipulated and tested. In effect, GIS is considered a database for storing spatial data similar to the geographic matrix described by Berry (1964). These spatial databases are often linked to visualisation tools that can display vector information, such as points, lines and polygons, and raster information such as bitmap images collected in the field or from remote sensing technologies. It is possible, however, to sketch out a more expansive notion of a GIS ontology, one that encompasses the imaginaries, practices and materials that assemble to allow for GIS itself to emerge.

GIS databases handle data according to either an object-based or relational database structure. The object-based database (OBD) resonates Nystuen’s (1963) primal isotropic plain, described earlier, which posits, “the elementary, abstract, geographical space that has no difference from place to place or in one direction to another; that is, not only are places the same, but movement effort is the same in all directions from every place” (1963, p. 37). Yet, it also has a Euclidean character, in that scientists conceive of this as a container space devoid of characteristics onto which spatial features, such as rivers, cities and roads, are placed as objects. These objects exist independent of their locations, or as Fonseca *et al* describe it,

The object model represents the world as a surface occupied by discrete, identifiable entities with a geometrical representation and descriptive attributes (2002, p. 126).

In this overview I will use the terms 'entity' and 'object' interchangeably, both referring to representations of regions, boundaries, parcels of land, water-bodies, roads, buildings, bridges etc. These objects within the database not only contain the characteristics of the represented real-world phenomena but also the possible behaviours of the phenomena. For Fonseca & Egenhofer (1999), in a GIS, geographic objects, are defined so that their behaviours and qualities are embedded within them; hence the structure of the computerised system in which they operate acts simply as, “a container of interoperable objects” (1999, p. 3). This point is echoed by Yuan (2001) who notes that, “Philosophically, the object-based representation corresponds to a container view of space, which exists independently and is populated with discrete entities” (2001, p. 83).

A relational representation of space or relational database structure (RDS) stores spatial information according to specific attributes in a series of tables. Rather than defining entities as distinct objects, a relational database stores the characteristics of real-world phenomena in a number of linked files. This is another contentious theme in deciding the most effective way of modelling geographic reality (Galton, 2003). That is,

In GIScience the object-based view and the field-based view have generally been presented as the poles of a sharp dichotomy, between which it has been a matter of debate as to which should be preferred. (2003, p. 2)

This kind of ordering of space resonates with Berry's geographic matrix (1964) (Figure 14), with data organised according to three spatial and one temporal dimension tabulating scientific observations of the world. The key difference between RDS and OBR, then, is in the way in which each model treats empty space. In RDS there is no such thing as empty space (Yuan, 2001). In RDS geographic entities -- for example rivers, roads, buildings, cities etc. -- are, “tied intrinsically to space in a manner that implies that they inherit from space many of its structural properties” (Huang, Xuan and Chen, 2007, p. 4628).

For Yuan (2001), geographic phenomena have qualities of both relational and object based entities which has consequences for how they are represented in a GIS, and how the GIS structures and models space. A wildfire, for example, is in some sense a discrete object with a clear fire-front line, but there are identifiable spatial and temporal variations within a fire. A wildfire may or may not be continuous and may or may not start again after almost being extinguished. Yuan (1996) suggests that human conceptualization of wildfires can be both

object- and field-like, and information needs for wildfire research and operations require both object- and field-based representations (2001, p. 84).

What is important to note is that Berry's matrix (1964) took into consideration time as a third dimension allowing for temporal qualities of objects to be defined within the "geographic fact". As Fonseca and Egenhofer (1999, p. 127) observes, therefore, "an object is only one thing, but it can play different roles during its lifetime". As well as defined objects changing and playing different roles (for instance, a person aging or a tree losing its leaves), Grenon & Smith (2004) observe that the real world processes, such as, "your smiling, her walking, the landing of an aircraft, the passage of a rainstorm over a forest, the rotting of fallen leaves" (2004, p. 140) are also geographic objects and are, "four-dimensional. They occur in time and they unfold themselves through a period of time." (ibid.) Similar to their real world counterparts, the complexity of the characteristics exhibited across temporal and spatial dimensions of geographic objects in GIS reveals their ultimately dynamic nature (Grenon and Smith, 2004; Goodchild et al., 2007; Schuurman, 2006).

Another key theme to be addressed when considering the ontologies of GIS is that of scale/granularity. This refers to the extent to which information is 'lost,' or the way in which the representation of geographic information is changed by generalisation. A simple metaphor for this would be the way in which a bitmap image – made up of pixels – loses clarity when one zooms in. For instance, "a rock can be apprehended as an object in its own right, or as a structured group of molecules" (Grenon and Smith, 2004, p. 141). Fonseca *et al* (2002) propose a binary of generalization or specialization. For instance, if one were to focus upon an oak tree in a forest, one could ask the GIS to be more specialised and display carbon sequestration of that tree, or perhaps generalise and request the total potential annual sequestration for the entire forest. Hence,

In a generalization, a more specific object drops some pieces of information and turns itself into a more general instance. In a specialization, a more general object gathers more information and becomes a more specific object. (FT Fonseca *et al.*, 2002, p. 147)

Fonseca *et al* (ibid.) also explain that the granularity or ontological level at which a GIS operates can be defined as either "fine-grained" or "coarse" ontologies (2002, p. 129). For instance, a fine-grained ontology would include every single tree as a geographic object and a coarse ontology would simply have the forest as a single object. The reason for changing the level of granularity like this would be to ensure compatibility with other GIS, or for creating lighter files for exporting. It has also become necessary to develop standard file formats such as the "ESRI shapefile" to assist the interoperability of different GIS packages that will more than likely have

differing ontologies; for instance, packages may work with OBR, RDS or a hybridization of the two. The consequences of this may be that,

Entities recognized by distinct ontologies may be differently related in each. In one ontology, for example, the relation of being on and between the cup and the desk is recognized, in another it is not. (Grenon and Smith, 2004, p. 147)

An Expanded Notion of a GIS Ontology

With the proliferation of open source and free to use mapping platforms such as *Open Street Map* and *Google Earth*, anyone with access to an internet connection and computer can contribute spatial information. Indeed, spatial information is now being crowd sourced from members of the public. The rise of the citizen scientist, or “neogeographer”, has made a significant contribution to what it means to model geographic reality in a GIS. Where once only state or academic institutions had the know-how, authority or access to GIS software, relative novices can now contribute. Furthermore, as well as contributing, neogeographers are also ordering and structuring their own data (Graham, 2010) bringing about new ontologies. Perhaps Kemp is well justified in her excitement, when she states, “As well as challenging GIS as it is today, it is useful also to turn briefly to what the future holds in store for GIS and all who use its tools” (2009, p. 17).

Some have suggested that this crowd sourcing of geographic information offers more pluralist ontologies and also epistemological consequences (Warf and Sui, 2010). Epistemologically neogeographic space opens up what was previously traditional GIS’ “panopticonic gaze” (Warf and Sui, 2010, p. 204) wherein academic institutions or government organisations structure, populate and control geographic data. Neogeographic space is arguably democratised (ibid.). Instead of a centrally controlled image of the world, neogeographic space is user-generated and multiplicitous in its perspective, such that:

In neogeography, the sharp divisions between the knower and the known, representations and the world they portray, epistemology and ontology are deliberately and creatively blurred and truths (for there is always more than one) are repositioned as a partial, contingent series of statements that reflect lived reality and are useful in it. (ibid.)

Some geographers, however, such as Goodchild (2009), have highlighted problems with using neogeographic or volunteered geographic information, insofar as there are no formal procedures for testing the quality of the information. Warf and Sui put forward similar concerns

about the reliability of such data but counter this by recognising that these notions of reliability, rationality and certainty etc. upheld by positivism can perhaps be overlooked in exchange for things like, “complexity, ambiguity, multiplicity, and contingency, the very things that most heavily concern critical social theorists” (Warf and Sui, 2010, p. 198). There are, however, those who are more suspicious of neogeography’s claims of democratising GIS’ ontology. Haklay, for example, suggests that while the advent of neogeography has opened up the practice of GIS, this augmented universe of objects “has merely opened up the collection and use of this information to a larger section of the affluent, educated, and powerful part of society” (2013, p. 66). There yet remains a gap between the production, and the utilisation, of GIS objects, stalling efforts to create new social movements and collective potentials (Pritchard and Gabrys, 2016). Nevertheless, what these analyses into neogeography also reveal is a host of objects, events and experiences that, together, are necessary for the constitution of GIS itself, including its self-positing ontology. Of course, such extended ontologies – the ‘what’ of GIS – have been noted by earlier scholars and approaches. As intimated earlier, Kwan has long argued that attention needs to be given to the emotive dimensions of GIS practice,

Like “the thrown-chairs, the put-downs, the red-faces and the hugs” and “the anger, the frustrations, the sadness and the joys” in planning meetings that involve the data or results generated by GT (Kwan, 2007, p. 24)

Kwan also espouses an explicit recognition of the creativity in the creation of maps in GIS such as GPS travelogues and 3D GIS video (Aitken and Kwan, 2010). Kwan’s (2008) own work on the experiences of Muslim women in Columbus Ohio following the attacks of 9/11 brings some of these ideas to the fore. Here, Kwan worked with her participant to produce a “collaborative 3D GIS videography” where her “feelings, emotions, memories, and experiences find expression in the video” (2007, p. 27). This kind of work helps to empower participants to tell their own stories. More broadly, feminist and post-structuralist critiques worked to challenge notions of masculinist visibility and top-down power relationships inherent in digital mapping technologies and GIS, opening up questions of “*whose* knowledges are being produced, *by* and *for* whom in deployments of and practices with the technology” (Ash, Kitchin and Leszczynski, 2018, p. 28).

Looking back on this and similar projects, Ash et al (2016) trace a broad history in the emergence of GIS, one that makes apparent ways of doing and knowing that have been glossed in hagiographic accounts that iterate a single origin for the field. Ash et al claim that these digital geographies emerge out of a confluence of three frameworks in geography for dealing with digital technologies. First, an information communications technology (ICT) “flattened distance

and rendered geography irrelevant” (Ash, Kitchin and Leszczynski, 2018). Nevertheless, cities, people and corporations restructured and repositioned themselves spatially around these physical infrastructures, creating novel landscapes and new proximities. Digital technologies, then, became integrated into and produced ‘smart cities’ where networked ICTs became an integral part of the fabric of urban space producing a “code/space” (Kitchin and Dodge, 2011). That is, everyday life has become so dependent on the effective workings of software that, “if the software failed, the space could not be produced as intended” (Ash, Kitchin and Leszczynski, 2018). Second, digital technologies enabled and were enabled by cyber space; that is, computer generated environments accessed via screen technology. Here cyber space was constituted as separate from ordinary space and mediated via human interaction with screens. Ash et al (2018) note efforts made to map cyber space as a “set of material infrastructures and space for shared experience” (p. 9) but explain how this mode of thinking of cyber space as distinct from actual or analogue space is problematic, in that, ‘cyber space’ and ‘actual space’ are instead (and increasingly) co-constituted. Third, ubiquitous computing figures digital technologies such as computers, smart phones, sensors, and RFID tags and so on, and the spaces that they produce as all part one realm. Ubiquitous computing avoids the problematic separateness of cyber or virtual space from everyday lived experience, “bringing computers into “our world”” (Ash, Kitchin and Leszczynski, 2018, p. 33).

Each of these strands posits a broad, dynamic ontology within which GIS has emerged, within which it continues to develop, and which GIS, in turn, shapes. Some geographers have paid particular attention to the physical manifestation of data infrastructures, such as intercontinental fibre optic cables, data centres, internet exchanges and so on. Others have focused on the relationships between the body, computer interfaces, and screens and the spatialities therein, paying attention to how screens manifest digital environments that via various affective qualities to, “alter the spatial understandings, embodied knowledge, political awareness and social relationships of users” (Ash et al 2016, p. 9). Some geographers focus on how the world is changing because of an increased ability to capture, store, analyse, etc. geographic data: here,

the focus is on the ‘actual geographies that evolve on the surface of the earth in the information age: the changes in and among places resulting from the increased ability to store, transmit and manipulate vast amounts of information, and the new patterns of geographical differentiation, privilege and disadvantage that these changes are bringing about’ (Ash, Kitchin and Leszczynski, 2018, p. 33).

A sustained effort has been paid to map how data flows from digital media – such as social networking feeds (RSS feeds, twitter, geo-tagged digital photographs and so on) -- can be used

to understand socio-spatial processes and events. In what may be termed a ‘digital humanities’ approach, meaning is sought in the corpus of big data; however, concerns as to the representativeness of this data remain.

Ash et al (2018) propose that geographers consider this ‘assemblage of the digital’ as a multiple ‘digital *despositif*’, or “ensemble consisting of discourses, institutions, architectural forms, regulatory decisions, laws, administrative measures, scientific statements, [and] philosophical, moral and philanthropic propositions” (Gordon, quoted in Ash et al., 2016, p. 13). Relevant research questions would then address: the exclusions inherent in applications of such technology – who and where is captured?; the exercise of power relating to who has access to digital tools and technologies; unpacking the power relations of the ‘interlocking technical stack’; resisting the perpetuation of masculinist, western centric, and colonial perspectives in economies and cultures of big data, algorithmic governance, digital technologies, and so on; and challenging claims to citizen centric and democratised data regimes in a world where corporate and political powers are increasingly taking ownership of such data. In recognising this dynamic ontology, of course, what becomes apparent is that the objects one is dealing with do not remain stable. Indeed, as Rose claims, the “mutability of digital images is one of the key characteristics digital visual culture”, insofar as, for example, “an image file itself has gone through multiple software transitions in order to become visible on a screen: source code, executable application and runtime experience” (2015, p. 5). Digital objects change form all of the time. They are processed, their file format is changed (altering the coded composition of the file), adjusted (changed dimensions and file size), annotated (attributed with more and more metadata), context altered (i.e. their relationship to other files is adjusted), and never fully present. That is, they are held on some invisible local or remote server or in the cloud, encrypted and compressed, and dispersed for more effective retrieval and distribution.

In similar vein, Dodge and Zook (2009) point out the often taken for granted ‘whereness’ of computers, insofar as while their desk top paraphernalia may be “hidden from view in anonymous server rooms and secure, windowless buildings” their necessary cables extend “under floors, in ceilings, and in conduits buried under road (2009, p. 11). For Amoores (2018), it is necessary to consider how data, application, and data uploading/manipulation practices live in very different environments that are often far removed – perhaps on a different continent. This diffuse geography can be related to the commercial requirements of the owner – perhaps the data centre is housed in some tax haven – or due to the physical requirements of the computer, such as a constant supply of water for cooling. Hence,

the cloud is actualized in data centres, located in places with plentiful land, favourable tax rates, affordable energy, water for cooling, and proximity to the main trunks of the network (Amoore, 2018, p. 8).

Yet, this rendering of the “cloud” in terms of its actual worldly, material, components is not a sufficient task in order to understand and come to terms with the work that it does in the world. Instead, one must ask: “how does it perceive and analyse the world?” (Amoore, 2018, p. 12). What Amoore is calling for is an approach that looks to the affective relationships that constitute the cloud, its producers and its users; an effort that runs counter to the usual interrogation of GIS as a mass of code, hardware and peripherals that must be disambiguated in order to get to grips with its ontology. Though Ash (2013, p. 45) uses video game playing to make his point, his broader argument on the affective character of the interface is relevant here, in that he also looks to how the connections between bodies and technologies develop specific capacities within both. Far from being the objective observer of spatial science, GIS practitioners can be thought of as enrolled in, “an ‘atmosphere’ of intensity, which bodies become attuned to” (Ash, 2013b, p. 33).

Relatedly Yuk Hui (2012) approaches the idea of the digital object that is far more visceral (rather than vaneerial) than we might expect when thinking about the seemingly random movements of the computer mouse and keyboard. This seems to be something that both humanism and cybernetics ignore that,

“we are interacting with digital objects: they are actually objects that we drag, we delete, we modify, and so on. The Web is acting both as an interface between users and digital objects and as a world in which these digital objects conceal and reveal—in both physical and metaphysical terms.” (Hui, 2012, p. 381)

What is significant about the digital object that Hui describes is that, yes, it has an element of mutability to it – it can be broken down into components, code, binary, circuitry and electrons. But, there is a limit to this. If one goes to the limit of signals and voltages, the digital object becomes inconceivable. It seems that this conception of digital objects, as things that we are actually touching and manipulating, rather than thinking of the computer as a surface or interface, is a far more appropriate rendering with which to study the affective qualities of digital technologies.

GIS as Assemblage

As noted above, the ‘what’ of a GIS can be thought of as an “assemblage of the digital”, or multiple ‘digital *despositif*’, as Ash et al (2018) put it. Assemblage is a difficult and contended term

but is used here to refer to a specific ontology that is, initially, a rejection of Marxist Geography and Cartesian ontologies. The former constructs the world according to specific relationships ordered by definitive structures and rules, while the latter see the world as made of, “discrete parts whose relations to other parts are external” (Rogers, 2013, p. 24). In contrast, an assemblage view conceives of a world made up of, “complex, changing, and emergent product of interactions that are only partly planned, ordered, or controlled” (ibid.). Here, GIS data sets and the maps they allow for can be considered “‘immutable mobiles’ – immutable because they keep some types of relations intact, mobile because of the way they circulate, allowing new translations and articulations to take place” (Wickstead, 2009, p. 255).

In placing the emphasis on the *how* of objects, scholars have, arguably, taken a practice-led approach to ontology itself. Indeed, Anderson & McFarlane (2011) describe assemblage as, “a way of thinking about phenomena as productivist or practice-based” (2011, p. 126). As such, post-humanist geographers configure their research methods to investigate how an assemblage of human and non-human actors compose everyday practices and generates specific affects that can be apprehended as ‘events’. These non-human actors can be anything, for example, a table, soil or an ant etc. and it is the agencies of these actors, as well as human beings, that are mediated through everyday practices and revealed via the themes of affect, embodiment, performativity and doing. In this line of inquiry, affect can be considered the medium through which the human experiences the materiality of the world (Rogers, 2013), but is more broadly a matter of the rubbing up of one object against another. Embodiment, here, tends to follow the work of the phenomenologist philosopher Merleau-Ponty, and is understood as the, “experience of one's own body [being] different from the objective or scientific picture of a body in physiological terms” (Blackburn, 2008). Likewise, Cresswell (1999) observes that embodiment is the process whereby the experience of one's own body is connected to the assemblage of humans, non-humans and agential relationships.

In post-humanist geographic practice, the term performativity relates to the production of identities, and understood as how one is perceived through their actions. For instance, gender is understood as something someone does as opposed to what one is (Rogers, 2013). Thus,

Performativity theories illuminate that the agent does not precede the ‘doing’ of the performative act or event. Rather, the actor ‘becomes’ through the event, while simultaneously drawing upon and reproducing a historical consolidation of previous (gendered) acts. (Holt, 2008, p. 237)

Understanding identities through the lens of performativity allows the researcher to reflect upon the role of more than the human actors in such ‘becomings’; this perspective can also be applied

to landscape and other areas (Nash, 2000). Similarly, one might also apply this point of view to the research process itself (Latham, 2003). Woods (2010), for example, notes how the researcher also becomes included in the performance of rurality, while Wylie (2005) interrogates the becoming of self and landscape as a ‘more-than-representational’ performance of walking. Doing can be understood here as the act of performing, and of becoming embodied. Doing refers to the practice of the other four and how these terms manifest themselves as events in the world. For example, Nash (Nash, 2000) describes dancing, “as the performative ‘doing’ of identity” (2000, p. 659). Similarly, the other terms can be used together so that Cook & Hemming (2011), for example, observe that to be affected socially or emotionally causes an embodied response.

For Woodyer (2008), thinking through performativity is a way to make, “explicit account[s] of relational configurations” (2008, p. 350). In children’s geography (though perhaps relevant to all empirical geographical work) is a, “reluctance or incapacity to talk on the child's part” (2008, p. 351). Woodyer (2008) espouses taking a performative approach to understanding embodied practice. This involves:

1. “placing the ethnographer within a web of intersubjective relations” (2008, p. 351), or becoming immersed and participating in practice.
2. Focusing on theoretical frameworks such as NRT, “which amplify the flow and contingency of social life” (2008, p. 352).
3. paying more attention to the sensory, rather than the, “privileging of discourse” (2008, p. 352).

As a researcher this involves paying attention to one’s own bodily configurations – what does the research context do to the researcher’s body? – but also paying attention to how the researcher performs their identity within embodied performance. For Woodyer (2008) this focus on a performative approach to embodied practice is a rebalancing towards the sensory, retaining the visual and discursive. She reiterates the notion that that embodied information is difficult to capture: “This embodied information cannot be captured, cannot be represented in a static form, and therefore must be experienced in real time. Practice brings about ephemeral spaces and times that only exist as they are being played out.” (2008, p. 384) Longhurst, Ho, and Johnston (2008) follow Crang (2003), who notes that many of the bodily and sensually mediated characteristics of the body are often neglected in positioning the researcher. They argue that some things about ourselves as researchers are acceptable to acknowledge, some, “remain off limits” and are considered “too messy” (2008, p. 213). Longhurst, Ho, and Johnston

argue that the emotional reactions of the researcher do matter, moreover. They also challenge the assumption that banality is intellectually unimportant. And that these banal emotional reactions, such as gagging in disgust, may indeed reveal more significant, even problematic, themes that are indeed constituents of the researcher's positionality.

In assemblage thinking the agency of actors is of specific concern; put more specifically, however, no agency in the assemblage is without a contextualised, situated nature. Furthermore, agency refers to an actor's ability to, "affect the circumstances that structure their thought and action" (Rogers, 2013, p. 6). Here, agency refers to power relations and the ability of an entity to act or affect another. More generally, as Holt (2008) observes, one's agency, "does not precede the 'doing'" (2008, p. 207); it is only in a situated practice (see also Simonsen, 2007; Holt, 2008; Cook and Hemming, 2011) that the individual is affected, embodied or performs, and it is via these means that they come into the world. For the post-humanist geographer nothing precedes practice, and an understanding of this world is thus reliant upon everyday practice (Latham, 2003; Simonsen, 2007).

Anderson and McFarlane (2011) provide quite a useful description of assemblage as it might pertain to geographical research. They offer definitions from three fronts from which the term is deployed:

1. As it is often deployed in the broadest sense, as a co-functioning of differently constituted elements to manifest agency and affects in ways that are more than the sum of their parts, or in unanticipated ways
2. Paying attention to the work of Deleuze and Guattari in which "assemblages can be divided on two axis" (2011, p. 125):
 - of desire – qualities things and relations
 - of enunciation – collection at languages, words and meanings.

Here heterogeneity amongst parts of an assemblage is maintained through relations that may change- there is a constant renegotiation of territory.

3. Pertaining to assemblage as a method of engagement with the world through experimentation, "open[ing] the researcher up to risk, embrace[ing] uncertainty, express[ing] something of the fragility of composition" (2011, p. 126).

Barratt (2011) uses assemblage to think through the relations at play in the climbing as a kind of cybernetic assemblage. This allows him to discuss the climbing boding in relation to themes

of corporality, hybridity, reordering of materials, prosthesis. For Barratt, the climbing body emerges from relations between human and non-human performance, “the 'out there' of the material world is implicitly linked to line 'in here' connected to the intimate fabric of our corporality” (2011, p. 398). Barratt discusses the plasticity of the climbing body. The climbing body is co-produced through the assemblage of human body, rock, and climbing kit, which are all altered in the practice - the body becomes toned, the shoes soften. The more the body does something, the more attuned it becomes -- becoming more efficient at climbing. Barratt notes how the climbing shoe is “rendered almost invisible” (2011, p. 403) because of its inconspicuousness in the act of climbing. Furthermore, Barratt notes that improvements in climbing technology and practice equipment can vastly improve the body's climbing capacity, and can influence how the climber negotiates certain climbs:

“Rather than the geology of the rock, it is the negotiation of climber-gear-rock that determines the route.” (2011, p. 403)

According to Dewsbury (2011), assemblage offers an alternative to Euclidean thinking, a different ontology, not as reductive as Actor Network Theory, allowing one to follow connections between objects without losing sight of the objects. Furthermore, for Dewsbury, “the assemblage is less about what it is then, and more about what it can do, what it can affect and bring about” (Dewsbury, 2011, p. 150). The assemblage is for understanding affect.

Summing up

Here I have discussed how GIS constructs a virtualised or simulated space with significant reliance on the epistemological assumptions of spatial science. That is, what GIS scholars refer to as ontology relies upon a structuring of space and geographic phenomena according to the traditions of spatial science. Berry's Geographic Matrix (1964), and to an extent Nystuen's Isotropic Plane (1963), are used to construct the way in which geographic phenomena are modelled. In a GIS, real world objects are tabulated as known truths about the world. And, GIS scholars have discussed how neogeography offers the potential for more pluralistic epistemologies; taken with due caution, citizen science methods present the possibility for more democratic and alternative approaches to gathering and structuring scientific knowledge.

What is significant here is how human geographers have broadened and extended the possibilities for understanding what GIS (and digital technologies generally) is by taking into consideration a more co-constituted or assembled approach to the subject. That is, human geographers have begun to think about how things like emotion, affect, the mutability of digital objects and technologies, legal, political and economic events and contexts rub up against each

other in the emergence and continuation of digital technologies. In taking such a broad-brush approach to agency, however, how has the *practice* of GIS been reconceptualised?

SECTION FIVE: GIS as Practice

Automated Geography and its Critics

In 1983, Jerome Dobson wrote an article entitled ‘Automated Geography,’ published in the Journal *The Professional Geographer*. Here, Dobson outlined how the application of GIS would alter the trajectory of the geographic practice and its role in society. Foremost was Dobson’s assertion that the “new computer-based techniques” (1983, p. 136) would reduce time consuming operations in spatial analysis. For instance, geographers using these systems would no longer need to be so concerned with learning the process of complex quantitative techniques but could instead rely upon the computerised system as a repository for this kind of knowledge. Dobson also notes that these new systems would ensure greater accuracy and ensure detail was not lost. He observed:

More important, the manually prepared map is simply a generalized “picture” of reality. The new product is a flexible database that can be incorporated readily into a variety of analytical as well as descriptive studies that can contribute to learning and gain greater value from the initial effort. (1983, p. 138)

Dobson explains how these new, dynamic spatial databases would provide the researchers with accurate and complex descriptions of the world, “without sacrificing spatial or topical detail” (1983, p. 140). Additionally, these systems would ensure that data is preserved throughout the automated practice, insofar as a computer-generated map or document produced from an automated geography would still be tied to the database from where it came. This means that, “all assumptions and data must be stated explicitly” (1983, p. 139). Furthermore, Dobson foresaw that as computing power per dollar was increasing, individual households and small business would soon have access to these technologies. Dobson writes with enthusiasm about the potential for more efficiency and speed, not only in the day to day of processing spatial data for geographers but also in the potential for these new technologies to assist in the testing of new theories and the generation of new hypotheses.

For Geography as a distinct discipline, Dobson notes that the application of computerised techniques would not, however, mean a deviation from its primary concern with “the study of spatial phenomena” (1983, p. 136). Moreover, Dobson maintains that both the “scientific” and “humanistic” (*ibid.*) branches of geography would find value in automatic geography. Despite

his enthused tone throughout this article Dobson does concede that there is a danger that those using automatised geography or computerised methods may fall victim to the allure of relying upon secondary data at the expense of new primary data that may seem, “difficult to automate” (Dobson, 1983, p. 139). Sheppard (1993) elucidates that,

One of geography’s strengths within its empirical paradigm has been its field tradition, which can be seen as focusing on primary data collection as a counter-balance to the constraints of secondary data sources (1993, p. 458).

Sheppard warns that geography’s emphasis on primary data could be sacrificed with the proliferation of the computerised methods inherent in Dobson’s work model. For instance, because of the little effort involved, a researcher may choose, “to concentrate on secondary data sources as substitutes for primary data collection” (1993, p. 459). Writing as a sceptic, Sheppard (*ibid.*) asserts that, “the fundamental questions of data collection cannot be finessed by technological change” (p. 458). For Sheppard, a susceptibility to favour secondary data is troubling enough in the face of geography’s tradition of field studies; but also, he notes, this is troubling because such datasets are more often collected and distributed by public or private agencies for specific ends. As Sheppard puts it, “it is naive to believe that what is good for government and industry is good for society” (1993, p. 460).

Further concerns about the future of geographic practice in response to Dobson’s article can be found in Pickles (1993) who, although conceding that Dobson’s “Automated Geography” (1983) is a, “useful marker against which to judge the speed at which computerization permeated the discipline and our daily practices in the 1980s” (1993, p. 454), emphasises that this work model fails to describe how an automated geography might influence the discipline beyond faster, more efficient quantitative processes. He notes a, “limited engagement of automated geography with the wider field of geographic theory” (*ibid.*). As Sheppard (1993) describes,

Dobson’s own description of geographic practice characterizes the discipline as both scientific and humanist, where scientists develop and test hypotheses seeking general laws, and humanists apparently engage in ideographic studies. (1993, p. 457)

Dobson’s understanding of geographic practice here refers to a purely applied sense of the term; that is, merely taking a method, devoid of conceptual underpinning, and using it to collect and analyse data. It was the second wave of critical GIS that took issue with this notion of an applied geography; instead preferring to think of GIS as a *critical practice* or praxis. This notion of praxis permits a reflexive attitude towards research; that is, it is a considered, self-aware and rigorous way of doing research. Rogers et al. explains it as “informed by a deep and conscious

understanding of the contradictions and problems of the contemporary world” (2013, p. 396). This more critically engaged second wave promoted a more humanistic and participatory approach to GIS practice (Schuurman, 2006) and led to Marxist and feminist-inspired uses of GIS in human geography research. For example, GIS has been used to address social issues such as, vulnerable communities facing environmental racism (McMaster, Leitner and Sheppard, 1997; Sheppard, 2005), as well as experiences of Muslim women post-9/11 in Columbus Ohio (Kwan, 2008). These efforts bring to the fore an intent in GIS practice to be to adhere to these precepts of participation and humanism.

The practice of GIS here, although technological, and emphasising the importance of accuracy, efficiency, specificity (of location - to neighbourhood scales; McMaster et al., 1997), also intends to help empower the communities studied. This is acknowledged by Sheppard, when discussing the uses of GIS in highlighting communities victim of environmental racism: “It is possible to imagine using GIS to empower and mobilize disadvantaged communities around environmental justice concerns” (2005, p. 10). Mei-Po Kwan’s (2008) work on the experiences of Muslim women post-9/11, introduced earlier, uses GIS in conjunction with other methods, such as oral histories, to construct maps of fearful places. Kwan (ibid.) describes GIS as an, “expressive” medium (p. 667) that allows the researcher to work with participants to create, “visual narratives” (p.667) of their experiences. This critically engaged practice allows research and participant to work together to, “explore make meaning of experience both visually and narratively” (p. 667). Practice is here politically infused, but also the people involved – researcher and researched – become visible in this mode of analysis.

Practicing Web 2.0

As Goodchild and Longley (2014) acknowledge, there are many who believe GIS cannot escape its origins in the tenets of logical positivism. They are, however, critical of this assumption, labelling it as merely, “a caricature of the positivist methods that pervade scientific investigation more generally” (2014, p. 1119); for Goodchild and Longley, GIS is no monolithic enterprise, conceptually or methodologically. Focusing on GIS achievements as an assemblage of lines of inquiry and applications, they argue that GIS has been associated with, and has become inseparable from, an array of disciplines associated with geography: “geomatics, geoinformatics, spatial information science.” Furthermore, “GIScience plays an important role in the practice of regional science”(2014, p. 1108). In a similar vein, Jarvis and Ashfield (2009) focus on the advantages of its “inherently interdisciplinary nature” (p. 1) working between computer science and geography. Elwood et al. also define GIS as an, “assemblage of practices” (2012, p. 573). Importantly, however, they note that these practices are tied to, “historically situated

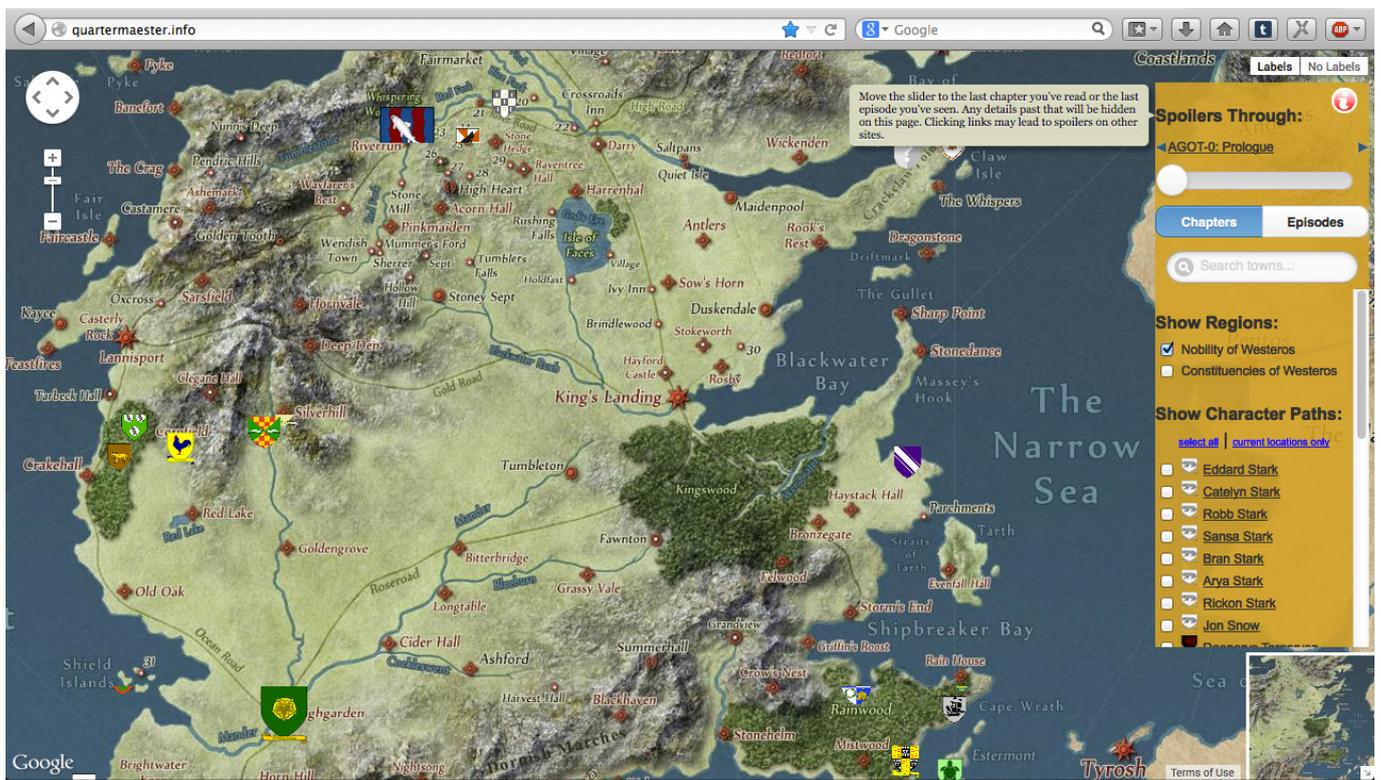
relationships around science, knowledge, and power” (ibid.). Other scholars have expressed similar concerns about GIS and its relationships and inherited ties to militaristic intervention, surveillance and industrial intelligence (Pickles, 1993; John Pickles, 1995; Schuurman, 2002). As noted above, practice is primarily understood as the politically saturated deployment of GIS as a group of technologies that allow for the recording, analysis and presentation of data that, moreover, has become conflated with normative apprehensions as to what appropriately constitutes a scientific knowledge production.

Such inherited ties are, however, increasingly problematised by the emergence of a Web 2.0 characterised by more user friendly interfaces, the growth of the internet and, more recently, GIS-focused web applications (Haklay, Singleton and Parker, 2008; Graham, 2010; Jones and Weber, 2012). Such developments have prompted a more complex understanding of what constitutes GIS that eschew an emphasis upon its products and their insertion into political and economic processes. Kitchin et al (2013), for example, observe that where once these practices treated, “mappings as stable, knowable, essential outputs” (2013: 484), current GIS practice is able to take a more iterative approach to mapping events as they occur, “advocating an ontogenetic position that understood maps as always in the process of becoming” (p. 480). This move away from seeing maps as static, definitive records of the world has also been shaped by the sheer increase in available data through open data initiatives by government and industry and volunteered geographic information (VGI). For example, the Ordnance Survey now allows anyone to download their 1:50000 scale maps for free, while *OpenStreetMap* is a map of the world created with VGI and is free to use. In the past decade, such Web 2.0 applications have meant that GIS practices can be more open to non-expert intervention (Warf and Sui, 2010; Haklay, 2013), to an extent diminishing claims that only those with specific technical expertise, access to infrastructure and funding can contribute to this method of generating geographical knowledge. Specifically,

...how mappings unfold through a plethora of contingent, relational and contextual practices and do diverse work in the world through discursive events and material sites in conjunction with other modes of communication (such as text, images, spoken word, interactive new media) and forms of practice (such as collaboration, presentation, publication, debate). (Kitchin et al., 2013, p. 494)

Importantly, this proliferation of available data and more intuitive user interfaces (Schuurman, 2002; Goodchild and Longley, 2014) has meant that not only the creation of maps, but the process of spatial analysis underpinning this has become a, “less formal, more inductive research protocol” where, “analysis can be based on data exploration rather than hypothesis testing”

Figure 15 - Screenshot from quartermaster.info - Interactive Game of Thrones Map (Available online at Quartermaester.info, accessed 30/12/2016)



(Schuurman, 2002, p. 259). Such freedoms are, however, both allowed for and constrained by the graphical user interface in modern GIS. As Schuurman notes, decisions made by the GIS user, the way in which they individually conceptualise space, and the way in which GIS methodology and practice evolve, are directly influenced by the architecture of the graphical display:

[These are] driven by the available options on the menu bar of the application. Thus, while the capacity for visual/intuitive interpretation may be expanded by the nature of GIS output, innovative treatment of the data may be restricted by the range of choice associated with the pull-down menus. (Schuurman, 2002, p. 259)

Certainly, these more intuitive systems allow those with a minimal understanding of the technical aspects of the software to manipulate spatial data easily. In this way, software design influences how data is read and understood. This is perhaps what Dobson (1983, p. 136) referred to as “new computer-based techniques.” Beyond geography, Web 2.0 and modern GIS applications have allowed scholars from other disciplines, as well as citizens, to discover the spatial applications of their own data. For example, Google Mashups have allowed users to create their own maps that can be displayed using the Google Maps interface. Some use the application to add create user generated content to the existing Google Maps base maps, while others create maps from fictional worlds (for example, Figure 15). A recent symposium at The University of Birmingham entitled *Telling Stories with Maps, the Geoweb, Qualitative GIS and Narrative Mapping*, saw scholars from a range of disciplines utilising GIS in their work. Most notable was Gregory et al.'s (2014) analysis of William Wordsworth's movements through the Lake District, using his writing to generate spatial data, and de Sa Pereira's (2014) analysis of Hemmingway's *For Whom the Bell Tolls*.

Relatedly, along with the continuing development of web-based technologies and more sophisticated software, GIS has aided in the development of mobile methods of gathering geographical data. Web and GPS enabled handheld devices have allowed researchers to capture people's movements in their everyday lives. Furthermore, desktop GIS applications allow the researcher to more easily model and conceptualise this information (Jones and Evans, 2012). As Delyser & Sui (2012) note, these methods, no doubt enriched by, but not reliant upon, these new technologies, “prioritize the researcher's being there, in motion, engaged in active knowledge production, seeking to understand mobile phenomena first hand” (2012, p. 296). Contrary to Sheppard's (1993) concerns that researchers would choose more easily accessible secondary data at the expense of geography's tradition of primary field studies, the application of GIS has instead, it seems, invigorated new corporeally-aware methods for the collection of

primary data. Mobile methods, Web 2.0, Open data, volunteered geographic information, the neogeographer, intuitive software design and development, and Google Mashups, have all led to a reimagining of how GIS is, and can be, produced, disseminated and used by geographers. The critiques of Sheppard (1993) and Pickles (1993) – sceptical of Dobson’s “Automated Geography’s” authoritarian and positivist underpinnings – have arguably been superseded by these new modes of GIS practice.

Practice-Led Research and Creative Practice

In recognising the plethora of practices that constitute GIS, geographers have brought a forensic scrutiny to the analysis of how these practices actually work, and the specific forms of work that they do. Ash (2012b), for example, investigates the phenomenology of habit, and discusses the idea of ‘technicity’ to illustrate how human senses and embodiment are reconfigured in relation to the practice of interacting with a computer game world mediated via a computer screen. Ash notes how participants embody the practices taking place onscreen. Relatedly, Hein et al. (2008) advocate the application of these post-humanist concerns in the practice of GIS to reimagine it as a ‘people-based’ rather than ‘place-based’ science, shifting the political focus of GIS from that of military strategy towards a, “technology of the self” (2008, p. 1272).

An especially fast-growing line of inquiry, however, has been to analyse practice via the work of artists – a cohort whose recognised expertise does indeed lie in ‘doing’ as well as practice-led inquiry. A politics can also be discerned here insofar as geographers are drawn to, “the way in which art offers the potential to think (and practice) space differently” (Hawkins, 2011, p. 468). Wickstead (2009), for example, discusses the work of video maker/artist Janet Hodgson in residency with an archaeologist working with GIS at Stone Henge. She moves from spatial panopticon of maps, references Poster’s claims of digital archives being super panopticon. In a similar vein, Hawkins’ (2010b) encounter with Tomoko Takahashi’s installation *myplaystation2@serpentine2005* was interpreted through these themes of performativity, embodiment and affect. A key aspect of her approach are passages of text recalling and giving shape to her sensuous encounter with the materials and their compositions:

Here, however, I have shafts and spots of light rather than charcoal lines or hues of paint. I do not look with this light but according to it. Permissive of my look, this light directs, focuses and frames my material experiences. I draw back from inspecting the tableaux and continue to circle the stacks. As I navigate Takahashi’s object towers, I am repeatedly forced to move towards and away from them, to peer amongst the groups of

objects and to bend over and peek through holes as areas are plunged into darkness or blocked from view (2010b, p. 333) .

There are thus two parallel narratives at work within this piece; one that is an in the field account of affect, embodiment and performativity, and the other a more formalised interpretation of these encounters. This is required insofar as:

...in the installation's twining together of a spatial politics with an embodied visual politics it, in effect, brings the consciousness of one's corporeality to the forefront of the art experience. (2010b, p. 335)

The methodological practices documented in Hawkins' article resonate with Last's (2012) "Experimental Geographies," whereby creative experimentation can destabilise a, "presumed binary of artistic-creative and academic-utilitarian research" by "de-romanticising and 'demystifying' artistic practice" (2012, p. 718). These discussions echo the longings of Sui (2004a) for a 'third wave' of GIS practice underpinned by an interest in the doing as well as critical appreciation of aesthetics.

Certainly, and building on the significance of doings as well as dialogues, Human Geography has been party to a renewed interest in more creative forms of practice (Hawkins, 2011; Marston and De Leeuw, 2013). In her article, "Dialogues and Doings: Sketching the Relationships between Geography and Art" Hawkins (2011) separates this interest into two strands. "Dialogues" refer to how geographers interpret works of art and import interpretations themes into their own research. "Doings" refer to the creative activities of geographers, where an artistic, creative practice has become part of their geography practice. As Hawkins (2011) observes, works of art can be useful in reinforcing relational, post-humanistic, assemblage understandings of space by querying a "Cartesian subjectivity" (2011, p. 473), by which is meant artistic practice is often well suited to destabilise structural ontologies. Straughan (2015) reiterates Hawkins', "aims to unpack the manner in which art 'is both corporeal and conceptual, embodied, but also embedded in history and culture.'" She notes how the artists *We Colonised the Moon*, for example, have explored the notion of practice to understand maintenance, temporality, spatiality and exposure, wherein:

WCTM have facilitated an intersection between the durational with the ephemeral, an intersection that pivots upon the practice of maintenance. (2015, p. 12)

Dixon et al. (2012) also find certain affinities with artistic practice, especially in relation to the plethora of methodologies and approaches to practice that have come about in the development of post-humanist geography. It is arguable that just as art has to a large extent moved beyond a

definitive art object, instead being made of, “an ensemble of practices, performances, experiences and artefacts” (Hawkins, 2011, p. 465), through post-humanist approaches geography too has moved beyond representation.

Taking a retrospective position, Marston and De Leeuw (2013) argue for a change in attitude from geographers in how art practice is regarded. While the works of artists have been recognised as empirical objects in geography for the last fifty years -- their editorial acknowledges geographers’ longstanding appreciation of the creative process of collage and montage as a method of enquiry and a way to understand place -- a more ‘practice-based’ relationship between geography and the arts’ (2013, p. iii) is relatively recent. They claim that with new cultural geography the work of art has been reimagined from a descriptive practice to a productive practice that does work in the world and has some part in the production of space. Such works “do’ political work in the world” (Marston and De Leeuw, 2013, p. iv). Yet, demarcating ‘practice-based’ research, or ‘creative practice, is difficult, insofar as,

Just as geographers produce work across the full spectrum of epistemological and ontological orientations, so too do artists and writers, whose disciplines are not dominated by one philosophy of knowledge or creativity. (Marston and De Leeuw, 2013, p. vii)

Both types of practice are underpinned by a substantial history and are considered valid approaches to knowing the world. The only difference Marston & De Leeuw identify explicitly is with regard to the intended work of the project, insofar as creative practice is geared more towards eliciting responses within the context of galleries, museums, and public spaces, while practice-based research remains open-ended but tends to be disseminated textually in journals and textbooks. For my part, I find this to be an important distinction. Since the ‘exhibition theory and practice’ module of my undergraduate degree in contemporary fine art practice I have been taught not to discount the significance of the method of dissemination. Such concerns can present challenges for geographers, Marston & De Leeuw observe, as they attempt to embrace an artistically inflected sense of practice. What is more, in the process geographers may well “lose sight of the importance and value of our own disciplinary schooling” (Marston and De Leeuw, 2013, p. vii).

Towards a Creative GIS of Play, Curiosity and Experiment

There has been an increase in collaborative projects between artists and geographers (as noted by Marston and De Leeuw, 2013). Hawkins (2015) notes how there has been an opening up of space within cultural geography to focus on the “practices and politics” of creative arts. For

Forster and Lorimer, this is often framed as, “initiat[ing] theory-making and practice in both directions” (2007, p. 426). Furthermore, arts practices offer more “interventionary possibilities” (Hawkins, 2015, p. 248) for geographers who have been able to collaborate and participate in art practices, which also allow them to take their work to new audiences. However, for those geographers that do participate in art making collaborations, Hawkins (2015) notes that is important to remain respectful of disciplinary differences between the artist and geographer – not to fetishize skill, but also recognise the value of such things. In this sense, for Hawkins, these experiences of doing artwork remain ethnographic.

Hawkins (2015) draws attention to how geographers have turned to the arts to evoke the more, “illuminating image” (Darby quoted in Hawkins, 2015, p. 250) of the world generated by creative practices, and to “challenge the ascendancy of spatial science” (2015, p. 250) as an overly systemised set of routines and practices. Here, arts practices offer a more subjective perspective, where drawing, painting and image-making itself can be understood as a process of “coming to know” (Hawkins, 2015, p. 251) the world. Furthermore, Hawkins notes how practices of image-making can contribute conceptually to geography using methods like ‘deep mapping’ which uses, “compositional strategies of collage and montage... to generate instability, thus creating energies of interception and disruption from which the new can emerge” (2015, p. 252). For Hawkins, these practices of ‘deep mapping’ not only provide novel modes of representation of the world, but also offer opportunities for intervention in the world. For Hawkins (see also Marston and De Leeuw, 2013) creative practice is productive a form of praxis – not just representational, but also as a means of intervention.

Hawkins (2015) reflects on her own efforts of trying to draw. Although frustrated at her ineptitude relative to her artist collaborators, she begins to understand the value of drawing beyond the goal of accurate representation. She refers to John Berger on this subject, who explains “to draw is to look, a drawing of a tree shows not a tree, but a bee being looked at” (Berger quoted in Hawkins, 2015, p. 254). As such, drawings are records of the process of looking, or paying attention. For Hawkins this brings to the fore the “impossibility of mimesis” or “the impossibility of capturing everything” (2015, p. 254). Here, mimesis is not about imitation but about embodied understanding of the world, or as Hawkins explains, “this was a practice of how careful looking was not so much about recording the place but discovering it” (2015, p. 255).

For Last (2012), recent appropriation of creative practices by geographers speaks to a broader theme of experimentation. Last sketches two threads in relation to experimentation in geography:

1. The adoption of artistic modes of representation such as using creative media such as photography film, and sound recording as new modes of representation, and the creation of new geographical imaginaries. This is not necessarily to create art, rather borrowing disciplinary registers and modes of representation to supplement traditional textual registers and subvert traditional forms of representation.

and

2. The challenge of undertaking risky research that embraces the possibility of failure. Thinking of experimentation in these terms brings to the fore issues of research ethicacy and speaks more to how knowledge is produced, figuring the experiment in terms of its parties, also the tensions and anxieties of researchers, ethics boards, funding councils and so on.

Others have discussed experimentation from more traditional understanding of experiment. As such, for Powell and Vasudevan (2007), geographies of experiment are about paying attention to the sites of experiment. They call for geographers to, “deploy ethnographic and historical insight in the development of geographical sensitivity to the spaces of actual experiments” and also to pay attention to, “bodies, texts, and practices that constitute spaces of experimentation” (2007, p. 1790). Relatedly, Kullman (2013) considers diverse sites of experiment and thinking about practice as experiment. Kullman follows work from STS that challenges our perception of, “laboratories as instrumental and ‘placeless’ setting, uncontaminated by the outside world and containing standardised equipment” (2013, p. 881). Rather, we should think of laboratories more as “deliberately arranged to generate surprises” (Gross quoted in Kullman, 2013, p. 881), and places where we acquire, “new knowledge about a range of entities and forces whose agency has largely gone unexplored prior to the experiment” (2013, p. 881). For Kullman, there is nothing placeless about the laboratory, indeed, there something very “situated about experimental knowledge”(2013, p. 882).

In an effort to come up with a production definition of curiosity Phillips (2010) links it to experimentation, and casts it as the, “desire to encounter the unknown” (2010, p. 449). Similar to play, curiosity has been cast as a childish pursuit (see Harker, 2010). Phillips (2010) describes a number of ways in which scholars have moved to embrace curiosity. He talks about Keri Smith and her book *How to be an explorer*, which, “invites the reader to open, perhaps re-open his or her eyes and mind to notice things, as if for the first time, without worrying too much about how practical or useful this may seem” (2010, p. 450) Phillips (2010) also notes the work of the Situationists whose focused curiosity, “has been portrayed as a form of exploration,

discovery and... adventure” (2010, p. 450). This notion of ‘focused curiosity’ has been used by some to separate curiosity from notions of childishness, “advocat[ing] focused and disciplined forms of curiosity” (2010, p. 449) or curious approaches that are more academically credible. However, Phillips notes that it can often be productive to reinvigorate or rescue childish impulses from the seeming rationality of adulthood. Moreover, Phillips (2012) asks us to be critical of notions that curiosity should be held in opposition of rationality/ productivity.

Phillips (2013), rather than pinning down some reductive definition for curiosity, seeks to reflect upon moments when notions of curiosity are evoked. He discusses efforts to create environments for curious engagements such that, “efforts are made to fashion extraordinary spaces, removed from the demands and routines of the everyday, which spark curiosity” (2013, p. 495). Such environments look to encourage inquisitiveness by promoting social interaction. They aim to release the rigidity in traditional learning environments, “creating fluid spaces, which encourage interaction and encounter” (2013, p. 496). For Phillips (2013), it is useful to think through how we imagine *who* can be curious. Phillips discusses how gender, mobility, and race can contribute to our understanding of how people become curious. Phillips attempts to dispel the notion that curiosity must be risky and dangerous, and that efforts to control and contain curiosity somehow undermines something vital. Phillips claims that, “the dichotomy pure and applied, vital and diluted curiosity does not stand up to scrutiny” (2013, p. 505).

According to Harker, play is too often associated with children, and thus childish. Therefore Harker (2005) draws together a number of theories to consider what play is, and what it is for. He notes:

- From psychoanalysis – where play is understood as developmental, leading to an understanding of self/others involving, understanding objects and objectivity, being creative, and doing and being active.
- As discourse Sutton-Smith, discusses play as discourse noting that play is, “as much about (everyday) ritual as it is about innovation” (2005, p. 51).
- From performance – As at the intersection of being and becoming. To understand play we must maintain our attention between being and becoming whilst resisting the temptation to pin down either.

For Harker (2005), in order to get at play it is useful to take into consideration affect and its apparent unlocatedness across bodies. He notes that, in play, affects are often heightened, prioritising physical and emotional experience, and reshaping capacities for bodies to attune to affective atmospheres. For Harker play, “allow[s] a greater role for the non-cognitive (and

therefore seemingly irrational) parts of the brain” (2005, p. 56). Furthermore, objects play a vital role in the performance of play. These objects participate in the dissemination of affect and contribute to the world of affects that make play possible. Significant for Harker (2005) is that play resists definition, and yet we all know what play is. As such, play is not always, “energetic, irrational, or opposed to ‘work’” (2005, p. 59). Harker gives an example from his own field study of a girl choosing to read at playtime. Furthermore, play is not always emancipatory. Sometimes involves practices that reinforce gender norms, for instance, boys playing football.

Woodyer (2012) shares Harker’s (2005) desire to unshackle play from notions of childishness, “because it constrains our appreciation of play as a significant geographical concern in its own right, well deserving of attention beyond the confines of children's geographies” (2012, p. 313). She discusses utilitarian and non-instrumental perspectives on play the former positions play and childishness as a necessary process to develop for adulthood. That is, play is not adult behaviour. The non-instrumental perspective, on the other hand, takes the approach that play is neither productive, moral or serious. Woodyer (2012) argues to liberate play from these binary positions and shift focus to the situatedness and performativity of playing. As such playing is becoming conscious, “[t]hrough its playing with limits, experimentation with rules, roles and meanings, and mimetic behaviour, playing contains transformative potential”(2012, p. 322).

Summing Up

To sum up at this point, I began this section by introducing Dobson’s (1983) enthused vision of the future of “Automated Geography” that promised, faster methods for quantitative analysis, and greater accuracy and possibilities for researchers to map the world. Dobson argued that through the proliferation of computerised techniques geography would remain true to the tradition of the study of areal differentiation. However, this possible future was criticised (Pickles, 1993; Sheppard, 1993) for its overtly top-down approach and reliance on positivistic ontologies. Following on from Pickles and Sheppard’s critiques more humanistic approaches to GIS have tried to disassociate it from notions of surveillance and industrial intelligence (Goodchild and Longley, 2014) and advocating more iterative approaches to map making (Kitchin, Gleeson and Dodge, 2013). Furthermore, Web 2.0 and open data initiatives have arguably democratised GIS, and new technologies have allowed for more mobile methods of practicing geography. Here, one might see practice as a technological sandpit for experimentation.

This section has also assessed the practice of post-humanistic geography and its assemblages of human and non-human actors mediated through the themes of affect, embodiment, performativity and doing to present practice as, “a way of thinking about phenomena as

productivist or practice-based” (Anderson and McFarlane, 2011, p. 126). According to post-humanistic geography, to render an exportable definition, to practice is to be. Finally, it was important for me as a creative practitioner to make a more in-depth assessment of cultural geography’s recent engagement with creative practice. Here, post-humanistic concerns have been applied to “dialogues and doings” (Hawkins, 2011). The former refers to interpretation of creative practice, and the latter, geographers’ own creative practices, employed as a method of enquiry. To date, and with reference to GIS, geographers’ engagement with creativity has been to note the efforts of artists using the technology as an artistic medium of expression (Butler, 2006; Kwan, 2007; JW Crampton, 2009; Kingsbury and Jones, 2009; Lin, 2013).

What is arguably missing is a geography *cum* art project that speaks to these notions of practice as a way of producing knowledge and understanding through creative methods that emphasise curiosity, experiment and play. Rather than focusing on GIS strictly as a medium of expression, such a project might address the *doing* of GIS, thinking through the immersive experience of working with GIS technologies, complex visual literacies, and the emotional dispositions at play.

SECTION SIX: ASSEMBLING GEOGRAPHIES OF GIS

Having parsed debates on the ontology of GIS, and the notion of practising GIS, I want to focus here more specific relations that emerge from practising GIS alongside others, and other things. Paay, Dave and Howard (2007), for example, take up the theme of sociality as it relates to architectural approaches to pervasive computing. They focus on, “sociality-places-bits nexus”(2007, p. 447) to consider how sociality is constituted across physical and social layers of the environment. Paay, Dave and Howard (2007) explain how individuals follow both physical and social environmental cues. Their approach to understanding sociality pays attention to potential frictions in urban spaces in order to aid in more effective design of pervasive computing in an architecture and planning strategy. Furthermore, they note how traditional wayfinding methods (street signs etc.) have been superseded by digital devices, so that there is less need for signage and people are socially connected via technology.

In counterpoint, Ramsey (2008) dwells on collaboration in GIS from a planning perspective. The focus here, is on participation. However, Ramsey illuminates some of the political relationships that tend to be assumed in PPGIS. That is, that through focusing on decision making, collaboration can foster the development of shared understanding, and the establishment of common goals for all parties. However, Ramsey argues more attention is needed to address the inherent power relations embedded in GIS practice. He claims that any

effective participatory GIS approach should take steps to expose and mitigate the power relations with which geographers are (or should be) fully aware.

Leszczynski (2014) begins by assessing the ways in which new spatial media diverges from critical GIS studies in terms of the mediating practices it allows for. Leszczynski is reluctant to rely upon the critical GIS project “as a starting from which to engage with emergent spatial information” (2014, p. 730). This is because this spatial media “does not conform to the same ‘systems’ metaphors” (2014, p. 731) brought forth by such debates. Spatial media is different. Leszczynski argues that there is a different epistemology at work with new spatial media – we come to know, or apprehend, spatial media on different ways to GIS. Leszczynski proposes that we instead think of spatial media as material, “epistemologically claiming spatial media as ‘media’ directly asserts their materiality” (2014, p. 731). As such, Leszczynski sets out the material qualities of spatial media as relating to:

- How location is intrinsic to mobile devices and as digital media produced in large part by mobile devices it is becoming increasingly spatialised
- A Geo-index – such that the web is ordered according to a spatialised index (made searchable and retrievable according to position)
- Applications of big data and, “using geographical frames of reference to structure our experiences on that content” (2014, p. 733) to make sense of it spatially.
- The positioning of users within a network, we and our devices become part of a sensor network.
- Through social media, users can leverage spatial encodings to mediate physical connectivity.
- Space is ontogenic, that is, being made by spatial media.

For Leszczynski (2014), rather than thinking through and attending to how *GIS* is produced, thinking through mediation allows us to question how we apprehend spatial media, and what it does.

Kinsley (2013) too looks to address the digital in terms of its mediating materialities. Kinsley looks to, “‘technics’ as a means of explicitly situating their materiality” (2013, p. 366). He notes how others have examined the agency of code in the production of space (Dodge and Kitchin, 2004). Kinsley (2013) uses theories relating to technicity to unpack the relations between human and technology. For Kinsley, human and technology are co-constituted, they make each other, “humans and technology co-evolved together... you do not get one without the other” (2013,

p. 372). Kinsley suggests that through transduction we can understand technicity, by following the trajectory of material interfacing through for instance, sending a text message. Similarly, Wilson (2011) discusses the work of geocoding citizens as a form of technologically mediated practice. For Wilson geocoding the urban environment is, “a constituted textual practice, a practice and language engaged through moments of training.” (2011, p. 357). For Wilson geocoding is bodily (or embodied) work, and as such they become literate in the language of local government and planning. For Wilson, this literacy becomes part of their own cyborgian formation of *their* geocoding body. The geocoder’s perspective becomes digitally constituted, “their vision is linked to code” (2011, p. 363). This allows them to, “assume ownership through their geocoding practices” (Wilson, 2011, p. 364)

Focusing more on the micro-skills involved in a human agency, Kwan (2002b) reflects upon the critical GIS literature from a feminist perspective. Kwan claims that the relative absence of a feminine perspective on critical GIS debates led to a deficiency in understanding the everyday experiences and agency of GIS users. For Kwan, this is problematic because it risks a deterministic approach of the technology and how it is practiced and potentially, “precludes the possibility for resistance or subversion of dominant practices” (2002b, p. 273). That is, the critical agency of GIS users seems to be missing from these debates. Kwan discusses her own research on women's daily mobility in Columbus Ohio in which she collected her own data and developed bespoke algorithms. Here, she claims she exercised her agency as a user to develop a research practice that was not only dictated by the confines of the software environment.

Relatedly, Richardson and Bissell (2017) discuss the qualities of digital skill. They talk about deskilling as work becomes automated, but also reskilling – in reaction to an increase in demand for digital skills. Richardson and Bissell recognise policy literature that tends to address changes in the labour market as requiring more investment in fostering digital skills such as those required to do data analysis. For Richardson and Bissell, this macro political approach, that aims to understand the kinds of expertise required for national economic development and propose policy recommendations. According to Richardson and Bissell this frames labour according to how people are paid or compensated for their work. Instead they offer a more processual approach to understanding digital skill. They borrow Foucault’s concept of micro politics to get better sense of digital skill in terms of materiality and practice in situ. This approach allowed them to pay closer attention to how skill is constituted in the workplace through, “in situ forms of enablement and constraint that wax and wane” and how “agency might seem sometimes to concentrate in the worker, and seem sometimes to be distributed beyond them” (2017, p. 2). They operate under the assumption that skilled work happens across body and tech, it is co-

produced between body and technology. Richardson and Bissell (2017) pay attention to the often overlooked skills in using digital devices: for example, so called ‘gig economy’ platforms like *Uber* and *Deliveroo* offer navigation but not the aptitude to avoid hazards on the road. Likewise, a job insecurity requires financial and time management skills. Richardson and Bissell (2017) explain that digital skills becomes easier through repetition but this familiarity is distributed, but also that intuition is emergent from this familiarity such that, “the intuitive bodily tendencies that develop through his specific envelope might find expression in other similar interfaces that are encountered” (2017, p. 7).

Unsurprisingly, emotion and affect have also been brought into discussions of how specific practices take place. Anderson and Smith (2001) claim that the importance of studying emotion is undervalued in geography, “frequently feminised” (2001, p. 3), and marginalised for the sake of more ‘objective’, and rational perspectives, speaking to the rational/emotional binary inherent in masculinist and positivist approaches. For Wood and Smith (2004), emotional geography is to do with, “the spatiality of the feelings around being and doing (in) the world” and also that “emotions are situated self-feelings” (2004, p. 534). They claim that emotions actually locate individuals, and hence why emotions are such an important target for geographical research. Wood and Smith pay attention to the emotive power of performing and experiencing live music. According to Wood and Smith, the arts, and music in particular, have particularly exceptional power to evoke a vast array of emotions. They note “when a performance is really working, it is hard both to ‘do’ research and to ‘be’ in the audience”. (2004, p. 540). There is a difference between thinking and feeling and perhaps a discrepancy in rationalising and articulating and making sense of emotions. For Davidson and Milligan (2004), geographers’ concern with emotion can be traced through studies of embodiment, which place the body is the primary site of emotional experience. As such, thinking is done via the feeling body. For Davidson and Milligan (2004), emotions are spatially mediated, they colour our experiences of the world and thus have material consequences, and we both make sense of our emotions spatially and make sense of space via our emotions.

Anderson explains how affect is different to emotion. That is, emotions are how affect moves through the body and “described as feelings” (2006, p. 736). Emotions, however, are personalised and individuated narrativisations of the progression of affect. Emotions are affect qualified, “owned and recognised” (2006, p. 737). Though this is not always a frictional process of the bodies rubbing against the world, it is often an, “artful corporeal intelligence- in-action” or a, “rhetorical, responsive joint action” (ibid.) Anderson explains how affect is excessive, so that affect never coincides with an equal effect in the world. According to Anderson (2006)

affect is not an event, it is neither inside or outside bodies, but oscillating. Relatedly, efforts have been made by Young and Gilmore (2013) to consolidate theories on affect and emotion to develop an approach useful for discussing a PPGIS project working with indigenous Peruvian communities. They make a distinction between affect – being of the body, or psychobiological – and emotion – as being sociological, or socio-spatial. Young and Gilmore talk about how affect is transmitted from one body to another - that affect is not only manifest in bodily actions such as smiling which often elicits a similar response in others through imitation. Moreover, they take from Deleuze, who, “describe[s] affect in terms of the intensity of a body’s attunement with the movement and self-organisation of the world around it” (2013, p. 815). Young and Gilmore discuss the interplay between the virtual (all that is possible) and the actual (what is happening?) And this is when it becomes political, as the effect upon bodies, produced by a particular flow of effect, depends upon the constraints or “functional limitations” placed upon that particular body. However, Young and Gilmore write that this theory of affect espoused by Thrift, has been critiqued by feminist scholars on the grounds that it makes a “false distinction between ‘personal’ and ‘political’” (Young and Gilmore, 2013). Furthermore, because emotions are always socially situated, that is, always subject to social processes “rife with inequalities and uneven power geometries” (2013, p. 816). As a result of this critique, many geographers take the approach that emotion is socially constructed. As such, “authors press the relationality of experiences and identity” (2013, p. 816). They set out a methodological approach for thinking through theories of affect and emotion, wherein: Affect places constraint upon body's ability to act.

1. Affects are expressed socio-linguistically as emotions
2. Affect and emotions are sometimes sticky - they stay with the body - endure.

Kwan (2007) makes a direct call for the affective dimensions of geospatial technologies to be taken more seriously in research. Following from developments in NRT work on emotions and affect in geography, Kwan asks us to “bring emotions back to bear up on GT practices” (2007, p. 30). Kwan promotes applying concerns of NRT relating to performativity and practice in order to better understand the affective and emotional dimensions of doing work with geospatial technologies (GT). This involves taking into consideration the subjectivities of the researcher and understanding emotions as part of the research process. As such, Kwan claims that individual bodies are often rendered irrelevant in GT, both in denying the partialities of the GT practitioner and those bodies affected by the application of GT. To remedy this Kwan suggests feminist GT practitioners can help by questioning prevailing assumptions of the possibility of detached rationality. Furthermore, practitioners should actively recognise their

own emotional positions in relation to GT research, particularly in impassioned attention to caring, emotional commitments and involvements. For Kwan, this is about making GT a more moral project, and as a result, better able to respond to themes such as violence.

Ash (2013a) addresses the concept of affective atmospheres in relation to how they influence non-human or inorganic objects. Ash discusses affective atmospheres that encapsulate both human and non-human in the same space-time. What Ash describes is affect beyond any kind of emotional feeling, produced with inorganic entities. He begins with Bissell's (2010b) conception of affective atmospheres as operating in the circulation of mood or feelings or as dispersing as contagion. Ash offers Bryant's (2011) concept of perturbation to take onto consideration non-human and inorganic matter's response to affect. In this sense perturbation is "the ability for aspects of one object to affect another in some basic way" (Ash, 2013a, p. 22). Ash gives the example of an *iPhone* being able to be perturbed by radio waves in a way that a human cannot be. Ash goes on to talk about how problems in the design of the *iPhone 4* led to unforeseen perturbations in its working. Ash claims that this approach to studying technological objects can offer a way to understand affective atmospheres that are not directly accessible by human experience. One important element of this concept of affective atmospheres is that, unlike in transductive approaches (Kinsley, 2013) to understanding digital technologies – where space is transduced, existing space transformed – instead objects produce atmospheres with their own space-times.

Ash (2015a) discusses how objects might be transformed to alter their affective capacities. He uses the example of smashing an *iPad* so that it becomes less like other tablet computers according to its affective capacities. That is, how the tablet is able to transfer electrical information into visualisations, to become more like a knife, in its affective capacity to cut. Ash (2015a) also talks about how inorganic or technical objects "operate as forms of tertiary or externalised memory" (2015a, p. 86) this means something of "the practice of writing is partially preserved entire pen itself" (ibid.). Organically organised objects are a kind of assemblage of technically formed matter that is in part formed by its utility – however, these are, "also autonomous outside of their human uses" (2015a, p. 86). Ash explains that all objects are in some sense homeostatic - they are able to maintain themselves as objects. In the case of technical objects Ash points to Simondon's example of an oil lamp, which would not be recognised as such if it were unable to maintain its functional oil lamp-ness, that is being able to provide light without bursting into flames and thus transforming the nature of its affective capacity to safely provide light. According to Ash (2015a) Simondon notes that inorganic organised objects do not achieve this homeostasis in the same way that organic objects do. For

an organic object or body there is constant, “theatre of individuation” (Simondon quoted in Ash, 2015a, p. 86) where many processes actively work to regulate, “minimise change”, create “feedback loops” to maintain the stability of the body as an arranged object, whereas with a technical object this process of individuation, “the very potential for homeostasis is defined in advance, at the moment of that object’s design or manufacture” (ibid.). However Ash notes that although, “[t]he affects’ technical objects produce are informed by the intention of their designer”, the stability of the object or, “the homeostasis of the object always has to exist alongside an associated milieu [space for the transmission of affect], which the designer or manufacturer has no control over.” (2015a, p. 89). There is a conflict between the perceived authority of the designer (coder, software developer, engineer, town planner) or their intention and the inability to foresee, or control, or plan for circumstances when homeostasis breaks down.

SECTION SEVEN: The Archive as a Disciplinary Formation

...the meaning of "archive," it's only meaning, comes to it from the Greek *arkheion*: initially a house, a domicile, an address, the residence of the superior magistrates, the archons, those who commanded. The citizens who thus held and signified political power were considered to possess the right to make or to represent the law. (Derrida, 1995, p. 9)

Jacques Derrida’s writing on the archive has been pivotal in contemporary reflections on the role and nature of the archive across numerous disciplines such as human geography (Kurtz, 2001; Withers, 2002; Featherstone, 2003; DeSilvey, 2007; Yusoff, 2008; Lindqvist, 2009; Lorimer, 2010; Lorimer and Philo, 2010; Cresswell, 2012; Sjöholm, 2014; Beel *et al.*, 2015), theatre and performance studies (Taylor, 2003; Lepecki, 2010; Schneider, 2012), visual arts (Sekula, 1986; Verwoert, 2004; Gielen and Maermans, 2007; Yerushalmy, 2009) and more broadly in historical and archival studies (Osborne, 1999; Harris, 2002; Van Zyl, 2002; Manoff, 2004; Clarke and Warren, 2009; Jones, Abbott and Ross, 2010). As Verne Harris notes, “It is impossible to speak [of the archive] without also speaking of Derrida” (Harris, 2002, p. 61). Yet, despite reference to Derrida in terms of digitisation, and digital humanities, no substantial linkage to his work can be found in critical GIS literature that frames GIS as a depository comparable to the archive. Given GIS’ increasing role in the digital humanities, perhaps it is useful to consider this issue. As the section’s opening quote from Harris *et al* illustrates, GIS is engrained with issues around authority and access.

Jacques Derrida's *Archive Fever: A Freudian Impression* (1995) begins by explaining the etymology of the word archive, tracing it back to the Greek word 'arkheion,' which refers to the house, "the residence of the superior magistrates" (Derrida, 1995, p. 9), as a form of authority. For Derrida, the archive is the place where knowledge resides, albeit deadened, under house arrest. If etymology is understood as the search for the origins of words then it is instructive that Derrida chooses this method of analysis as he introduces his etymological investigation of archive with what would seem like a contradiction, "Let us not begin at the beginning" (1995, p. 9). However, as Carolyn Steedman (2001) explains, Derrida is stating that words are not equivalent to an origin, and yet often become the basis for just such a quest. The search for starting places is a fatal exercise, and it is this impossible quest for origins that Derrida names as a sickness (Steedman, 2001), the *Mal d'archive*.

In *Archive Fever* Derrida's uses Freud and psychoanalysis as an exemplar of the archive, but also an entry point into the desire to archive. Susan van Zyl (2002) emphasises this, explaining that, "psychoanalysis is itself an archival science" (p.41) with its themes of "unwanted remembering" and "active forgetting" (see also Steedman, 2001; Van Zyl, 2002, p. 51). Derrida finds Freud's writing useful in its desire to uncover beginnings and moments of inception. What Derrida is looking for in Freud's work is way of approaching the phenomena of the archive that does not regard it, "simply a recording of the past" (Van Zyl, 2002, p. 40), and there are a number of operations at work within psychoanalysis and Freud's writing that Derrida considers useful for making sense of the desire to archive. What Derrida identifies in Freud's writing as the notion of the 'future-to-come,' for example, notes that future events are often required to make sense of prior events. Susan van Zyl explains that,

Freud suggests that subsequent events may be necessary even to establish the very identity of earlier ones, and that the psychic work done by events defined in retrospect can often be understood only when we admit to the power of this complex operation. (2002, p. 53)

It is what Freud calls the 'death drive' that, Derrida argues, underlies the drive to archive. This is because without the death drive there would be no need to save "in material form all that the death drive seeks to destroy without remainder, to annihilate even beyond the point of ashes" (Van Zyl, 2002, p. 59). To archive, then, is to make sense of the past from the perspective of the present; it is also to preserve something of a future for the self, in the form of a locative past that *anticipates* the self.

Derrida's investigation of the etymology of archive, as well as serving to highlight the futility of the search for the inception and origins, also brings about another set of themes relating to the

nature of the archive. That is, despite the trouble of establishing an origin of the archive, it nevertheless is tied to the idea of state (Steedman, 2001), state power and authority over the public, the individual and the body (Harris, 2002). For Derrida,

They all have to do with this topo-nomology, with this archontic dimension of domiciliation, with this archic, in truth patriarchic, function, without which no archive would ever come into play or appear as such. (1995, p. 10)

Practice is firmly located in the psyche, but this in turn is facilitated by, and facilitates, a social order predicated on top-down authoritative formations. “As Freud and Derrida know,” writes Van Zyl, “the role of patriarch continues to reveal itself in the psyche of the archivist; obedience may be deferred but it is obedience nevertheless”(Van Zyl, 2002, p. 45)

Lynch (1999) explains how Derrida moves on from etymology to coin the neologism ‘topo-nomolgy’ to bring together the concepts of place and law. This ‘topo-nomolgy’ delineates the source of patriarchal authority responsible for the formation of the archive (Derrida, 1995; Lynch, 1999; Harris, 2002; Van Zyl, 2002). This authority designates not only what is (and is not), it concerns where and how consignation (meaning what is written) is done, and how and where it is written, such as on the page or on the body. As Verne Harris puts it, “Control of consignation, the exercise of a toponomological ‘archontic power’, is at the heart of political power” (see also Steedman, 2001; Harris, 2002, p. 67). Despite the far reaching consequences of such a concept, little engagement with this idea of the “topo-nomological” specifically, beyond recognising its responsibility for the patriarchal power of the archive (Withers, 2002; Beel *et al.*, 2015), is evident in geographic discourse. This is quite surprising considering the significance of such a neologism. Compounding the words *topos*, from the Greek meaning place, and *nomos*, meaning the law also from Greek but frequently understood as common law or by consensus of the people would seem an interesting concept specifically for geographers. The geographic relevance of such an idea, however, has not been lost on some postcolonial scholars. Indeed, Ananya Jahanara Kabir (2009) recognises the potential of certain sites to invoke ‘archontic’ power, more specifically “in Derrida’s words, “the violence of the archive”” (p.51) that,

This anxiety that the border’s visibly insistent authority cloaks is figured in traces of epistemic violence, whose cartographic sign is the occluded Line of Control (LOC). (Kabir, 2009, p. 51).

Michel Foucault expands upon this enunciative power, albeit with a difference. Rather than begin with an investigation of the etymology of the archive, Foucault identifies the archive as a

system for ordering statements and establishing, ultimately, ‘what can be said’: “The archive is first the law of what can be said, the system that governs the appearance of statements as unique events.” (Foucault, 1972, p. 129) Although equally as abstract (Osborne, 1999; Withers, 2002; Manoff, 2004) as Derrida’s rendering of the archive, Foucault’s description does not take on Derrida’s topological qualities, neither does its power come from some kind of top-down state authority. Instead, for Foucault, it is in knowledge itself and the possibility to communicate knowledge that the power of the archive resides. In short, Foucault’s archive is the repository from which all human discourse is drawn; it is a virtual place from which all possible statements reside. What is key, in Foucault’s notion of the archive, is that we cannot stand outside of the archive; we cannot fully become archivists because we cannot articulate what he calls a ‘total history’. We can however, diagnose something of our experiences, contributing to a more dispersed ‘general history’.

A total description draws all phenomena around a single centre - a principle, a meaning, a spirit, a world-view. An overall shape; a general history, on the contrary, would deploy the space of a dispersion. (Foucault, 1972, p. 10)

By dispersed, Foucault means that there is no linear master time here; instead, there are diverse spatio-temporalities that rub up against each other, such as heterotopias (Foucault, 1984). Mike Featherstone reads this as in opposition to “the unifying structure we find in traditional humanist accounts to a system in which a multiplicity of discourses are created from a given set of data” (2003, p. 596).

For Foucault, archives create objects (e.g. populations). Examples of such archives are state paper records, libraries, museums, exhibitions etc. According to Foucault what rules such objects as “objects of discourse” (Foucault, 1972, p. 41) are three elements, namely: (1) “Surfaces of emergence”; This is how people become registered by the state through their life. (E.g. births, deaths, marriages, professional accreditation, claiming state benefits, voting etc.); (2) “Authorities of delimitation”; The institutions that hold such records, and are recognised by society to have the capacity to take control of such information (e.g. tax offices, NHS, DVLA, government agencies), and (3) “Grids of specification”; The way in which this data is collected (e.g. census, maps). What we need to understand, he argues, is the on-going formation of enunciative modalities (describable ways of being), which consist of: (1) Who is qualified to speak? This is to do with on what grounds such individuals claim to speak the truth, have the right to speak, their status (including expert witnesses, academics, medical doctors, politicians etc.); (2) From what institutional sites? How do the sites from which these qualified speakers speak mediate the significance of what is being said? Foucault, for example, gives the example

of the hospital as, “a place of constant, coded, systematic observation, run by a differentiated and hierarchized medical staff, thus constituting a quantifiable field of frequencies” (1972, p. 51); and (3) In what relation to the objects? What relationship does the speaker have with their object; through what methods does he/she define the object.

Geographers have used Foucault extensively to talk about the role of the state in creating repositories (Harley, 1989; Belyea, 1992; Ogborn, 1992; Goss, 1995; J Pickles, 1995b; Barnett, 2001; Jones, 2008; Kwan, 2008; Legg, 2008), and the nature of power. In cartography, JB Harley (1989) makes the argument that maps are not mere communication devices but are the kind of documents defined by Foucault as the “objects of discourse.” Similarly, Barbara Belyea (1992) asserts that, “maps determine our perception of [the world] rather than the reverse” (p. 12). According to Harley, maps as repositories of knowledge have become, “what Foucault called the exercise of ‘juridical power’”. The state, according to Harley (*ibid.*) in his reading of Foucault, guards its knowledge through its privileged status of its ‘ability to speak’:

The state guards its knowledge carefully: maps have been universally censored, kept secret and falsified. In all these cases maps are linked to what Foucault called the exercise of ‘juridical power’. The map becomes a ‘juridical territory’: it facilitates surveillance and control. Maps are still used to control our lives in innumerable ways. (1989, p. 12)

Scholars writing on colonialism have also acknowledged the archive’s power delineated through these enunciative modalities. Ann Laura Stoler (2002), for example, explains how colonial archives operate as, “documents of exclusions and as monuments to particular configurations of power” (p.96) that, “concealed, revealed, and reproduced the power of the state” (p.97).

While instructive, Foucault and Derrida’s writing on the archive has been deemed by some scholars too abstract to be of use in considering the concrete practicalities of using archives, and hence of the contingent nature of the archive itself. On this subject, sociologist Thomas Osborne proposes that we simply consider the archive as, “a principle of credibility” (1999, p. 53) that becomes manifest in practice. Similarly, according to Withers,

It is, at least in my experience, the result of contingency, of the haphazard accumulation of ‘stuff’ (Steedman 1998) rather than of pre-ordained governmental scrutiny. (2002, p. 305)

Certainly, recent work on archiving, and engaging with archives, (DeSilvey, 2007; Cresswell, 2012) has gone on to document how constructing and reading archives can be a more ‘creative’, ‘messy’, ‘contingent’ endeavour. geography’s deep-rooted tradition of field studies and its attendant practices have meant that geographers have long paid more attention to how

knowledge is produced. Further to this, geographers have made more of the ‘encounter’ between singular selves and texts in the practice of archiving and researching archives. According to Lorimer, for example,

Geographers can make some reasonable claim to having re-discovered the power of the story, ushering in more thickly descriptive – sometimes lyrical, highly decorative – prose. (Lorimer, 2010, p. 269)

Cresswell (2012) also sees archives as more “contingent, messy and permeable” (p.166) affairs. He takes his study of what he calls ‘value gleaners’ from the ad-hoc archive of the now closed Maxwell Street Market in Chicago as evidence, but also expands this assertion claiming that even, “official archives are sites where it is possible to read against the grain and find unofficial stories in the absences and unintended presences” (ibid.). His study of the Maxwell Street archive explores the way in which different actors contributed to the formation of this archive. He notes the lists of random objects written by journalists in an attempt to impart some sense of the hugely varied paraphernalia that once inhabited the market; the efforts of one enthusiast to house the left-over stuff from the archive in his home; and perhaps most insightfully, describes the practices of those ‘value gleaners’ responsible for salvaging the objects that were originally taken off the streets of Chicago to be sold on the market.

For DeSilvey (2007), it is the obduracy of objects themselves that further facilitate this contingency. DeSilvey explains how her efforts to inventory documents and artefacts from a Montana Homestead often seemed to resist conscription. The difficulty seemed to stem from her ability to find a suitable system with which to categorise the artefacts she found; a system where such a multitude of objects, meanings, signs, events could be made analogous within an archive that was relevant to both past and future imaginings of the site. She found that,

The significance of the objects altered as they moved through different contexts and as they came into contact with people who asked different things of them. (DeSilvey, 2007, p. 888)

“Objects refused this emerging order” (DeSilvey, 2007, p. 880), despite this attentiveness to the experience and potential of the individual encounter.

Yet, the notion that the archive is a place of significant authority does persist. Jan Verwoert explains that, “a text becomes a document when it is incorporated into a system of information management” (2004, p. 9) such as an archive. Furthermore, in entering this ‘system of information management,’ the document becomes inscribed with the authority of the institution that hosts the archive. For instance, “A Document filed in the institutional library of the Vatican

will speak to you with the authoritative voice of the church, even more so because the name of the individual who filed it will have been obscured by the history of the institution.” (2004, p. 10) Verwoert also comments on how this authoritative voice might speak through the physical qualities of these repositories of knowledge such as libraries and archives as, “Upon entering a grand traditional library you will be overpowered by the sublime sensation of encountering history in its totality.”(ibid.). Cresswell also acknowledges these assumptions of archival spaces as a, “sealed, special, kind of place” (2012, p. 166). And, Lorimer describes his first visit to an archive, noting, “the distinct impression that ‘the archive’ was somewhere between a labyrinth and an impregnable fortress.” (2010, p. 251) What is more, and despite the potential for archives to be engaged otherwise, for Lorimer (2010), work in classical archives was traditionally, “founded on an objective, positivist mode of inquiry where the researcher’s neutrality and detachment from the subject was a matter of principle, and thus s/he could not feature as a wilful, political or emotional agent in its midst” (Lorimer, 2010, p. 251). In this method, the researcher was distanced from the material of the archive, his/her role was purely to read and construct, deduce, and to adhere closely to such positivistic disciplines. Here was found,

...cross-referencing between documentary sources to ensure the triangulation of evidence; the need for pin-point precision backed by an awareness of social bias and the ‘tainting’ of data; the systematic consideration of possible relations between different variables and the setting up of multiple working hypotheses; and, the use of supposition only until a pressing case for falsification emerged.(ibid.)

Gielen & Maermans (2007) recognise similar claims for an ultimate authority when situating the archive in regard to their “an-archive”, or the ubiquitous digital archive of contemporary life. They take their cue from Foucault, characterising the archive as laying claim to the genesis and control of knowledge. For them,

... the archive is the quasi-transcendental but always historically particular system that makes specific statements possible, thus framing both language and every specific corpus of utterances during a particular period. (2007, sec. 4)

Importantly, however, they argue that the classical archive deals with knowledge as ‘read-only’ meaning that once a document is archived it can no longer be added to - it is ‘closed’. This is quite different to the way in which documents are dealt with by digital archives. In the classical archive a document is finished, in a way sealed; in the digital documents and entries in the archive are always changing. The document you are reading, for instance, in my own archive, is already on (at least) its eighth version; previous utterances have been numbered and stored in my personal digital, cloud-stored archive. The digital document may be forked (a common term

used for the development of open source software when one developer in a collaboration wishes to take project in another direction), duplicated, broken apart, or otherwise become absorbed into another larger body of work (such as a PhD thesis).

This shift, in some regards, can be attributed to the seemingly limitless storage space afforded by computerised, cloud storage, but is perhaps more symptomatic of a paradigmatic shift away from knowledge as “read-only” towards the ideas underlined by *Web 2.0*, that of user generated content and crowd sourced information. These modes of operating require a different approach to what is archived and how such information is structured. However, despite the promise of plurality, openness and interactivity offered by the digital archive these systems still raise profound issues relating to power and access. Gielen and Maermans (2007) acknowledge, for example that through these ubiquitous archives, informed by intelligent information gathering systems we, “are related to a particular life-style or stamped on a specific profile” to the point that we, “cannot contest these external characterisations, for they are backed by often numerous data on what we have done, chosen or said” (2007, sec. 3) It is from this position that the digital archive situates its authority over the user. It is in the logic of the computer system; in numbers, statistics and demographics that the user ‘allows’ him/herself, or ‘surrenders’ him/herself, to be catalogued. The authority of the institution that previously underwrote the authority of the archive has been replaced by a slightly different vehicle for truth claims, that of the technological, a computerised, Boolean logic. Subservience to which leads us to “acquire an always particular external identity on the basis of information stored in databases” (2007, sec. 3).

In a similar vein Veldon (2007) discuss online public content creation in the form of wiki’s (such as *Wikipedia*, *WikiHow* and *Baike.com*) as a type of digital repository of knowledge. Since the creation of the internet there have been an increasing number of these, with the remit of expressing plural voices: These certainly offer more opportunities for engagement; as Velden explains, such digital archives facilitate, “the idea that human knowledge can be managed in a database shared by everyone”(2007, p. 236). Veldon also points out, however, that such databases, such as Wikipedia, have problems with integrating the knowledge of indigenous nations. In Wikipedia, which is intended as database of human knowledge, and where other articles and subjects are vastly inter-referenced creating a vast web of relations, those of indigenous cultures seem isolated.

Veldon attributes this to the fact that the way in which such databases organise and store knowledge is predicated on a Western metadata system, which “will determine how an object will be ordered in the overall system, thereby limiting its possibilities for its relations”(Velden,

2007). Further to this, online repositories of digital photographs and videos such as *YouTube* and Flickr are becoming seen as digital archives and repositories of cultural knowledge. Belk (2013) argues that unlike the museum, whose function was to bring order to chaos, the role of such new digital cultural archives will be to abdicate this specific responsibility in favour of “folksonomy”(2013, p. 6) and relinquish their roles as “institutional gatekeeper who regulates what can and cannot be posted” (ibid.)

Dalbello (2007) writes on how the internet itself is being archived, and the obstacles that face archivists working with such huge amounts of data. The internet is archived using bots, which are programmed to collect webpages and linked documents from all over the web. Dalbello explains that this act of archiving is, “based on understanding the web as structured record of historical experience and the process of disaggregation of that record into data”(2007, p. 44). However, Tanya Clement (2015) maintains that the way in which we interface with databases, or digital archives, is in fact very similar to the way in which we deal with traditional analogue archives. Clement even draws on Derrida to note that, “The interface poses as the objective gatekeeper to archives of seemingly agnostic content, but the content and its functionality generally reflect the situated and subjective practices of a particular institutional setting”(2015, para. 17).

Despite JB Harley’s discussion of post-structuralism (1989) and subsequent discourses relating to cartography (Belyea, 1992; Crampton, 2001) the idea of actually rendering the GIS as an archive has not been broached in any sustained fashion by critical GIS discourse. One exception is Brannon (2013), who discusses the related field of remote sensing and satellite imagery in relation to the archive. Brannon claims that such images create, “reductive, standardized database[s] understood to be true representations” that, “removes historical and political contexts to make visual analogies” (2013, sec. 291) However, scholars working in the field of locative media (such as GPS enabled mobile phones, satellite navigation devices and electronic tags used by the criminal justice system) have made steps to question the ontological underpinnings of locative media. Zeffiro (2012), for example, notes how locative media is in some way haunted by, “the spectre of the flaneur” (2012, p. 255). This has the effect of coding all data from the perspective of, “male/white/bourgeois, thus, a figure in possession of privilege” (ibid.). However, despite Zeffiro’s assertions of privilege, other facets of the flaneur are useful in terms of a methodology for thinking about the archive. Buck-Morss (1989), for example, writes about the flaneurie as a “form of perception”(1989, p. 345) critical of mass culture and adopting a policy of “look, but don't touch” (1989, p. 345). Relatedly, Buck-Morss also recognises the flaneur’s ability to “transform reality into an object that can be consumed

passively, pleasurably, and directly” resisting the temptation to turn this into “a tool that will make it possible to wake up from the dream” (1989, p. 144).

To sum up at this point, archives have described as having a disciplining role. However, there seems to be a shift concerning the understanding of the archive, investigated as a series of affects that emerge alongside others, opening up possibilities for something else to arise. As Van Zyl observes, the archive is increasingly a “solid place of material accumulation on the one hand and as an unstable and ever-changing site always open to the exigencies and recasting of the future-to-come on the other.”(2002, p. 53) These ideas reveal new forms of engagement with the archive, but also new archive formations.

Before turning to this issue however, I would like to discuss how the archive has been juxtaposed with the repertoire. So far, this section has understood archives as analogues – that is, collected as objects that are equivalent in the sense that they are equally part of a system that gives them meaning and relevance. Key here is the organising and managing system at work, the intent of this data management, and the translation of data into practices that affect people in various ways. Through Derrida and Foucault’s poststructuralist lens, we understand how knowledge is constructed, organised and deposited in the archive but we must be allowed to ask what, if anything, is outside of the archive. What is it that creates singular meaning, without analogous relationalities, what is this knowledge that resists becoming part of a system of shared meaning? One common concept often placed in binary opposition to the archive is the ‘repertoire’ (Taylor, 2003), the lived, embodied traces of performance do not disappear but reside in the bodies and memories of those who encounter, create manifest and the performance.

As Guevara (2005) notes, “the embodied knowledge of the repertoire resists the written knowledge of the archive” (2005, p. 240). In performance studies performance is often referred to as that which does not remain. This lies outside of, or is the remainder of, the archive or what might be more usefully termed the analogue archive. It is performance’s specific trouble with representation that means that, “according to the logic of the archive, ... performance cannot reside in its material traces, and therefore it ‘disappears’” (Schneider, 2012, p. 101). It is argued that it is only through the embodiment of such singular knowledge can be preserved in, ‘the repertoire’.

Summing Up

In looking over the sections of this chapter, the material on the archive has arguably strayed the furthest from the more usual chronologies and hagiographies of a GIS field. Yet, what I hope

has become clear is the relevance of issue for GIS. In this last section, I began by asserting that there is a lack of discussion of how GIS relates to post-structural literature concerning the archive despite a significant amount literature from the humanities. I note that although critical GIS literatures have pointed time and again towards concerns relating to authority, access, and the innate structuring of GIS technologies, scholars are yet to make an explicit link to the archive as a mode of formation and interrogation. In response, I have outlined Derrida's ideas relating to the archive, drawing from his *Archive Fever: A Freudian Impression* (1995) in which he renders the archive as the place of state power and authority over conscription and the body. I also consider Foucault's writing on the archive from his book *The Archaeology of Knowledge and the Discourse on Language* (1972). I note that for Foucault, unlike Derrida, the archive is an abstract authority for ordering statements and what can be said; and, the manner in which such critiques have been taken up by scholars such as Harvey to think through cartography as a field of expertise and site of enunciation.

What I have also tried to do is problematise the everyday usage of archives, and the manner in which objects resist conscription despite the proprietorial atmosphere of the sired archive (DeSilvey, 2007; Lorimer, 2010; Cresswell, 2012). For me, this issue becomes further complicated when thinking of the differences between the 'classical' and the 'digital' archive; as Gielan & Maermans (2007) note, whereas the classical archive is seen as read only, the digital is not necessarily so. Contributions to the digital archive bring a new gloss to now familiar concerns regarding the user surrendering themselves to be catalogued. Certainly, a reinvigorated theme in the study of what the archive does with knowledge, information, objects, is the question of what the archive cannot store. Perhaps inspiration can indeed be taken from performance studies, and the notion of the repertoire, to think through how aspects of practice resist the textual knowledge of the archive. Though in the next chapter I go on to outline how my own research has helped constitute an archive, yet I do want to hold onto the idea that in viewing/reading the infographics presented there is also room afforded for other modes of recollection and cataloguing.

CHAPTER THREE: Pursuing the Doing of GIS

SECTION ONE – Introduction

The proceeding literature review suggests GIS as an ontology, a practice, and as an archive, insofar as these demarcations are debated and critiqued by researchers who deploy GIS for various projects, and who ponder the broader ‘place’ and contribution of GIS to the discipline at large. What these literatures also suggest, however, is that there is a materiality that is invoked in the doing of GIS that is not so easy to reconcile with the commentaries that proceed to articulate, and reflect upon, this experience. Such a materiality, indeed, becomes manifest even as one reads articles on screen or in hard copy, jots down notes of particular ideas and concepts, and begins to sort notes into an archive of one’s reading practice and findings. The manifestation of these materialities is enabled by a suite of imbricated, embodied knowledges – reading, writing, reflecting – and made tangible to me as an array of feelings, from excitement to anxiety, that propel me to ask new questions, but also to halt in perplexity. And yet, this visceral, sensuous experiencing of GIS remains distanced from the stated concerns and remit of the academic commentaries themselves, as though they existed in a separate and abstract time-space continuum. Despite the more recent conceptual attentiveness to the ‘doing’ of GIS, the scholarly literature on this field struggles to work through the implications of this both in terms of how such an attentiveness is to be parleyed into an interrogation of GIS, but also what such an interrogation might itself produce in terms of new modes of thinking and doing GIS.

As noted in the introductory chapter, the intent of this PhD is to consider the question of what is GIS? In this chapter and following on from my broad review of relevant literatures on the subject and the identification of identifying traits, I want to embed my reading practice within a broader methodological approach. That is, I want to expand on the research design I produced so that I could pursue this question in stages that, while often overlapping in real time, nevertheless allowed me to summarise findings from one stage, and propose new questions to propel my work forward. My initial methodological approach focused on two established techniques of data collection – an ethnomethodology and participant observation that seek to make visible the materialities of ‘doing’ as well as crystallise thought and feelings on the process.

For Woodyer (2008) ethnomethodology allows us to think through how meaning is actually generated rather than in terms of the co-constitution of objects. According to Woodyer (2008), key to ethnomethodology is the call to do, immerse, and experience practice with our research subjects, and a focus on the mundanities of everyday life to, “expose of the comonsensical” ,

“bring mundane practice into being,” and “actively addressing knowledge that is profoundly practical; that which is lived not deliberated” (2008, p. 355). Furthermore, Woodyer (2008) notes how ethnomethodology is useful in noticing moments of immersion, the transmission of tensions, becoming energised, and making practices visible. However, it is also about resisting the notion that there exists a separation between cognitive (brain) and non-cognitive (body).

Loughenby (2009) discusses his experiences of trying to bring together the seemingly discordant approaches of non-representational theory (NRT), which brings forward affect, and ethnomethodology. For Loughenby “NRT is concerned with the liveliness of practice [and] ethnomethodology... mechanical operation through social interactions”(2009, p. 1409). Both are more concerned with, “how social practice happens than why it does” (2009, p. 1409). Both NRT and ethnomethodology, he notes, have been described as overly reductive in their attentions to, “the momentary and the minute” (2009, p. 1411), precluding any critical and usefully rigorous attention to the political. Loughenby suggests a way that both NRT and ethnomethodology can be useful as part of the same empirical study of disaffected young men:

NRT allows a nuanced analysis of the affective experiences and capacities of young people. Ethnomethodology offers a means of enabling this analysis through detailed empirical research (2009, p. 1414).

For Loughenby, ethnomethodology allows participants to be cast as “capable actors”(2009, p. 1418), and can be applied to understand the affective and emotional dimension of their daily lives. Where ethnomethodology focuses on “intonations, body language etc.”(2009, p. 1422), NRT can be used to get at, “affective dynamics [of] atmosphere, charisma and inspiration” (ibid.).

Laurier and Philo (2006b) too make comparisons between NRT and ethnomethodology, though their concern relates to the impossibility of representation. For them the position of NRT is that,

all language is representation, all connection with reality is through representations, and systems of representation have been constructed to mask, distract from and in effect 'serve' ideological interests (2006b, p. 354)

Laurier and Philo (2006b) offer that “many practices are indeed not representational, and moreover, that many elements of language-in-use... are not representational as well” (2006b, p. 355). Moreover, they take issue with the notion that representation is indeed impossible. They use an example from their own empirical studies in cafes, to argue that it is uncertainty rather than impossibility that haunts the task of attempting to discern the intentions, drivers, capacities

of their participants. Encounters in daily life are always steeped in uncertainty, but that does not prevent us from representing what happened.

According to Laurier and Philo (2006b), commonplace understandings of research data should be embraced, rather than met with scepticism. Laurier and Philo reflect that this might be taken as an excess of attention to empirical detail, overly descriptive, and “naively inductive”. As such, they explain that, “the point of this inquiry is as *phronesis*” or wisdom gleaned from practical knowledge. Furthermore, gestures are also of significance to ethnomethodological research, which Laurier and Philo read as, “public displays of minded doings when others can infer manifesting intentions, expectations and motives” (2006a, p. 195) that are also reliant upon talk in order for the to be properly understood.

Ethnomethodology is about what is classed as competency in a particular situation (Laurier and Philo, 2006a). With ethnomethodology we can ask: what are the socially acceptable limits of an encounter. In this regard, people must know what kind of gesture is appropriate, what is considered opportune and where gestures become critical:

the lonely gesture knows its limitations, even so, in that the woman who brings napkins should not have leapt to get a mop and bucket: that would definitely be an odd gesture, and would potentially be interpreted not as supportive but rather as critical, condemnatory, provoking a sense of embarrassment on the part of a toddler's mum. (Laurier and Philo, 2006a, p. 202)

According to Laurier (2010), there are no clearly defined steps for carrying out participant observation, it is always contingent upon the situation in which it is done. However, in order to be good at it you need to be able to notice things that normally go unnoticed. It is also useful to start from a point where you are a relative novice as it gives you the opportunity to reflect upon your own experience of becoming proficient and or becoming invested in practices and cultures. As such, the lay perspective is valuable, and Laurier recommends that the researcher attempts to hold on to it and make notes before it fades. Participant observation should provide the researcher with highly detailed descriptions from the field. However as Laurier notes, “it does not have a handle that you can turn to make result pop out.” (2010, p. 12). The value here is in the researcher's ability to pay attention and notice things, practices, relationships, and commonalities that are normally missed. Laurier also espouses the usefulness of video recording in doing participant observation. This can complement field notes, but also serve as a useful reminder for things that cannot be immediately formalised in writing during research because you are too immersed in doing. Philo and Laurier, reflect that although people may act

differently in front of a camera, the aim of participant observation is not necessarily to capture, “unimpeachable data” (2004, p. 18).

In what follows, I comment on how I identified and thought about particular objects of inquiry and proceeded to collect data. However, I also proceed to discuss how this data was reflected upon but also *archived* for further consideration. In the process, what I hope becomes clear is how this methodological chapter is itself predicated upon the deliberations about, and practices of, my archiving of GIS; certainly, the format of much of the chapter is taken from my archive. That is, throughout the PhD I worked with infographics; combinations of word and image that conveyed key issues and events, as well as summarising what I considered to be interesting findings. And, this chapter deploys infographics as well as text – instead of the more usual text accompanied by tables - as a means of conveying to the reader the research design for this PhD.

As a narrative form, infographics are intended to convey large amounts of data in a form that emphasises data patterns and relationships; and as with *PowerPoint*, for example, there is a particular affective capacity associated with these. Infographics lend themselves to the assumption that complexity can be usefully simplified, for example; that the order portrayed is a stable one, found over time and space; that the meanings asserted by word and image are complementary and reinforcing; and that what is hidden, or glossed, is of lesser analytic significance. Yet, when considering how often research is narrated in the form of extended text accompanied by tables (such as ‘List of Interviewees’) that somehow summarise the actual ‘doing’ of the project, especially in a methods chapter that summarises what was done, how, where and with what effect, I find a considered and critical use of infographics to be useful. In this chapter, I use a suite of these to convey my research design, and progress; importantly, however, what matters is not so much that informational content, though this is certainly key to guiding the reader as to what happened, as the format itself and its affective capacities.

That is, these infographics are designed to evoke the data visualisation techniques of GIS, constructed from cells and layers, and re-sortable into a host of other configurations. These infographics have been constrained to an A3 sizing, inside of which sheet there is only so much space that can be filled legibly with text/image if the remit of the infographic – the conveyance of meaning quickly and simply – is to be accomplished. Thus, when planning these infographics, I worked hard to resist the tendency try and get every aspect of the project on to one A3 sheet or ‘cell’. In order for the infographics not too become too cluttered, I experimented with a maximum of three different scales, dimensions, or levels of resolution, at a time. This is a matter of the relationship between the gaze and the paper – only so much size 10 or 12 text fits on an A3 page in a way that is easy to follow. In creating these infographics, I found the most

significant limiting factor for information that could be visualised was the graphic devices that could be used to differentiate different scales, dimensions, or levels of resolution. For example, if I wanted to differentiate between two different categories I might choose a different colour to signify this difference; or if I wanted to represent a relational link between two different elements in the graphic I might use an arrow, or I might enclose similar elements with the same shape. In this way, graphic devices exploit the pattern recognition abilities of the human eye. In what follows, the devices used are: colour (the individual text boxes are filled with only one of three different colours, each corresponding to a broad categorisation or my activities), a horizontal axis (that represents the timeframe), and arrows (that suggest a flow or relationship between the boxes or activities). What I have also done is to 'unpack' particular boxes in a follow up A3 sheet: this link is denoted by use of a black dot in the former. As with a GIS data base, each A3 'cell' can be broken up into a series of subsequent A3 cells; or, can be integrated as one of a series into another A3 cell.

SECTION TWO – Infographic Account of the Research Design and Process

Figure 16 – Infographic 1 - My Process of Familiarising and Learning How to Use GIS





1. MY PROCESS OF FAMILIARISING AND LEARNING HOW TO USE GIS

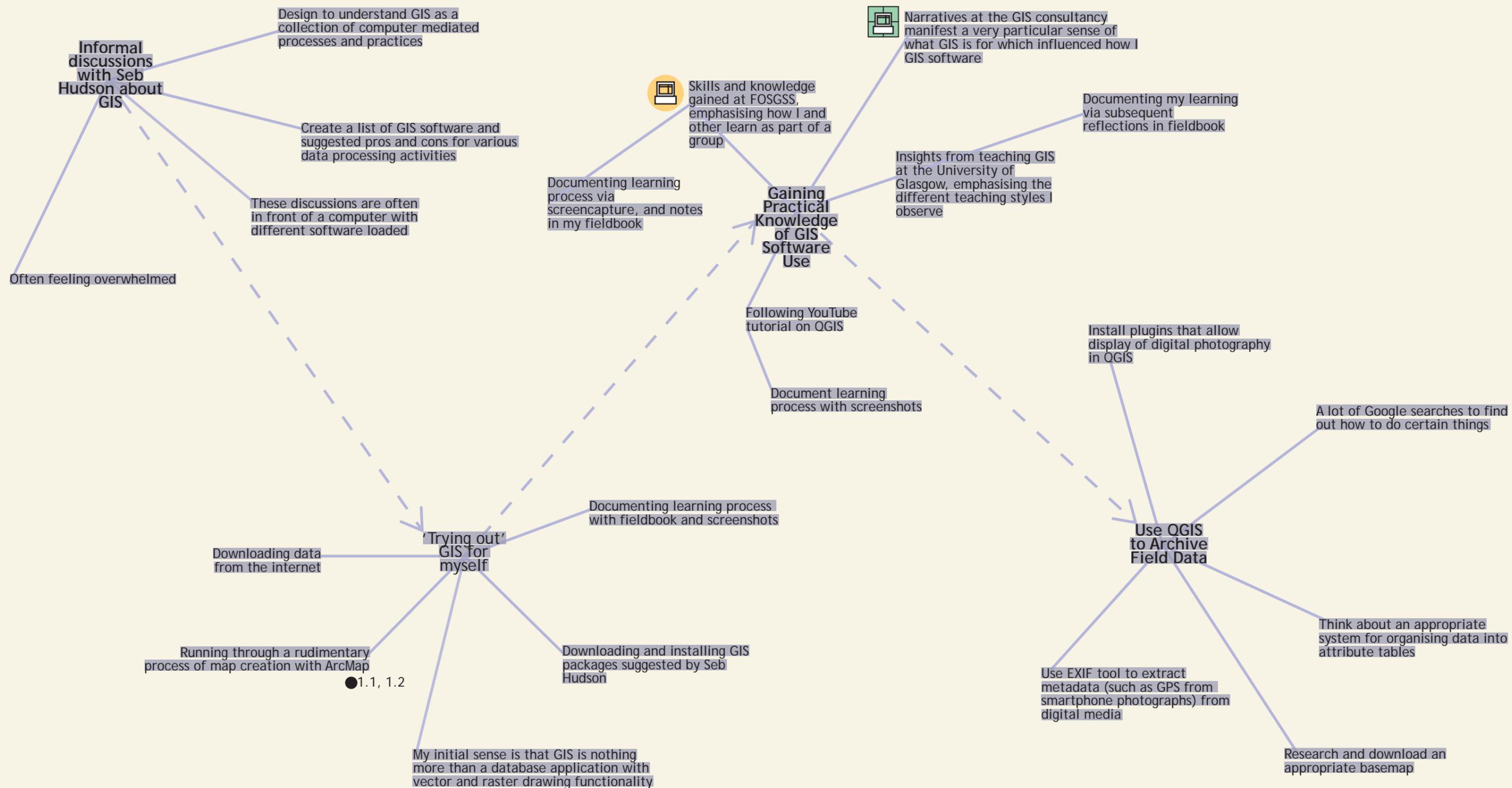


Figure 17 - Supplementary Cell 1.1

Hand drawn flow chart to explain the process of importing data to ArcMap from Edina Digimap



Importing Raster ~~Files~~ + Vector Files from Edina Digimap.

1. ~~Go to~~ Go to `digimap.edina.ac.uk`.
2. Select 'Ordnance Survey'
3. Select 'Download OS mapping data for use in GIS/CAD'
Then 'Data Download'
4. Use the cursor to zoom to desired position on ~~the~~ the onscreen Map of the UK.
The map details will refresh as you zoom and pan
5. From the left side menu bar select how you would like to select your ~~data~~ data.
Select 'Draw Rectangle'

6. Now use the cursor to click and drag ~~an area~~ to select an area on the map.
7. ~~Data~~ Data available for your chosen area can be selected from the side bar.
i.e. ~~check~~ check the tick boxes next to the required data sets i.e. 'topography'
8. Click 'Add to basket', name your download (for your own use) and click request download.
~~You~~ You may need to log on to the system via your institution for access
9. Wait for your Digimap data ~~link~~ download link to be emailed to your registered email address.
10. When your data is downloaded (via email link) extract and from ArcMap select 'add data' find your file and click 'open'

Figure 18 - Supplementary Cell 1.2

Hand drawn flow chart to explain the rudimentary process of adjusting the map viewer in ArcMap



To Zoom, crop and pan

8 steps

1. In Arc Map change the view to 'layout view' (bottom right of main window)

2. Select the 'select elements' tool from the menu bar, now click and drag the map data image on the page to reposition.

Edina works with grids so you may have more data than you need if you used the 'Draw rectangle' tool. - You may need to zoom in. To do this select the zoom in icon  from the top menu bar.

Select again the specific area you would like to display on your map.

The map window on ~~the~~ your page will now only show that data

5. The map appears on an A4 sheet - to resize the map object/window appropriately again select the 'select elements'  icon.

Use this tool to grab and resize the map window

6. You can also use this tool to reposition your map by clicking and dragging the object.

7. If need to reposition the ~~map~~ data in the window (for example - ~~that~~ you ~~need~~ need to frame information further east.) - Click the pan icon  from the main menu bar and grab the map, sliding the data to the left.

8. These steps can be repeated in any order.

Figure 19 - Infographic 2 - Planning and Interviewing: Environment Systems





2. PLANNING AND INTERVIEWING: ENVIRONMENT SYSTEMS

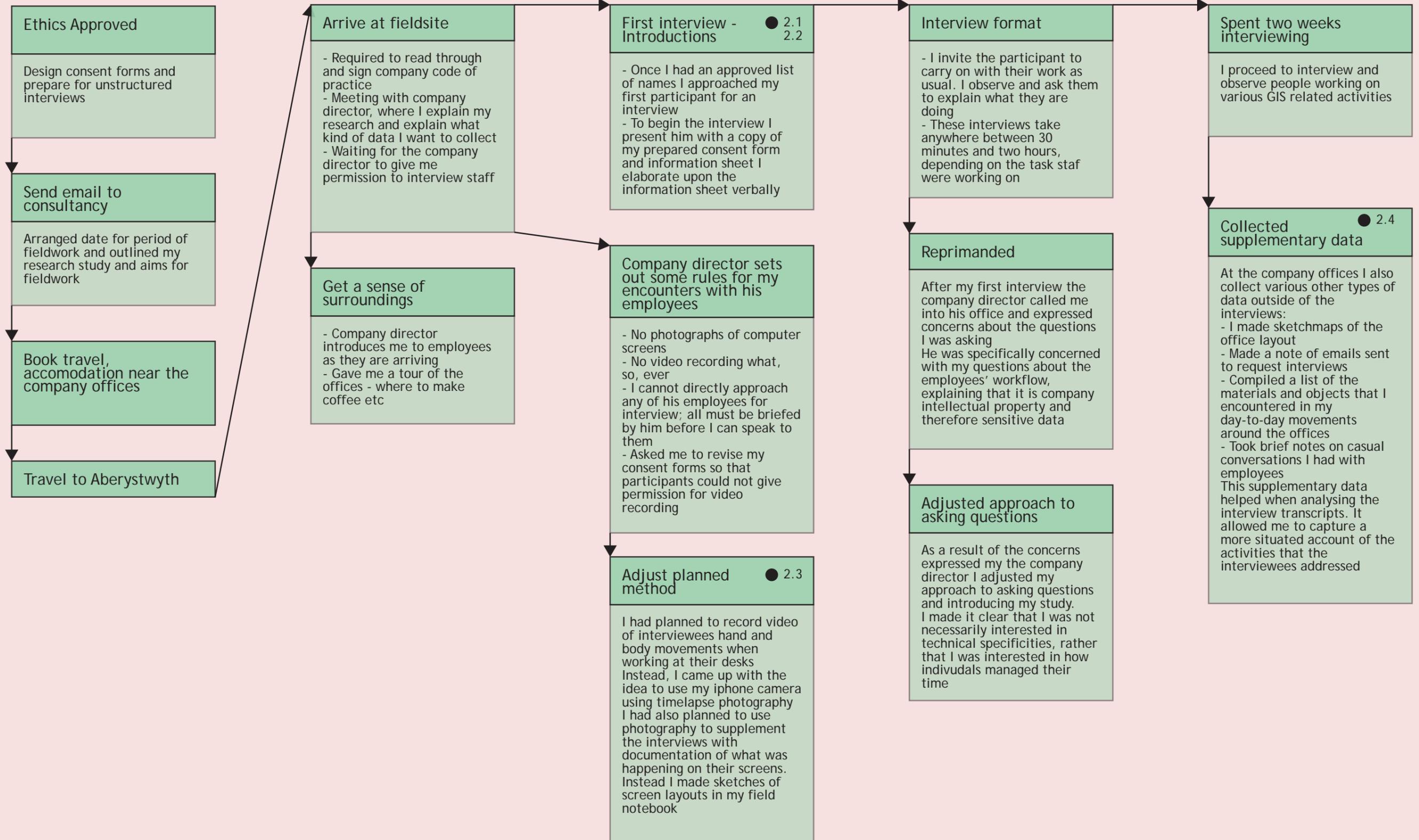


Figure 20 - Supplementary Cell 2.1

Participant Consent Form



Snap, pan, zoom, drag: Working with GIS as a framing device for creating new geographical imaginaries.

PARTICIPANT CONSENT FORM

This consent form must be completed and signed before participation in the research project can take place.

- I have read and understood the information sheet provided.
- I have had the opportunity to ask questions and to further discuss this project with the researcher.
- I understand that any information I provide to the researcher may be used in reports and papers unless otherwise requested.
- I understand what my participation in the project entails and am happy to be observed by the researcher.
- I recognise that detailed notes will be taken by the researcher throughout the process and understand what these notes will be used for.
- I understand that I am able to withdraw from the project at any time by contacting Philip Nicholson through the contact details provided on the information sheet.
- I am aware that if anonymity is requested I will be assigned a pseudonym in the write up stage of the project.
- I understand that all field notes and/or recordings will be kept securely.

Please tick the appropriate box below. If you do not want to be photographed or recorded please leave this section blank.

- I give permission to be photographed as part of the research.
- I give permission to be recorded using a dictaphone as part of the research.

In accordance with the information I have read on the information sheet and the statements above, I am happy to go ahead with participation in the research.

Signed _____ Date _____

Print Name _____

Telephone _____

E-mail _____

Figure 21 - Supplementary Cell 2.2

Participant Information Sheet: Environment Systems





Art, Science and Geovisualisation

INFORMATION SHEET

My name is Philip Nicholson and I am a research student in the School of Geographical and Earth Sciences at the University of Glasgow. I am inviting you to participate in a research project looking at peoples interactions with graphical user interfaces in the GIS profession. Before you complete the consent form please read this information sheet which will outline my project, what participation will entail and what I am hoping to achieve. Following this please feel free to contact me with any questions you may have or to discuss the project further on the contact details provided below.

The Project

The aim of my research is investigate a number of topics relating to the practice of those using geographical information systems (GIS) and working in the field of geographical information science. First and foremost, I will need to establish what is meant by the term “GIS practitioner”. Then, the focus will be upon how these individuals interact with the graphical user interface in contemporary GIS, paying particular attention to embodied interactions between the hand and screen. What's more, the study will consider themes of visual literacy, aesthetics and look to destabilize institutionally cultivated binaries between the practice of art and the practice of science. Ultimately, my research aims to demonstrate how GIS practice can be more sympathetic to creative methods of imagining the world.

What will taking part involve?

Participation in this research project will consist of participant observation and/or semi-structured interviews.

Participant Observation

Participant observation will take place over set periods of time which I will agree with you prior to commencing research. I will ensure that this method has minimal intrusion into your work space, however it will involve an element of conversation whilst you are carrying out tasks. I will be observing your interactions and experiences whilst using GIS software and may ask you to talk me through particular processes.

Interviews

Your participation in this research may require you to take part in a short, informal interview. The time, date and location will be decided with you individually through further contact. Some of the topics I am looking to cover in the interview are:

- What your understanding of GIS practice is.
- Your uses of GIS software.

- How you experience and understand the software whilst discussing your more physical and psychological interactions with it.
- The aesthetic values of the software and impacts this has on conceptualisations of space both inside and outside your place of work or study.

With your permission I may ask to video or tape record the aforementioned interactions. This is to ensure accuracy of information and also to help with dissemination of my work. However, your consent is needed before this can take place.

What will happen to the information gathered from the research?

Information will be kept securely on a password protected computer and only be available to myself and my supervisor.

Field notes will be coded and, where necessary will be written up further. Interviews will be transcribed and then coded. This will allow for analysis of the data.

This data will then be used in reports and in my final PhD project. I am also looking at more creative ways to disseminate information, this may involve showing video footage of the research process or using voice clips. Where this is the case, I will send you any recordings of you I am planning on showing to gain final consent from you before showing them.

Final Details

Your participation in this research is entirely voluntary.

You have the right to terminate the research and/or withdraw from the project altogether. This can be done by contacting me using the details below or telling me in person. No further questions will be asked and any information I have collected from you prior to this will be destroyed.

Please do not hesitate to contact me for further information regarding this project and participation in it or to ask any questions you may have.

If you would like to take part in this research please get in touch and we can arrange a suitable time to meet, where I will provide you with a consent form to complete.

Contact Details

Project Researcher: Philip Nicholson

Tel: 07917106500

E-Mail: P.Nicholson.1@research.gla.ac.uk

In case of concern with this project please contact the research supervisor:

Deborah Dixon : Deborah.Dixon@glasgow.ac.uk

Figure 22 - Supplementary Cell 2.3

Time-lapse photography contact sheet: Environment Systems



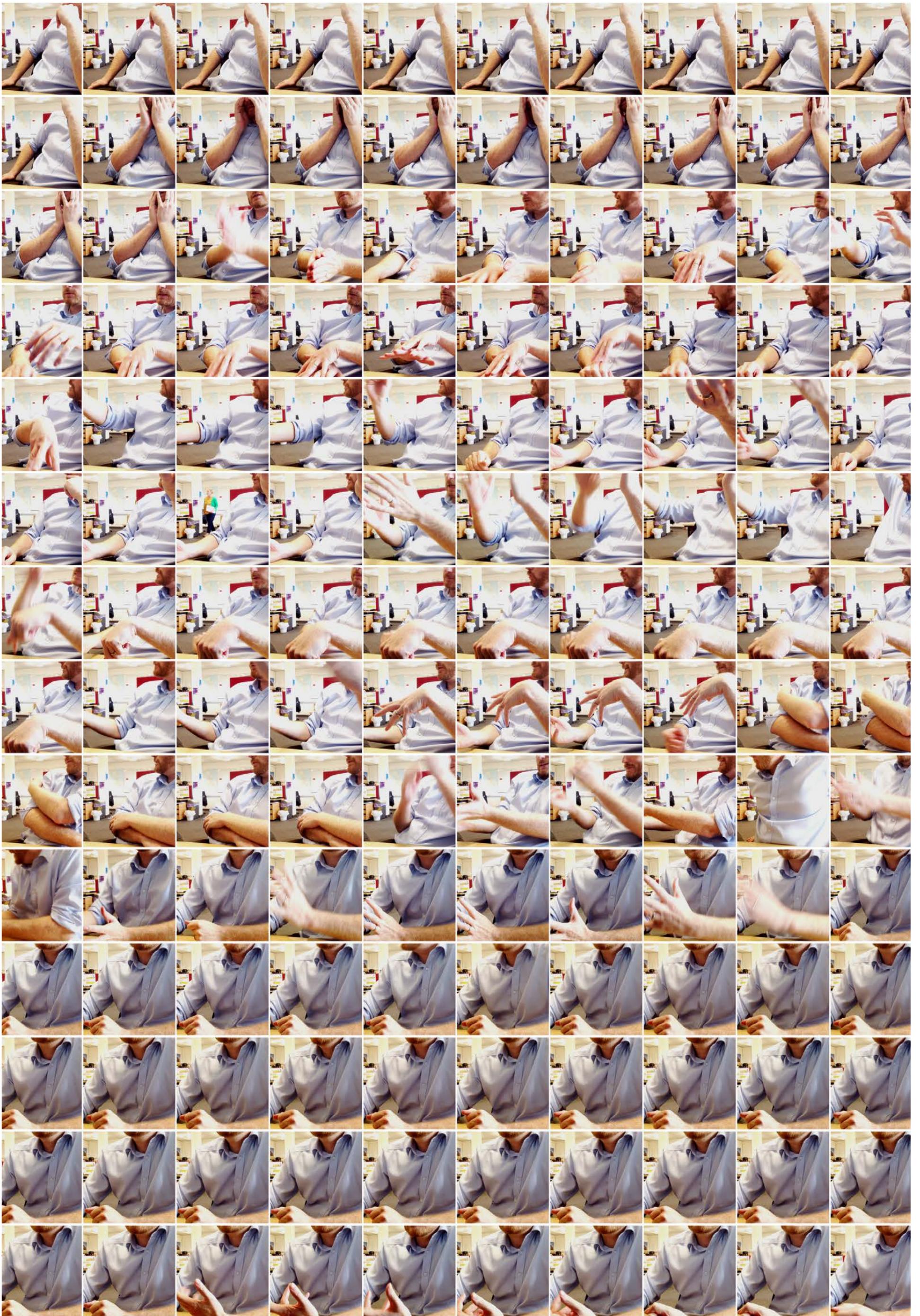
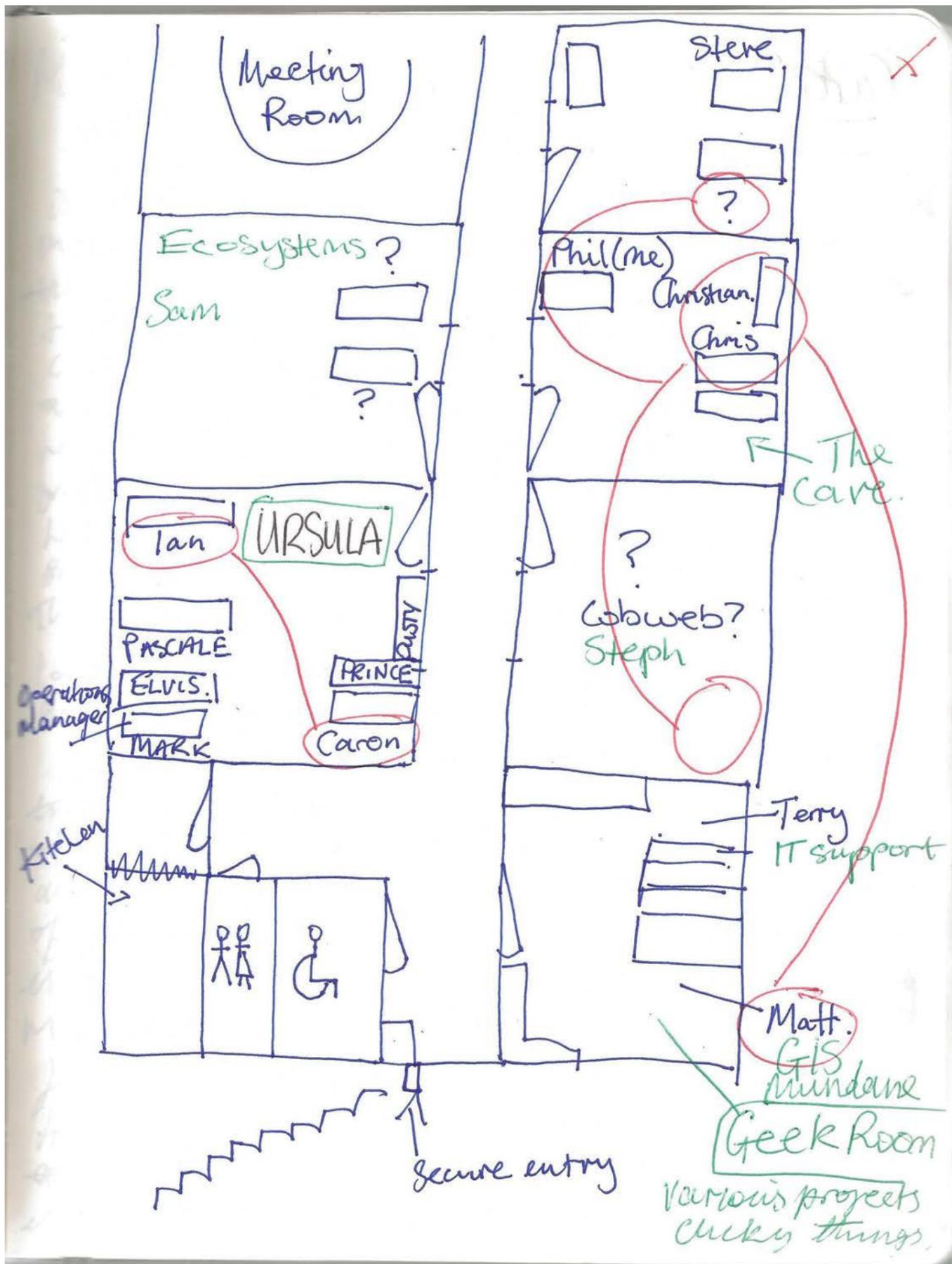


Figure 23 - Supplementary Cell 2.4 and 2.5

Sketch map from field notebook: Environment Systems

Notes and observations from interviews: Environment Systems



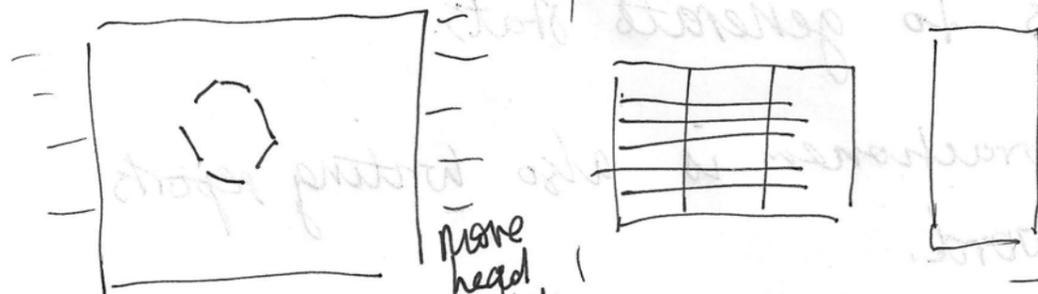


eye follows cursor

- When move to different screen head moves.

Nodding and things seem to be working out. How long?

interaction between 3 main windows



draw rough polygon across adjacent layers edges

Select appropriate fields in table

• Scroll across to check entries

REPEAT

End. 11.19.



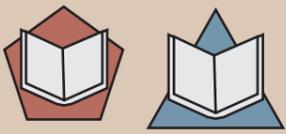
• click drop down

• Select field calc.

• change text.

Figure 24 - Infographic 3 - Planning and Interviewing: The National Library of Wales and the National Library of Scotland





3. PLANNING AND INTERVIEWING: THE NATIONAL LIBRARY OF SCOTLAND AND THE NATIONAL LIBRARY OF WALES



National Library of Scotland

National Library of Wales

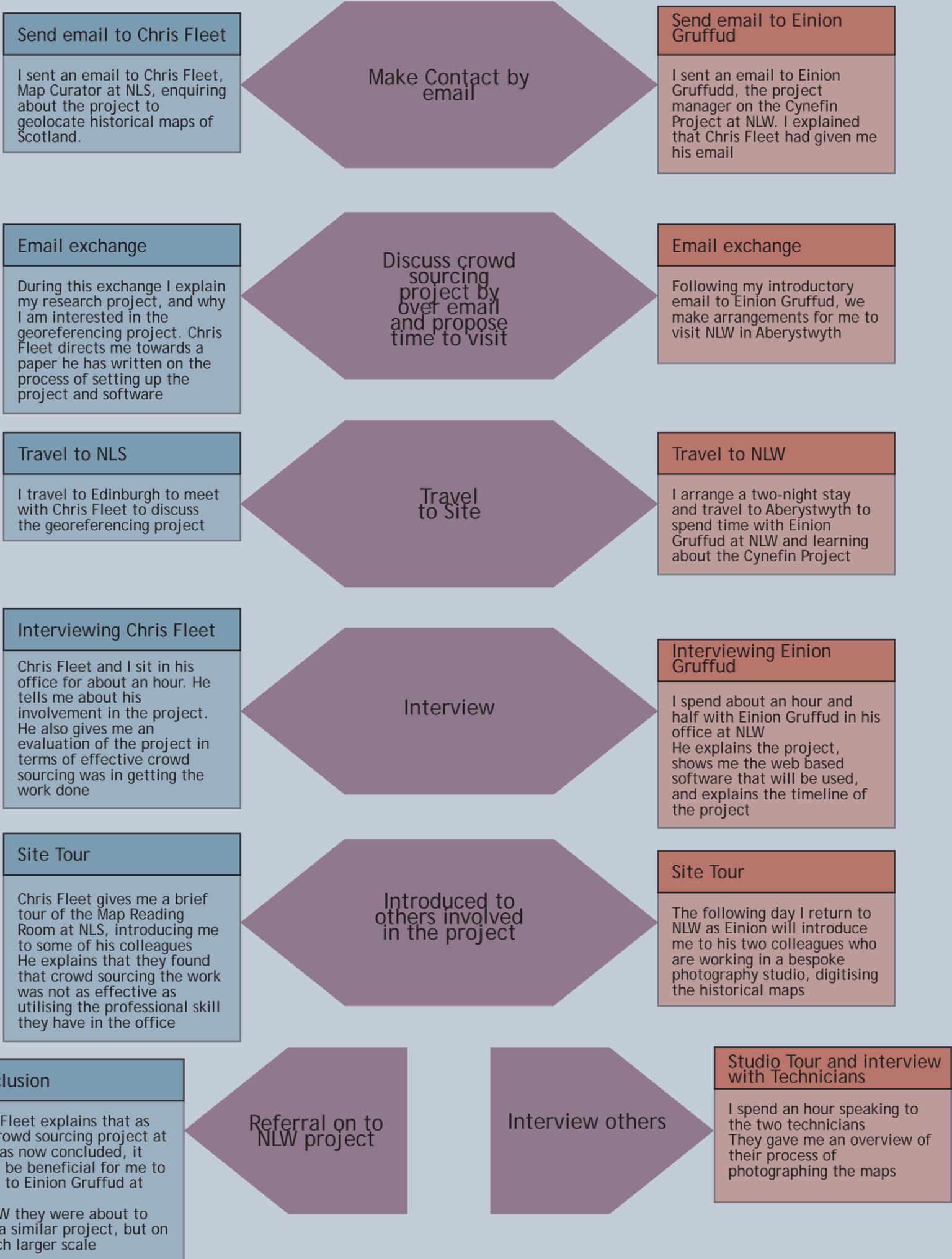


Figure 25 - Infographic 4 - Planning and Learning GIS: Free and Open Source GIS Summer School





4. PLANNING AND LEARNING GIS: FREE AND OPEN SOURCE GIS SUMMER SCHOOL

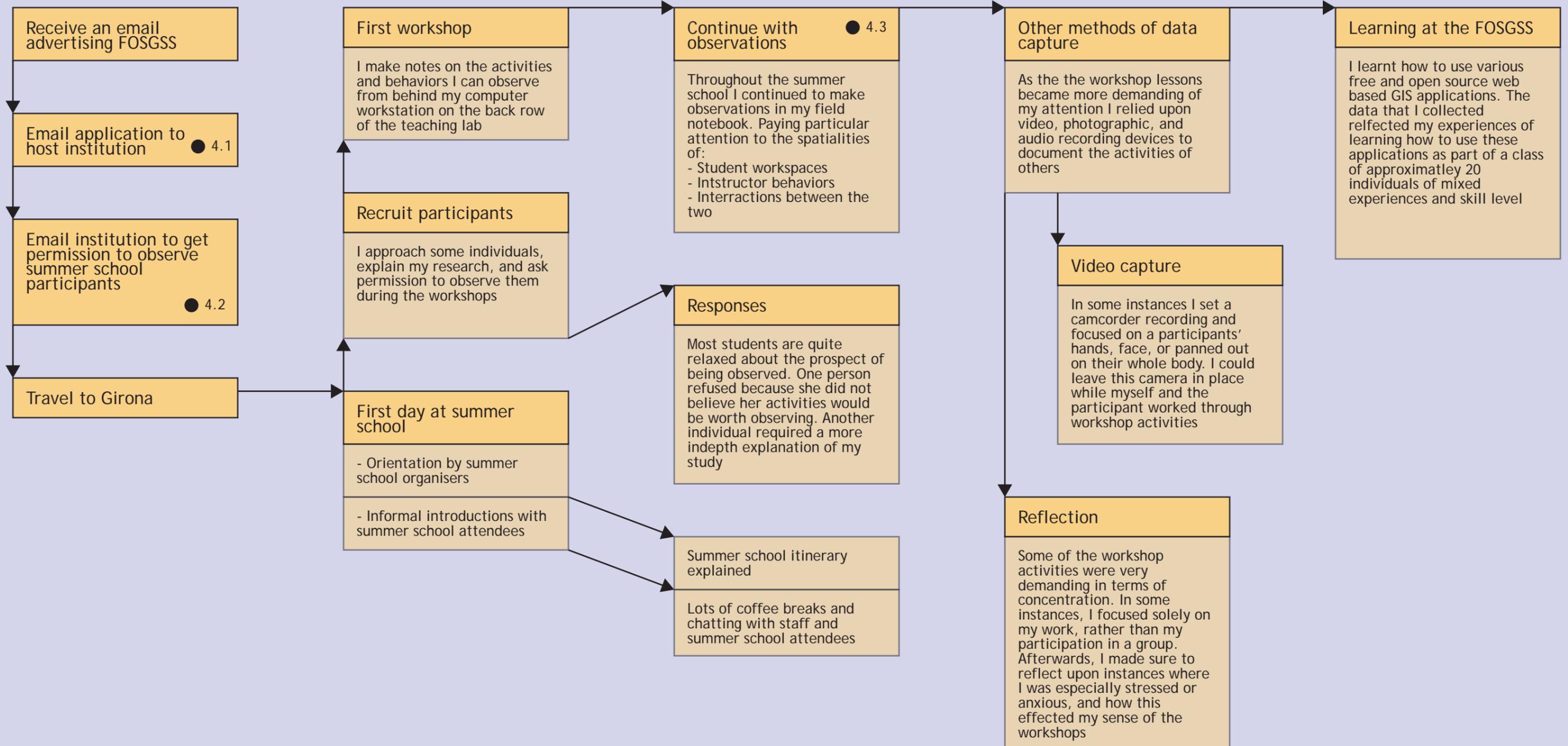


Figure 26 - Supplementary Cell 4.1 and 4.2

Initial email to apply for GIS Summer School

Email outlining my intentions during the Summer School



Philip Nicholson

From: Philip Nicholson
Sent: 05 February 2014 15:55
To: [REDACTED]
Subject: Summer School Application
Attachments: Glasgow Student ID Card - Philip Nicholson.jpg; ATT00001.htm; Philip J Nicholson CV 2014.pdf; ATT00002.htm

To whom it may concern,

Please accept my application to the 5th Open Source Opportunities in GIS Summer School. These are my details:

Name: Philip Nicholson
Passport Number: 105400183
City of Residence: Glasgow
Country of Residence: United Kingdom
Email Address: p.nicholson.1@research.gla.ac.uk

Interest in attending the summer school: This will be an excellent opportunity for me to meet other researchers and professional interested in the development of GIS. It will be of great value to my PhD project on creative applications of GIS. Furthermore, although I am a very computer literate individual and have recently spent a great deal of time familiarising myself with GIS packages, my main area of expertise is in art, design and aesthetics and so the opportunity to learn the skills offered by the summer school will be of great value.

Philip Nicholson

From: [REDACTED]
Sent: 09 June 2014 13:55
To: Philip Nicholson
Subject: Earlybird student registration Philip Nicholson

Dear Philip,

Thank you for informing us about your research. From our side there is no problem as long as you do not interfere with the development of the course, students agree and their anonymity is respected.

See you soon.

Best regards,



De: Philip Nicholson [mailto:p.nicholson.1@research.gla.ac.uk]

Enviat: viernes, 06 de junio de 2014 12:57

Tema: Re: Earlybird student registration Philip Nicholson



I have a couple of queries regarding the workshop. My main interest for attending the workshop is to gather data for my PhD research on how GIS practitioners work with software. I need to ask participants of the workshop if they would mind participating in my research. The primary methods I will be using will be participant observation and informal interviews. For participant observation, I will be making observations about the way in which participants and teachers in the workshops relate to GIS software. This means making note of the kinds of instructions given to participants and their actions when using the software. I will be paying particular attention to relationships between hand, eye and screen and how participants verbally describe these embodied relationships. My observations will be unintrusive and will be simply be recorded in a journal from my perspective as a participant. I will anonymise the names of all participants. However, due to the ethics procedure at my university I am required to provide participants with an information sheet about my research and ask them to sign a consent form. I will follow up my observations with informal interviews with participants but these can take place outside of the summer school at a later date.

I hope this is ok. Please get back to me if you have any concerns. I am happy to answer any questions you may have.

My other query relates to the receipt for my payment. I have not yet received it. Can you please send it to me ASAP.

Kind Regards
Philip Nicholson

PhD Candidate in Human Geography

Figure 27 - Supplementary Cell 4.3

Example page from field notebook: Free and Open Source GIS Summer School, Girona



1 Student workspace

- looking over the top of screen to see instructor.
- type address into browser
- check link to download.
- look in folder and open presentation. (without being asked)

STUDENTS FOLLOW ALONG. - Student workspace mirrors instructor's projection.

- taking paper notes
- one hour in - students become restless. denoted by the creaking of chairs. more movement in the room, more people reclining. More hand touching face.

2 Instructor behaviors - Instructor opens from front of room

- Writes short URL on blackboard. - says nothing for 1 minute
- Talks - standing at the front of the room. "Two different mechanisms."
- OGC
- "Any questions" -> Check speed.

Semantic interoperability:
- ontologies etc. -> Bringing them together
When talking about this more hand movement

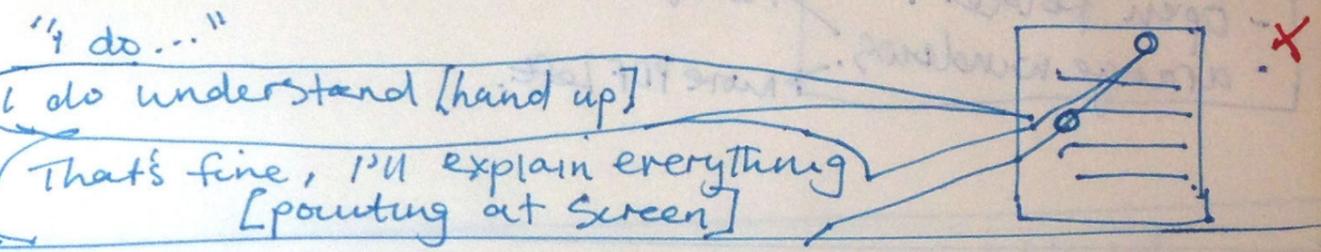
standards
About half hour in to presentation begins to use laser pointer as slides become text heavy.

- circular movements of laser pointer.
- puts pointer down to move hand and explain how SDI's work.

3 Interactions

"How many people have used
↓
reluctant hands up from some stu
"How many people have heard of the OGC"
↓
hands up.

~~this includes~~ inclusive
"I'm noticing commonalities"
"we have SDI and inspire people."

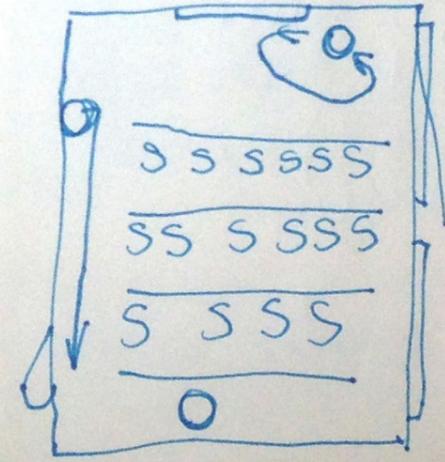


notes 16 people.

- OGC standards.
- > "You can connect to it"
- "You can query it"

"You've heard of Slippy maps"
↓
constantly checking knowledge.

-> 1 hour in "has everyone used a FIS before"



- Staff
- Students.

Figure 28 - Infographic 5 - Unpacking my Creative Practice: Office cum Studio



5. UNPACKING MY CREATIVE PRACTICE: OFFICE CUM STUDIO

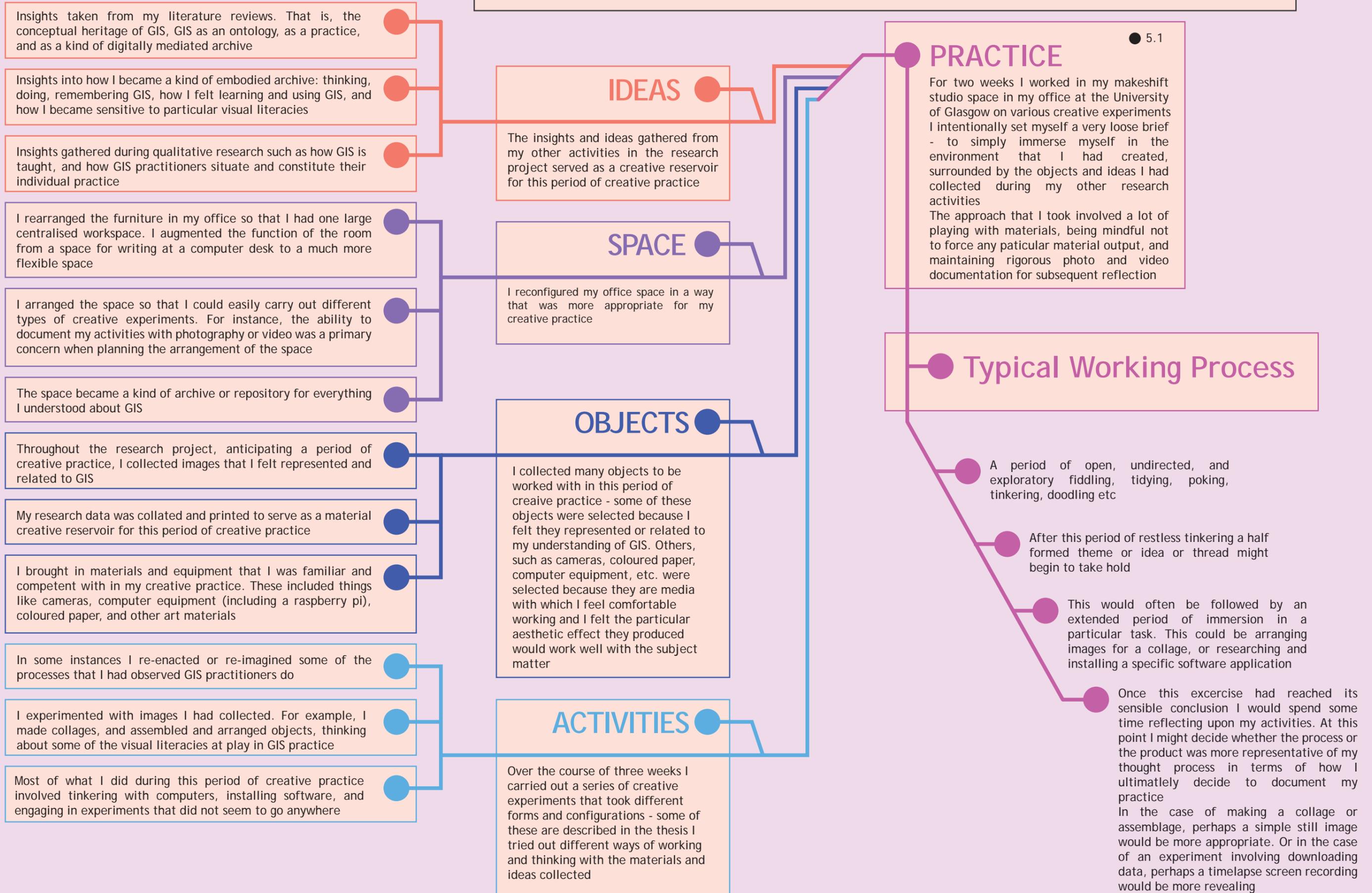


Figure 29 - Supplementary Cell 5.1

Photograph taken during creative practice



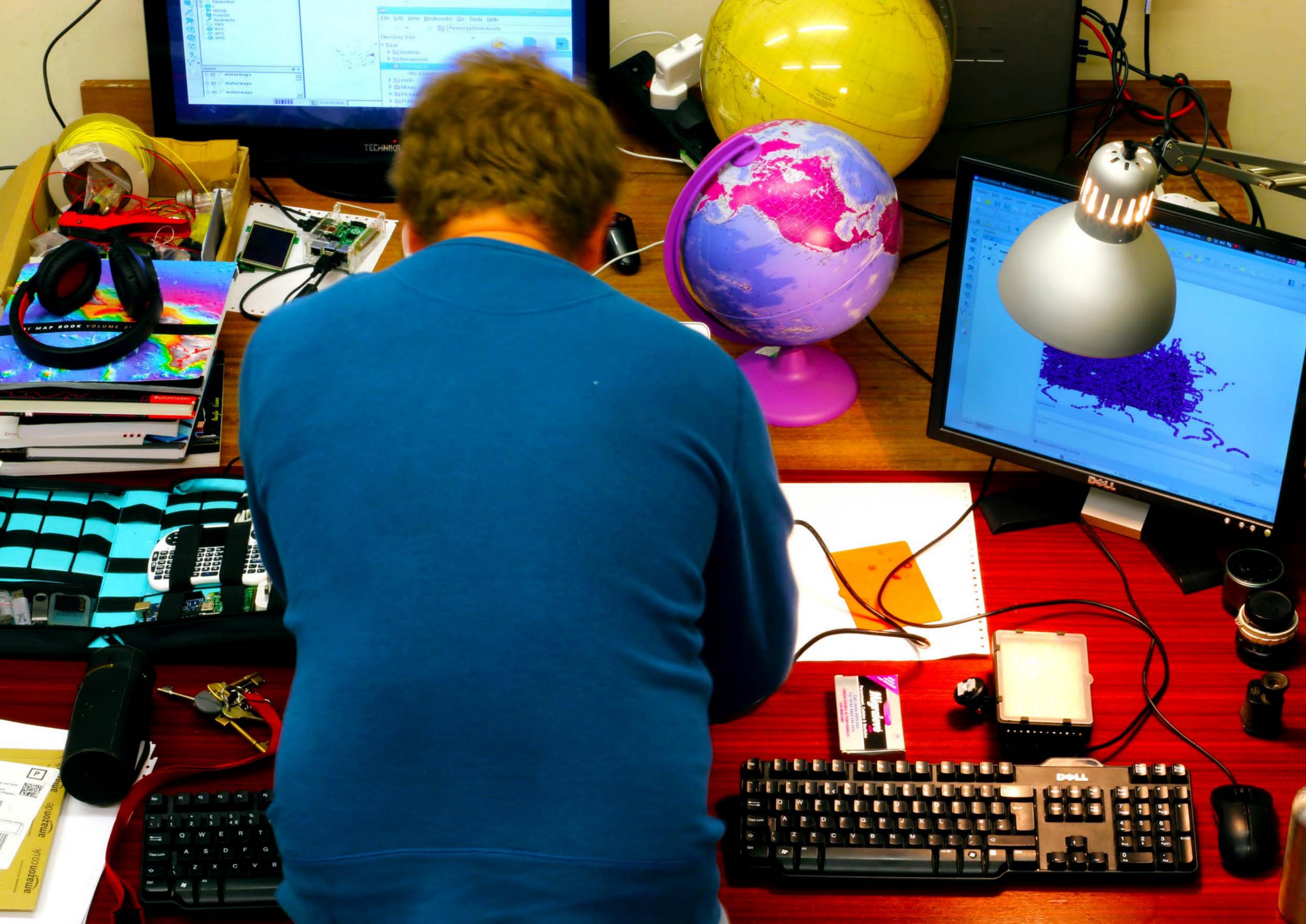


Figure 30 - Infographic 6 - Archiving and Analysing



6. ARCHIVING AND ANALYSING

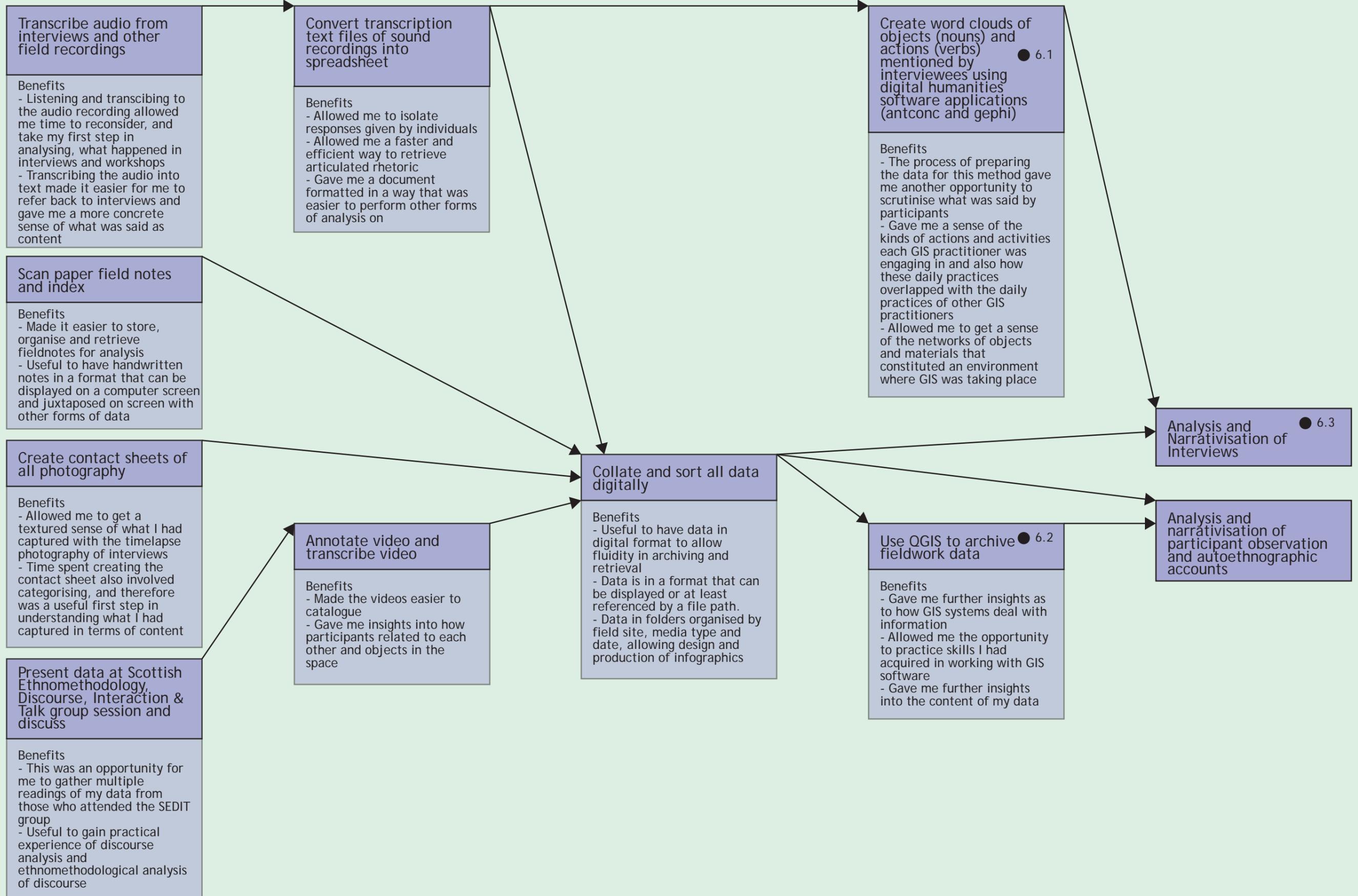


Figure 31 - Supplementary Cell 6.1 and 6.2

Still screenshot of Gephi interface

Still Screenshot QGIS interface during the process of archiving my fieldwork data



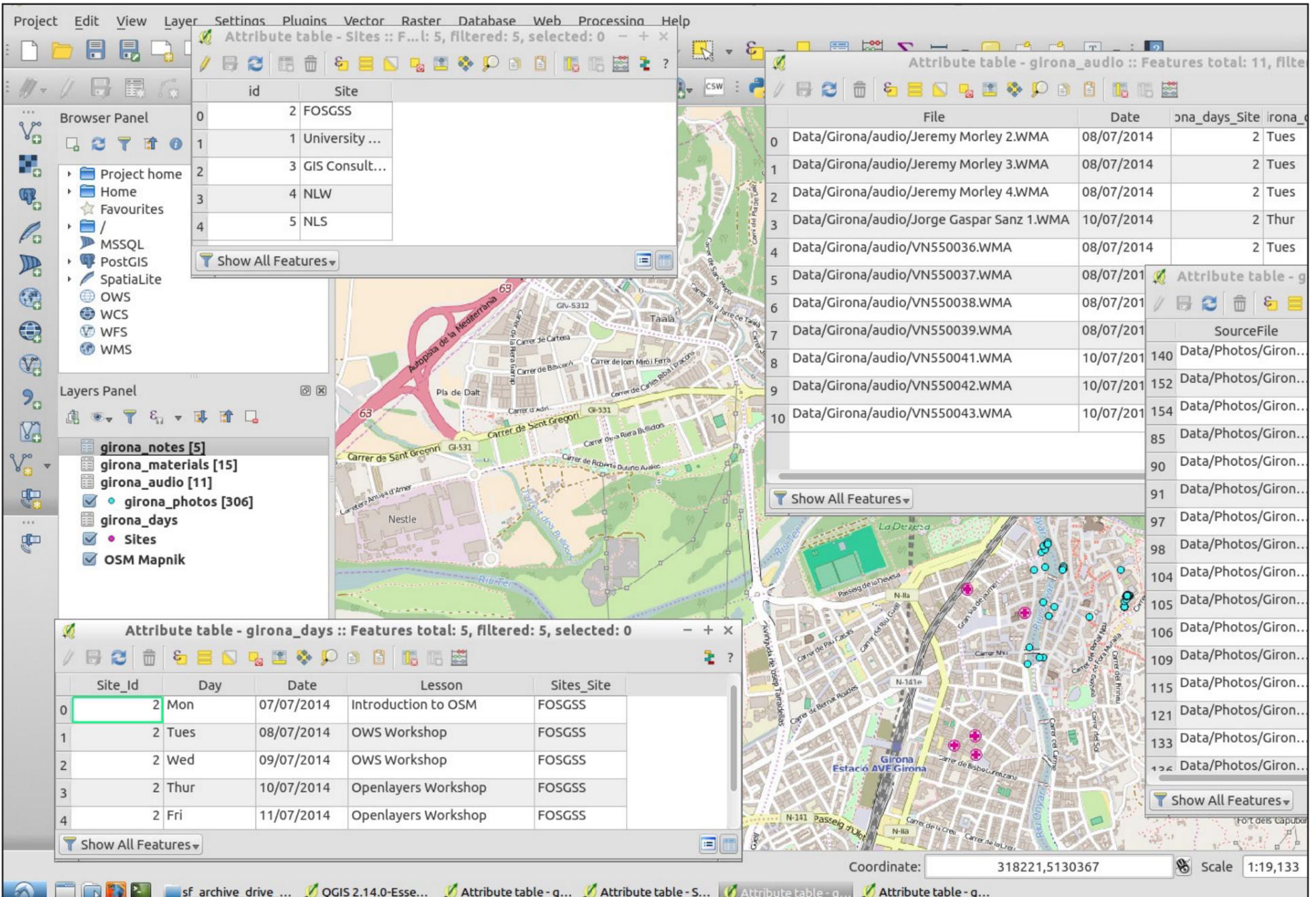
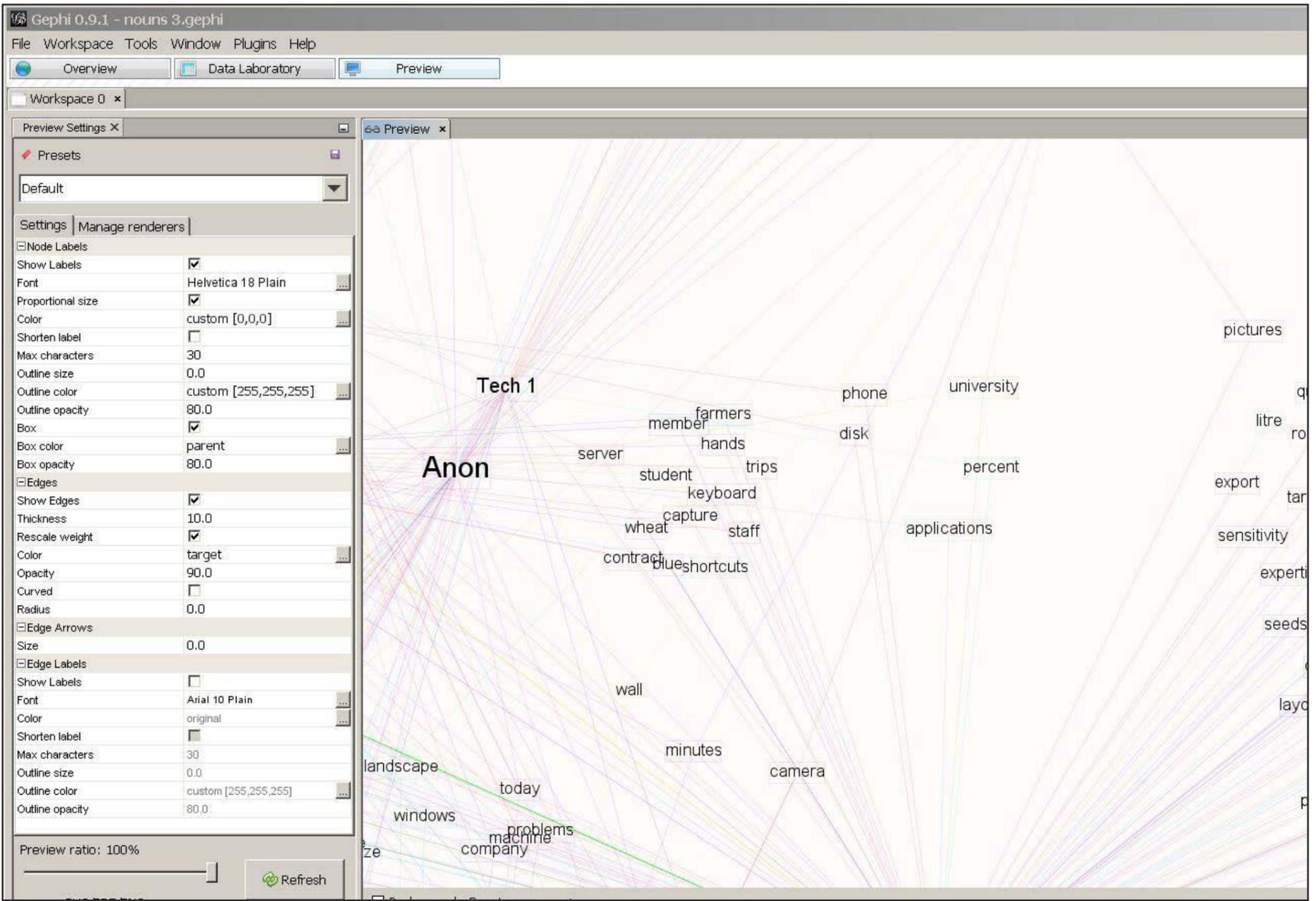


Figure 32 - Supplementary Cell 6.3

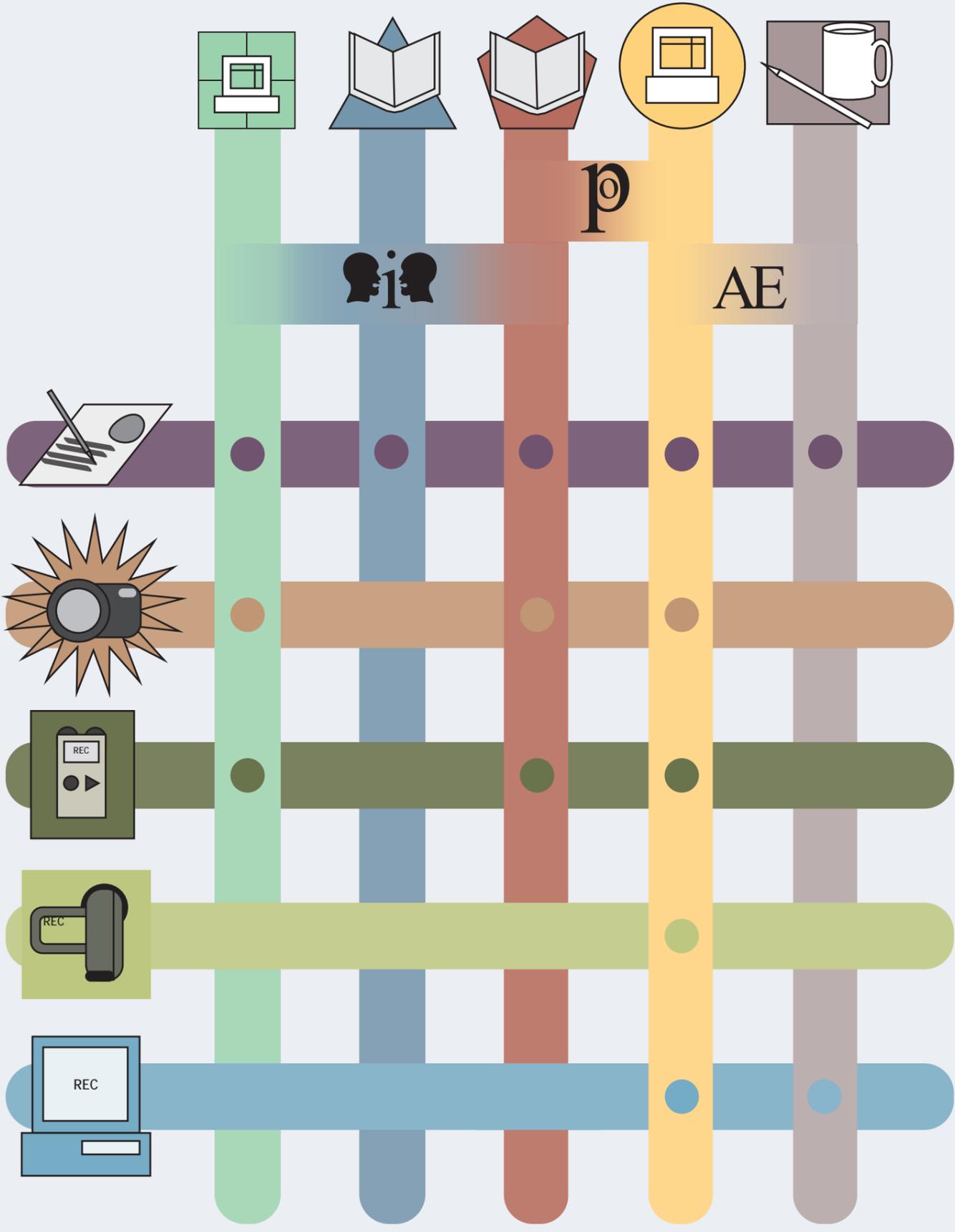
Photograph of process of narrativising interview data



Figure 33 - Infographic 7 - Sorting Recorded Data



7. SORTING RECORDED DATA



LEGEND		Field Sites	Data Collection Media
Qualitative Methods		GIS & Remote Sensing Consultancy	Handwritten Fieldnotes
Interviews		National Library of Scotland	Still Photography
Participant Observation		National Library of Wales	Audio Recordings
Autoethnography		Free & Open Source GIS Summer School	Camcorder Recordings
		University of Glasgow Office	Computer Screen Recordings

Figure 34 - Infographic 8 - Thinking Through Collected Data



8. THINKING THROUGH COLLECTED DATA

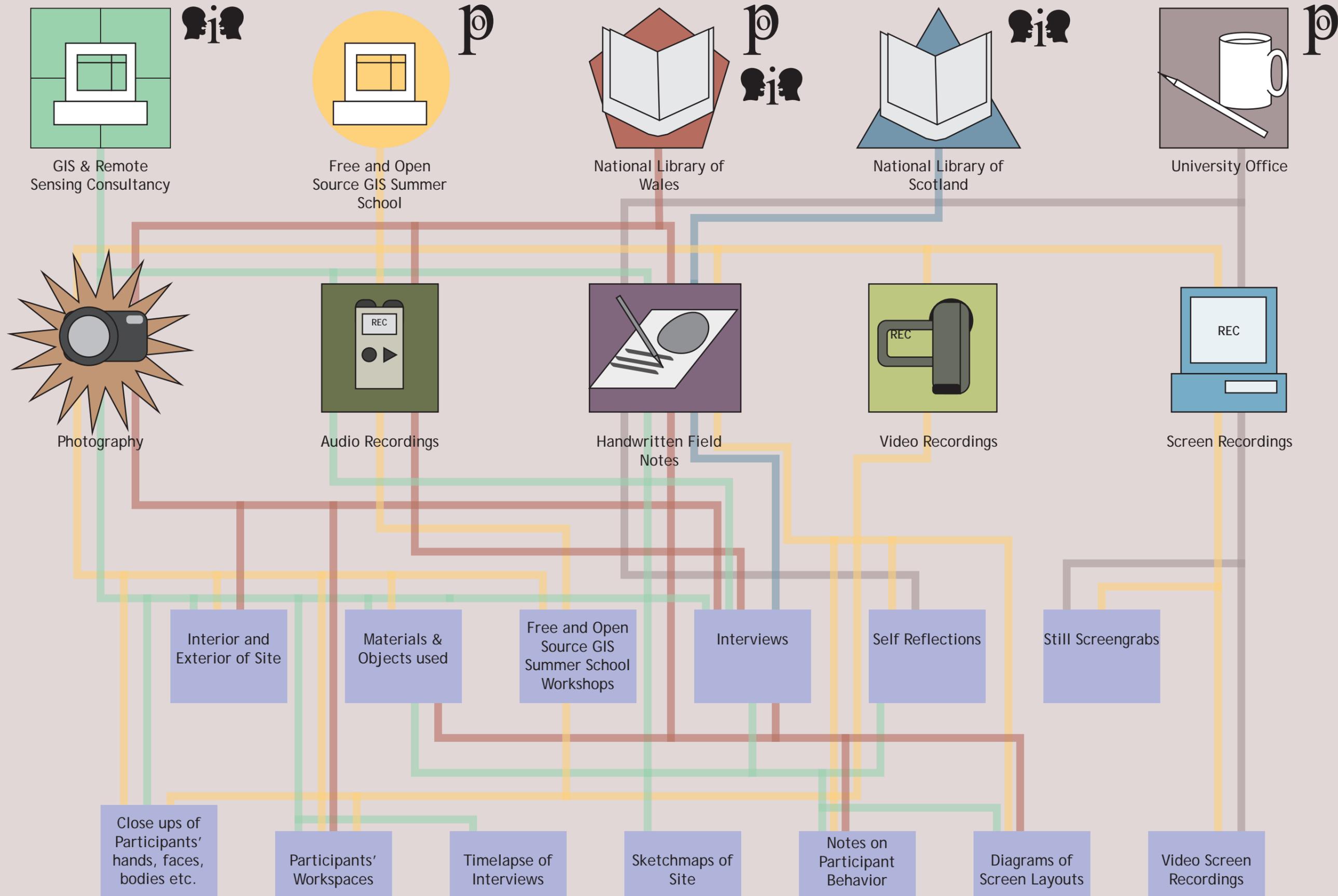


Figure 35 - Infographic 9 - Compiling Recorded Data



9. COMPILING RECORDED DATA

University of Glasgow Office			
 			
 Handwritten Field Notes	 Camcorder Video	 Screen Recording	 Embodied Experiences
Lists of Materials Self Reflection Notes from discussions with Seb Hudson Insights using QGIS to archive field data Notes on other GIS software	Webcam recording of me working with QGIS	Still screengrabs of QGIS as I work through YouTube tutorials Still screengrabs of process of using QGIS to archive data	Remembered experiences of learning - including emotional dispositions New understanding of how certain software packages work

Free and Open Source GIS Summer School					
 					
 Handwritten Field Notes	 Audio Recording	 Still Photography	 Camcorder Video	 Screen Recording	 Embodied Experiences
Lists of Materials used Descriptions of participants' interactions with computers, screens, space, other individuals Sketchmaps of Site Diagrams of Screen Layouts Self Reflections	Discussions between participants Instructions given by workshop leader	Photographs of participants' workspaces Photographs of site interior and exterior Closeup photography of participants' hands, faces, bodies etc. Photographs of teaching lab during workshops Photographs of materials and objects used	Video of participants working during workshops - including closeups of hands, faces etc	Video recordings of participants' screens during workshop activities Video recordings of my own screen during workshops Still screengrabs of my own screen during workshops	Remembered experience of learning new skills during workshops - including emotional dispositions New skills acquired from workshops

GIS & Remote Sensing Consultancy			
 			
 Handwritten Field Notes	 Audio Recording	 Still Photography	 Embodied Experiences
Lists of Materials used by staff Descriptions of participants' interactions with computers, screens, space, other individuals Sketchmaps of Site Diagrams of Screen Layouts Self Reflections	Interviews with participants	Photographs of participants' workspaces Photographs of site Closeup photography of participants' hands, faces, bodies etc. Photographs of materials and objects used Timelapse during interviews	Remembered experience of learning new skills during interviews - including emotional dispositions

Legend	
	Participant Observation
	Autoethnography
	Structured and unstructured Interviews

National Library of Scotland	
 	
 Handwritten Field Notes	
Notes from interviews Observations of staff in situ	

National Library of Wales		
 		
 Handwritten Field Notes	 Audio Recording	 Still Photography
Notes from interviews List of materials used by staff Observations from scanning studio	Interviews with staff Studio tour	Photographs of scanning studio Photographs of objects and materials

Figure 36 - Infographic 10 - Tracking Research Progress



Year 1

Learning from Seb Hudson

- Discuss practicality issues of working with GIS
- Discuss software packages including ArcGIS, QGIS, GRASS

Desk-based research

Install software packages and began to experiment
Read and assess secondary literature

Doing map making process in ArcMap

Document process as a flow diagram in field book

Follow YouTube tutorials for QGIS

Document learning process with screengrabs and annotations

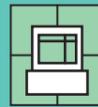
Ethics proposal written and Approved

Year 2



Visiting the National Library of Scotland

Interview staff about recent crowd sourcing georeferencing project



Spend two weeks with GIS and remote sensing consultancy

Interview company employees about GIS practice
Observe everyday practices
Observe GIS as situated practice



Attending the Free and Open Source GIS Summer School (FOSGSS) at the University of Girona

Observe participants and take part in workshops and collecting field data

Attended *Scottish Ethnomethodology, Discourse, Interaction & Talk* meetings organised by Eric Laurier at the University of Edinburgh

Share, analyse and discuss video clips from FOSGSS with the group



Visiting the National Library of Wales

Interview staff working on crowd sourcing georeferencing project

Transcribing field interviews

Annotating video footage from fieldwork



Archiving fieldwork data using QGIS

Geolocated photographs, videos, transcripts, etc. and organised in a relational table system

Collating field data

- Organise into folders
- Arrange by media type and date



undertaking creative practice in university office

Practice was documented as a series of short video clips, collages, and photographs

Presenting video clips from creative practice at theatre studies colloquium

Gathered feedback from participants

Year 3

Creating word clouds from interview transcripts

Used various digital humanities software and tools such as antconc and gephi, and excel to extract actions (verbs) and things (nouns) from interview transcripts

10. TRACKING RESEARCH PROGRESS

SECTION THREE – On Reading the Infographics

Infographic 1 – Familiarising and learning how to use GIS

This infographic focuses on my process of familiarising and learning to use GIS software – a participant observation - and draws primarily on field book notes and sketches. It is a flow diagram that prioritises four groups of activities loosely arranged in chronological fashion from left to right. I begin with a series of informal discussions with my external supervisor Sebastian Hudson, a GIS consultant and practitioner; these were usually composed of a number of hours sitting in front of a computer whilst he showed me certain aspects of his work for the GIS and remote sensing consultancy (where I would later conduct fieldwork studies). Following on from, and in between, these discussions with Seb Hudson, I spent a lot of time on my own investigating in more detail the points raised during our discussions. That is, these discussions helped direct my secondary reading on GIS, but also prompted me to take on ‘ownership’ of the doing of GIS by downloading, installing and playing around with the software packages that Seb introduced me to. During these activities, I began to formulate some impressions of how GIS software was constituted. That is, from my perspective, and having an extant familiarity with mostly creative software, I likened GIS to vector and raster drawing programs such as *Adobe Photoshop* and *Illustrator*, with the added functionality of a database system.

After this rather tentative exploration of numerous software packages, I determined that in order to get a better sense of GIS as a practice I would need to work with some data. The third step in this flow diagram indicates some of the activities I undertook to gain this more practical understanding of GIS software. For example, I followed a number of *QGIS* tutorials that I found on *YouTube* and documented my progress; here, I gained a sense of some of the features of *QGIS* such as adding vector files, clipping vector files, difference analysis, making buffers, making shape files, and querying attribute tables. These *YouTube* example tutorials used freely available data from the UK Department of Energy and Climate Change. I also gained practical experience during my fieldwork study at the Free and Open Source GIS summer School, which brought up issues around working with and creating web-based GIS maps and interfaces. The exercises at the summer school mostly involved learning how to create and customise java web-based GIS applications, and preparing data for use in these applications. I learnt how to edit java and html code to display the data, and used server and desktop GIS applications like *PostGIS*, *QGIS*, and *GeoServer* to prepare the data for the web. In one such exercise, we worked with freely available data from online sources such as *OpenStreetMap*, Ordnance Survey, and British government “Open Data” to create an interactive web map of bus networks in and around Nottingham. This involved, working with this data that had been downloaded for us by

the instructor to configure a java-based web application. The instructor introduced us to the online repositories of code and reference materials that would help us configure the application. He guided us through a tutorial that allowed us to create a map viewer in our web browser by installing various applications and adjusting the code to suite our task. In this instance, we also learnt how to process this downloaded data into files for use on *GeoServer*.

I also demonstrated in GIS labs at the University of Glasgow. This activity allowed me to get a sense of how GIS was taught as part of an undergraduate geography degree programme. In these teaching labs, I was responsible for answering students' questions about the tasks they had been set. These tasks usually involved rather basic processes, such as performing queries, creating new layers, and using buffers. When a student asked me for help it was often because of things such as selecting the wrong map projection at the start of the exercise or complaining that they were unable to see their data when they layer they were looking for was at the bottom of the stack in the side panel. During this experience of teaching I became very familiar with these sticky points to the point that I became very efficient at assessing what had gone wrong.

Further to this, I feel my fieldwork studies at Environment Systems gave me a sense of the everyday experience of the GIS practitioner. That is, during my time at the Environment Systems offices, I observed how individual GIS practitioners organised their workspaces and workflows (both within and outwith computer software), I gained an understanding of the kinds of skills and proficiencies they embodied, they told me about the value that they think their work has, and I witnessed various emotional dispositions manifest in the doing of GIS. Making these observations allowed me to consider and trial a particular approach, or way of disciplining, or training oneself to work with GIS.

The final step in this flow chart focuses on my efforts to use *QGIS* to archive my fieldwork data. In addition to *QGIS* I was, of course, archiving via field notebook and photos, amongst other media. However, in considering *QGIS* I could address, and gain first-hand experience of how *QGIS* dealt with my data. That is, the way in which the design of the interface and ontological underpinnings of the database structure lead me towards particular outcomes. This was also an opportunity for me to work with GIS in a more independent manner. It allowed me to gain insights in to how it felt to order my data according to these inbuilt structures. As I felt my way through the interface, I drew upon skills and knowledge learnt during previous encounters with GIS to imagine what else was possible. The process involved the installation of *QGIS* on my university desktop computer, a lot of google searches, and time spent preparing and ordering my data so that it was in an appropriate format for *QGIS*. This involved compiling comma separated text files (CSVs) of lists of files and their relevant attributes, extracting

geolocation metadata using a command line application called *ExifTool*, and adjusting my filing structure to make the process of importing data easier. This process raised a host of emotions around the doing of GIS. Prominent here was the sense of frustration, for instance, when trying to get certain plugins to work, and a sense of achievement when things worked the way I intended.

As this infographic illustrates, teaching myself GIS was quite a complex process. Over the course of the research project I became familiar with particular elements of GIS via various different types of encounters. These learning encounters can be broadly separated into two categories; that is, time spent alone in front of a computer, and time spent working with and being directed by others. The latter includes the time spent at FOSGSS, taking part in the workshops where the instructors would talk us through – and we would follow along – specific exercises. The instructor would type an address into the web browser, download a zip file, extract the data from the zip file, and then instruct us to do the same, meanwhile explaining what the data was and how we would use it in the next step of the exercise. The method of learning promised class cohesion – we would all complete the task at the same time – and we would all gain an understanding of how the software was supposed to work. However, this method of working did not allow us to experiment, there was no element of problems solving, and we were left with little scope for understanding how we might customise the process for our own purposes. At Environment Systems, although there was no element of hands-on interaction with GIS software, through discussion, I was able to gain a sense of how practitioners managed their workflow and data, and how by taking ownership of their work they asserted agency. That is, the practitioners at Environments Systems had a greater amount of independence to determine how they worked, their computer workstations were bespoke, they had designed and implemented their own workflows, and written much of their own code to make the work possible.

In the same way, I found that the undergraduate students in my GIS labs responded well to this kind of self-determination and space for independent (sometimes referred to as creative) thinking. During my time demonstrating in these teaching labs I observed two different styles of teaching students how to use *QGIS*. In the first labs that I demonstrated in, the lab leader asked the students simply to follow her actions as they were projected on to a screen at the front of the class. The other style I observed encouraged the students to be much more independent in their approach to learning. They were given worksheets at the beginning of the class. The worksheets included a set of activities divided into tutorials and problems. The tutorial activities directed them (in a step by step manner) through a series of processes in *QGIS* to produce a

specific outcome – such as using the query builder to create a new layer. The worksheet for each lab contained a number of these tutorial activities (each explaining how to use a specific tool in *QGIS*) followed by one or two problems to solve. These problems were designed so that the student had to demonstrate an understanding and use the tools they had used in the tutorial activities to create a map. This style of teaching GIS required minimal direction by the lab leader. Rather the lab leader and I were simply present to help the students if they got stuck.

For my part, I learnt a lot whilst demonstrating in these teaching labs. Not only was it useful to observe this method of teaching that encourages a level of independent thinking by the students, it was also a good opportunity for me to observe where the students were stuck and needed assistance. That is, almost every interaction I had with the students in the teaching labs related to moments when the text instructions failed to adequately explain how to complete the task, or when the student needed assistance in connecting the dots. For instance, working out how to implement what they had learned of the *QGIS* tools to carry out a slightly different task, to answer a different question, or work with a slightly different dataset. The insights gathered working with the students in this way were extremely valuable when I was working with *QGIS* on my own. This time equipped me with a repository of solutions to the problems faced by the students.

As noted above, I learnt a great deal talking to, being directed by, and assisting, others. However, I feel that it was only when I took time to work on my own, self-directed project that I was able to familiarise myself with the software with a degree of confidence. A key element in my process of teaching and familiarising myself with *QGIS* is exemplified in Cells 1.1 and 1.2. These cells are taken from my notebook and document a process of constant unpacking and reflection. In a similar way to the worksheets used by the students in the GIS labs, these cells break down the process of making a map in GIS into a flow of smaller actions. Another significant element of this self-directed learning is the sense of achievement gained when one overcomes a problem. For instance, when I was importing my fieldwork data into *QGIS* it took me quite a while to work out how to properly import GPS data so that the point data would appear in the correct position on the map window. If someone had told me exactly how to do it I may have completed the task in a fraction of the time, but I would not have attained the sense of achievement I felt working it out for myself after hours of google searching, and time spent banging my head on the desk in frustration.

This infographic ‘works’ by pulling together a number of such seemingly disparate activities - deeply buried and nested in amongst my more conventional data collection techniques - that took place over the course of the PhD. It affords these a relevance and significance insofar as

they allowed me to become familiar with a key dimension of the everyday, mundane practice of GIS; a practice that is predicated on searching for, installing, learning to operate, and experimenting with the possibilities adhering to, software. Here I have pulled out otherwise glossed events, interactions, practices, and insights, and linked them together in a flow of events that emphasises a growing confidence in regard to the doing of GIS, but also, I suspect, a growing sense of empathy for GIS practitioners. As an infographic, the A3 cell simplifies what was a complex, often fraught, process of learning; but, it also starts to link these experiences into the more conventional sites and objects of research via the use of the two site icons: The Free and Open Source GIS Summer School and the GIS and Remote Sensing Consultancy. These links, then, convey something of how my becoming familiar with GIS software provide me an embodied knowledge to take forward into these formal settings.

Infographic 2 – Conducting an Ethnomethodology: Environment Systems

Before embarking on this fieldwork study, I had spent some time reading literature relating to GIS and practice. I had also spent some time speaking to my external supervisor about his GIS practice and my hope was to expand my understanding of what it means to practice GIS. These preliminary activities had provided me with insights that I had distilled into three characteristics of GIS practice, or thematics. These were that GIS is data-heavy (requiring users to handle large amounts of data), is mediated (involving many different components – such as computer hardware, software, office furniture etc.), and assembled (requiring an array of different skills and proficiencies). My time spent at the offices of Environment Systems allowed me to explore these thematics further by interviewing the people that worked, but also by spending time familiarising myself with the site, its everyday operation and layout in an ethnomethodology.

I conducted unstructured interviews at Environment Systems with participants who were engaged in work that relied on the use of GIS technologies on a daily basis. These unstructured interviews involved sitting alongside my participants at their computer workstations, asking them questions specifically about what they were doing, but also allowing space for more open-ended conversations about the nature of the work that they did. We spoke about what was happening on the screen, the pitfalls of specific software packages, how data was managed and by whom, whether or not they enjoyed their work, and so on. I would sit with each participant for approximately one to two hours; the duration of the interview would usually be dependent upon how long it took them to perform specific task. In some instances, I had to be careful about the kinds of questions I asked, specifically regarding what was referred to as intellectual property.

My intention, speaking to these individuals, was to collect data on how GIS practitioners articulated their daily practice. These interviews or conversations were recorded using a sound recorder and later transcribed into individual text files. I also made handwritten notes during and after the interviews, reflecting upon observations that I was aware could not be captured by the sound recording. For instance, if the participant gestured towards something that was happening on the screen, I would make a note, sometimes an annotated sketch, of what I could see, and make a rough note of the time so that I could later link my notes to the audio. During the interviews, I also set up my iPhone to take photographs of the participant, often focusing and framing relatively intimate spaces, such as, their hands on the keyboard, faces as they looked at the computer screen. These photographs were also timecoded so that I could link them to the audio transcripts. These photographs were useful in evidencing and exemplifying some of the more embodied reactions that my participant exhibited during the process of the interview. Overall, these interviews sought to capture something of how GIS practitioners articulated their daily practice, and also how they imagined and practiced GIS as they were immersed in the 'doing' of GIS.

I recorded interviews using a sound recording device so that they could be transcribed later. To accompany these sound recordings, I took photographs of the participants and their workspaces using a DSLR camera and, in some instances, I set up my smartphone to take photographs at regular intervals throughout the interview. These collections of time-lapse photos focused on very small sites such as the space occupied by the participant's hands on the desk or their face. I also took extensive field notes pertaining to participants' actions, descriptions of the day-to-day working of the various sites (paying attention to hierarchical structures and more general observations framed as snapshots in time of specific sites) and lists of materials at work and sketch maps of the site.

This infographic gives a sense of the process involved in carrying out interviews and an ethnomethodology by ordering my activities as a series of moments connected in a flow chart. Each box in the flow diagram represents a particular moment during my process of setting up and carrying out my research project. If one follows the arrows, there is a chronological flow to the infographic, with each box representing a complication in the process, or the enrolment of further actors. Forks in the flow of the infographic suggest how complications were resolved. For instance, when I had planned my fieldwork study I did not expect to have so many limitations placed on how I could move around the offices and interact with employees. In this sense, the infographic marks out these moments and illustrates how I adjusted my research plan to accommodate the changes imposed. Moreover, by separating the field study into a flow of

moments in the process of carrying out research it gives an impression of its complexity. The moments, represented by text boxes, reveal things like the logistics involved in arranging the field study; the diplomacy required to set up research; how the formal structure of ethics approval fitted into the carrying out of the study; how I became familiar with the site and its everyday operation and layout (exemplified in supplementary cell 2.4); how I became accustomed to the delicacy required for research with others who are employees; and how I adjusted my research design *in situ*. I feel the supplementary cells, referenced within the infographic further unpack these moments, contributing a sense of the work done to produce their material traces.

Infographic 3 - Planning and Interviewing: The National Library of Wales and the National Library of Scotland

I spent time at the National Libraries of Wales and Scotland talking to those involved in preparing materials for crowd sourcing projects to georeference historical maps. Spending time with these individuals was a good opportunity for me to get a sense of what was involved in these kinds of citizen science, or neogeography, projects. In my studies of literature relating to GIS, neogeography had frequently been held up as a progressive force in the practice of GIS. That is, involving non-expert, members of the public, in the capture, storage, and organising of data for geographic research. For this reason, two projects, one at NLW, and one at NLS were of interest to me. At these sites staff were involved in projects to crowd source the georeferencing of historical maps. To gain access these individuals I first contacted the person in charge of the project at NLS. This was Chris Fleet, the map curator based at the Maps Reading Room at NLS. I emailed him giving a brief overview of my PhD project and detailing my specific interest in his project to crowd source the georeferencing of historical maps of Scotland. After several email exchanges, where he drew my attention to a paper he had co-written on the project, and I gave him a sense of what I would like to talk to him about, we arranged for me to spend time at the Maps Reading Room to talk to him and some of his colleagues. After I met with Chris Fleet he put me contact with Einion Gruffudd at NLW, who was managing a similar project to georeference historical maps of Wales.

At NLS, I would sit with Chris and his colleagues and ask them about their work. I took notes in my field book as they explained the objectives of the project and how it had been facilitated by a colleague from the British Library and a software developer; working in concert, they had created a web application that allowed members of the public to contribute to the project. As I had specifically expressed an interest in the crowd sourcing project, he gave me the contact details of a colleague of his at NLW. He explained that the project they were about to start at

NLW was much larger in scale and ambition – working with a much bigger collection of historical maps.

Following this, Chris Fleet introduced me to Einion Gruffudd, the project manager on the NLW project and I travelled to Aberystwyth. We met in his office and we sat at his desk in front of a computer for about an hour as he explained the objectives of the project and explained the cultural significance of the Welsh Tithe maps that were to be geolocated as part of the project. I recorded this conversation using a sound recording device and also took notes in my field book. As Einion talked me through the *Georeferencer* web application – that had originally been created for the Scottish project and since updated – I took photographs of his computer screen. In the following days Einion was to give me a tour of the scanning studio that had been set up to digitally capture the maps so that they could be uploaded to the Georeferencer servers. In the studio, I was introduced to two technicians who had been employed by the library to scan the Tithe maps. Einion and the two technicians explained the process of scanning the maps. They had designed and built a bespoke photography studio that allowed them to digitally capture these particularly large and cumbersome artefacts. They talked me through the process involved in setting scanning the maps. I recorded the audio of this studio tour and took photographs of the equipment and materials in the studio as they explained their significance in the process.

This infographic outlines the process of interviewing at these two sites. It presents the process as a vertical flow of touchpoints, or points of contact, with the interviewee as we make introductions, arrange logistics, spend time discussing their respective projects, and then how one discussion snowballs in to another introduction. By positioning these two encounters alongside one another the infographic highlights some of the similarities between the two, but also marks specific points of departure from a mirrored flow with text boxes that further unpack the specificities of each interaction. For instance, at each site I began with a relatively intimate discussion with the project leaders and then was introduced to others working on the project and shown around the site. The text boxes that elaborate on these situations give a more site-focused account of what happened.

Infographic 4 - Planning and Learning GIS

The aim of this period of fieldwork was to collect participant observation data, and insights from an ethnomethodology, that captured something of what it is to learn GIS. I enrolled in a summer school at the University of Girona to take part in the workshops and classes. I selected this site because it allowed me to gather insights on a particular pedagogic approach to learning GIS. That is, for the most part, learning was done as part of a group, being directed by a teacher.

Over the course, I documented my observations, keeping a record of my activities, and those of the other students.

Again, the infographic is arranged as a flow chart according to a grid pattern with arrows denoting the order of each step in the process. The infographic evokes a smooth flow of activities -- from corresponding with research participants, logistics, recruiting participants, to in-the-field adjustments to research design -- each step leading to the next, but also some of the moments that disrupt the ordered flow. For instance, by forking the flow in the infographic I was able to elaborate on the strategy I adopted for collecting data. In the main flow of the infographic, I simply state that I recorded video and audio; however, by unpacking this further, forking the flow of the infographic, I could explain how this worked in practice -- that setting up a camcorder to record allowed me to focus on taking part in the lesson. Each box has a title that distils that particular moment or activity, and some are supplemented with short descriptions of what occurred. These moments can be unpacked further, as noted by the presence of a black dot within a box, and the insertion of a following A3 cell. These additional or supplementary cells allow me to demonstrate a sense of the materiality of my fieldwork studies. That is, they serve as physical traces of the work that was done to apply for the summer school, and they also work to demonstrate how data was collected, linking this collection of cells into the wider network of the project.

As with infographic 2, this graphic works to a timeline, but each moment can be unpacked to convey a sense of the complexity of each activity or event. What they also project is a particular visual aesthetic that resonates with a GIS data visualisation, insofar as I have deployed the graphic language of *Adobe Illustrator*. Both infographics only use three colours that correspond to the colour used in the logo for site that they reference. What is more, arrows pointing down must come from the bottom left corner and be attached to the top left of the next box, unless the arrow was pointing to a box in the next column, in which case it should come from the bottom right and connect to top left. Furthermore, if the more than one arrow was connecting to boxes in the same column, then the arrows are set to be four grid squares apart.

Infographic 5 - Unpacking my Creative Practice

This infographic describes the approach I took during a period specifically set aside for creative practice as part my research project. The intention of this period of creative practice was to show how my creative practice had influenced the PhD project, but also to explore how the PhD project had influenced my creative practice. My ambition was to make a number of creative works, using my research findings as a kind of creative reservoir. At the being of these two

weeks, I reconfigured the layout of my university office in a way that I thought would be conducive to the kind of creative practice I was used to. That is, my workspace was transformed from a single desk (containing a PC workstation and piled with papers) in the corner of a room into a large flat surface in the middle of the room surrounded by computer hardware, scatterings of fieldwork data, photographic and video recording equipment, and various miscellaneous art materials (coloured paper, glue, coloured pens etc.). I worked on a different creative experiment every day in this makeshift studio space, all the while doing trying to keep the focus on making. During this time, I worked on various different kinds of creative sketches, doodles, performances, re-enactments, and photographic images. The outputs of this period of creative experimentation are described in Chapter 6.

This infographic reads from left to right, and the reader is first introduced to the ‘reservoir’ of thoughts, doings and objects that I accumulated over the course of my research with the intent of using these to produce a creative response to the question of ‘what is GIS?’ This reservoir, amongst others, included things such as, images collected from the internet, time-lapse photographs from interviews, various pieces of computer hardware, like a dot matrix printer, and a raspberry pi, and so on. It then distils my practice into four distinct strands, or components. That is, the infographic explores this ‘practice’ as a confluence of ideas, space, objects (or things), and (productive) activities (exercises, or experiments). It then provides a typified working process for each day, again chronologically ordered.

Here, ‘space’ refers to the configuration of the environment in which I made the work. For example, in this infographic, I refer to the way I repositioned furniture in my university office so that the space was more conducive to making. ‘Ideas’ refer to the repository of insights and findings taken from my research project. ‘Ideas’ might include things like my understanding of the visual literacies at play in GIS, such as grid epistemologies, and some of the mundanities of GIS practice, like testing and running coded instructions for the computer. In this infographic, the term ‘objects’ refers to the material paraphernalia involved in my practice. This is the stuff that I touch, manipulate, move around, juxtapose, layer etc. However, in practice, these ‘objects’ often serve as material manifestations of ‘ideas’, standing as a visual metaphor. This does seemingly contradict the ontology implied by the infographic, that of four discrete elements of practice; but, this is simply a matter of the limitations of this graphic form. It is through the application of ‘activities’ that practice is motivated. This included the different ways in which things happen in the studio space. For instance, during my two weeks working in the studio I engaged in a number of different activities, such as, re-enactment, collage, photography. These activities are a kind of catalyst, or lubrication for the other three elements, bringing them

together to create something new. However, just as the other three elements of my practice require activation by these (productive) activities, activities require objects, space, and ideas to produce something.

Rendered via the visual language of a circuit board diagram to present the constituent parts of my creative practice as ‘input’, ‘assemblage’ and ‘output’, the infographic represents a particular notion of practice as a tightly woven system. As such, what the infographic does not show is how iterative the creative process was and is. That is, this graphic gives the impression that the confluence of these four elements happens simultaneously. In practice, however, the different elements tend to fade in and out of prominence throughout the process of making. In other words, as this infographic focuses on unpacking terminology and examples, it cannot demonstrate the more nuanced temporalities at work. For instance, what I have termed as ‘ideas’ here were not constantly at the forefront of my attention. Using the terms set out in the infographic, during periods where I am immersed in doing, I feel entirely caught up in ‘activity’ and ‘object’ with little conscious regard for ‘ideas’. What I mean by this is I tend to be more caught up in an active engagement with the objects, rather than a pointed thinking through of concepts or ideas that underpin the concerns or themes of the research project. This is why I chose to include supplementary cell 4.1, as I feel it effectively illustrates a particular moment of immersion that is surrounded by objects.

Infographic 6 - Archiving and Analysing

This infographic has a more complex temporality than its predecessors, insofar as it conveys how the process of assessing and archiving data was a period of sustained reflection, but also a looking forward to possibilities that had now been opened up. As such, this infographic links to many of the other figures in this series, addressing something of how data was collected, where, and to what effect. Nevertheless, there is a distinction here between assessing and archiving in terms of particular steps undertaken, some of which have been unpacked further into following A3 cells, and particular reflections I have chosen to emphasise. This distinction, I would argue, arises more from the steps chosen for emphasis rather than from a separation of thought from process. There is also a sense of flow here, as a particular step leads to a particular reflection, which leads to a particular step and so on. The process culminates on the right-hand side of the infographic with the reflective writing up of the empirical chapters of the PhD.

In this infographic, we gain a sense of the different ways in which I ‘encountered’ the data, and the role of the medium in that encounter. That is, how the capacities of the medium allowed me to get a different sense of the data. At various points throughout the archiving and analysis

process, my data was displayed on screens in a number of different ways. In this way the screen acted as a framing device for the data, it allowed me to zoom (both in the sense that I could magnify data (in the case of photographic images) but also seamlessly move across different levels of granularity), and also gain a sense of the interconnectedness of the data, for example moving from one attribute table to another (within the GIS application) seamlessly, or viewed in an entirely different application – with the click of the mouse or a keyboard key combination. Furthermore, the particularities of different software applications and their GUIs - for example *QGIS*, with its multitude of tools, dropdown menus, and window panels – have the effect of rendering different experiences of the data displayed. For instance, *QGIS*, allows me to make certain layers invisible and then invisible again. This and many other capacities of these software – and indeed physical materials, such as paper notes - brings to the fore the mutability of the data.

The follow-on cells that I have chosen to complement this infographic give a sense of how my process involved visualising data in different ways. Cell 5.1, for example, shows how the interview data is represented in the network visualisation application, *Gephi*. *Gephi* allowed me to link words to interviewees and visualise the commonalities – in the words used, the things referred to and the actions described – by different interviewees.

Infographic 7 - Sorting Recorded Data

This infographic is very much intended to be reader-orientated insofar as it provides a relatively easy to read overview, or ‘map,’ of the different kinds of data collected at each of my field site for the reader to navigates. The graphic is basically a table with the x-axis showing my field sites and the y-axis the methods of data capture. The icons at the top of the graphic represent each of my field sites. From left to right these are: the GIS and remote sensing consultancy, The National Library of Scotland, The National Library of Wales, The Free and Open Source GIS Summer School, and my office at The University of Glasgow. Down the left side of the graphic, the icons represent the different media I used to capture data. These are, from top to bottom: handwritten field notes, photography, sound recording, video recording, and computer screen capture. The graphic also illustrates what ethnographic methods were used at each field site.

The infographic was designed so that when the vertical lines (each representing a different field site) intersect with a type of data collection that was used at that site they overlap that horizontal line. However, when the field site intersects with a type of data not collected at that site the vertical line passes underneath the horizontal line. In addition, each confluence of site and type of data is marked with a circular hole in the vertical line. Therefore, for instance, at Environment

Systems, I carried out unstructured interviews and collected handwritten field notes, photographs, and audio recordings, and, as the table illustrates, I did not collect video recordings or screen captures. The reason I did not collect certain types of data at certain sites varied. For instance, at Environment Systems I was unable to make video recordings or capture the screens of the individuals I was talking to because the staff and the management at that site were particularly sensitive about this. The first reason was that they needed to control the type of data I was taking in order to protect their intellectual property, and the second reason was that some of the data that may appear on the screens might not belong to the company, and/or be politically sensitive.

Unlike its predecessors, this infographic uses no text (bar a legend) to communicate quite a complex network of approaches to data collection. All field sites, types of data, and data collection approaches are defined by an icon that I designed so that they were not too complex, but still distinctive enough to be recognisable. These could be used as a recurring common reference point throughout this series of graphics. The colour palette plays with the tone and intensities with the ten options used to distinguish between the ten different fields in this table, without being too garish on the eye.

Infographic 8 - Thinking Through Collected Data

This infographic became quite an unwieldy composition as the intent was to elaborate on the information communicated in the data capture and methods table, Infographic 7. After I made that table I realised that the data capture fields did not sufficiently describe *what* it was that I had captured. For instance, that table did not differentiate between DSLR photography and the time-lapse photography I captured using my smartphone. The top two rows of this graphic communicate the same information as the previous graphic. At the top are the field sites, each represented by a particular icon and accompanied by smaller icons that signify which approach was employed at that site, and the second row shows the data collection methods. The third and fourth rows (the pale lilac boxes) go some way to unpack these data types and give a better idea of the systematic research design process that was emerging over time.

In order to understand how data was collected at each site the reader follows the coloured threads that join the objects from one row to another. For example, if we follow one path of the yellow thread that starts at the Free and Open Source GIS Summer School, it leaves the field site icon and connects with the video recording icon. A yellow thread then leads us from the bottom of that icon to two boxes, one labelled 'Close ups of Participants' hands, faces, bodies etc.', and another labelled 'Participants' Workspaces'. Thus, from this we can understand

that video recording was used at the Free and Open Source GIS Summer School to capture close ups of participants and their workspaces.

Though as an infographic this example does not succeed, insofar as it does not simplify complex data ready for a quick glance, it nevertheless ‘works’ as a means of conveying the complexity of data collection that underlies a research design, no matter how systematically it is intended to operate. I like the way field sites, media, and data, are visually and systematically threaded together. The graphic folds different temporalities (as I was at the field sites at different times) and spatialities (adhering to ideas, objects, and actions) together so that the three levels of data can be connected. But also, one can perceive the contingencies and stutterings of research practice as threads make their way to some boxes but not others. At some sites, a particular mode of data collection may be restricted; at others, a particular mode might well be more appropriate, leading to more time and energy spent on building a database. The resulting ‘map’ of sites, techniques and data types is varied, shedding light on how a research project brings particular objects and issues into the foreground.

Infographic 9 - Compiling Recorded Data

This infographic was also drawn up as a response to its predecessor, in that it became an effort to simplify and rearrange the information illustrated in the threads infographic 8. Although the prior infographic was useful at identifying flows and commonalities in the *way* that data was collected across the different sites – typifying a data collection approach one might say – this meant the primary focus was indeed on the links between field site and type of data. In counterpoint, Infographic 9 arranges that same information in a way that gives more focus and detail to *what* was captured by the various data capture methods.

In this infographic, the different field sites are arranged in rows with a box to label the site and the type of ethnographic method applied (denoted by icons used throughout the infographics). Underneath each of these site boxes is a row of boxes that resemble post-it notes. These boxes are categorised according to data type (field notes, audio recording, still photography, and so on) and underneath are brief descriptions of examples of what was recorded at that particular field site using that particular method of capture. So, for instance, we can see from the third row down that at the GIS and remote sensing consultancy still photography was used to capture time-lapse images during interviews. Eschewing the visual language of the flow chart, or circuit diagram, I have opted here for a retro approach, adopting the style of educational posters that covered the walls of my maths and science classrooms in high school. The pastel colours and

the arrangement of boxes of information are reminiscent of periodic table or ‘SOH-CAH-TOA’ trigonometry posters; in this case, we begin to see populated a world of GIS components.

Infographic 10 - Tracking Research Process

This ‘end of the series’ infographic is a return to the notion of a chronological display, giving a sense of how my research project unfolded over the course of three years. It does not give an in-depth overview of the entire research project; rather, it lays out particular moments, or milestones in the development of the project. In addition, a flow chart gives some sense of how each activity lead on to the next. Each box containing text is situated on the timeline by the triangle at the top of the box. The colour of the box differentiates three different kinds of activity. The light brown boxes are activities undertaken in my university office and are part of a sustained effort to familiarise myself with GIS. The teal boxes are particular moments of fieldwork at different sites. And the orange boxes detail my efforts to analyse and unpack my fieldwork data. The arrows originating from some of the boxes give a sense of how the process of research flowed from one activity to another. For instance, the infographic illustrates that I transcribed my interviews from the GIS and remote sensing consultancy and used them to create word clouds, and that I also used *QGIS* to archive those transcripts.

Placed at the end of a series that unpacked my research in various ways, this infographic provides the reader with a sense of how my reading, interviewing, observation, tinkering, writing and drawing pulls together to form a sustained critical and creative inquiry into the what of GIS. This infographic provides an overview of this research project and positions the following chapters. The next chapter focuses on my activities interviewing individuals at three sites, as they work with GIS as part of their everyday practice. That is, Chapter Four focuses on the testimonies of these individuals to consider a number of thematics that activate their practices in different ways. Whilst I have not explicitly commented upon the process of writing up the following empirical chapters in this methodology, these chapters in themselves go some way to unpacking this process. For instance, in the next chapter I adopt a different approach to rendering my experiences learning about GIS, that of narrativising my experiences of interviewing GIS practitioners.

CHAPTER FOUR: Reflecting on the ‘Job’ of GIS

SECTION ONE - Introduction

The intent of this chapter is to critically assess and ground literature (as discussed in Chapter 2) on collaboration, sociality, agency, assemblage and the ‘doing’ of GIS in the context of GIS practitioners at the consultancy Environment Systems. Scholars have noted – and sought to refute – that GIS has been most often cast as a solitary practice, “developed for use by individuals”, (MacEachren, 2001, p. 431). However, Ramsey (2008) (as discussed in Chapter 2) has noted how collaboration in GIS practice can foster better decision making, the development of shared understanding, and the establishment of common goals for all parties. For MacEachren (2001), the affordances of distributed information systems can aid collaboration in GIS, allowing users to work together discuss and making decisions. Relevant to this collaborative/solitary issue in GIS are ideas relating to sociality, insofar as individuals associate with others and form cooperative groups.

At a broader level, and reflecting upon critical GIS literature from the early 1990s, Kwan (2002a) notes that the critical agency of GIS users is often overlooked. Moreover, the absence of a feminine perspective led to a deficiency in understanding the everyday experiences and agency of GIS users. Kwan notes how she was able to exercise her own agency by collecting her own data and developing her own bespoke algorithms. For Anderson & McFarlane (2011), however, assemblage is a productive way to think about the *situatedness* of that agency. In the broadest sense, assemblage is about understanding co-functioning of differently constituted elements to manifest agency and affects in ways that are more than the sum of their parts, often in unanticipated ways (ibid.). Dewsbury (2011) finds assemblage a useful alternative to Euclidean thinking, an ontology that allows us to follow connections between objects without losing sight of the objects, and most importantly for understanding affect. For example, Barratt (2011) uses theories of assemblage to understand the practice of rock climbing as an assemblage of human body, rock, and climbing kit, but also notes how the climbing body emerges from multiple agencies and affects, such as improved strength and familiarity with rock shoes. With pertinence to GIS, Richardson and Bissell’s (2017) attention to the micro politics of digital skill allow them to gain a sense of the situatedness of the materialities and practices of digital work, shifts in the distribution of agency between body and technology, and the question of how workers become familiar with and intuitive of digital work. In seeking to ground these ideas through my own practice-led research, I sought to answer the question of how, then, would GIS practitioners consider their particular agency, as well as the context within which this agency emerged?

In this chapter, I focus on the data collected from a series of interviews conducted at Environment Systems with the aim of understanding the “what” of GIS via a consideration of how GIS practitioners articulated their own daily practice. In carrying out the interviews, I decided to take an unstructured approach; that is, rather than beginning with a specific set of questions for the participant, I instead elected to encourage the interviewees to carry on their work as usual and to talk to them about each task as it was undertaken. This interviewing method sought to capture something of how participants imagine and practice GIS. That is, I wanted to draw out and focus on these active reflections, undertaken while immersed in the ‘doing’ of GIS, as moments, albeit prompted, through the interviewing process itself, when GIS becomes visible in a particular way. I was especially interested in exploring how GIS becomes visible as a demarcated practice – “I am doing GIS” – with given attributes and undertaken as an exercise of agency. This sense of an agency in turn lends a sense of ownership – “this GIS practice is mine” – to the events being discussed, as well as, by extension, a sense of connectedness to particular objects and paraphernalia necessary to undertake these practices. Furthermore, my aim was to encourage new dialogues to emerge from these interview situations (Mohan, 1999; Crang, 2003; Sin, 2003; Anderson, 2004). That is, my role as interviewer was crucial in helping construct these reflections: I found myself encouraging the articulation of these reflections, thus ‘co-producing’ in effect reflections on, for example, the visual literacy skills being manifest, the management of time and effort, the routinisation of ‘doing’ GIS, and the corporeal dispositions through which ‘doing’ GIS was accomplished.

After reading literature relating to GIS practice (such as Schuurman 2002; Elwood & Leszczynski 2011; Sui 2014; Goodchild & Longley 2014; DeLyser & Sui 2012; Sui 2004; Philo et al. 2008; Preston & Wilson 2014- see chapter 3), and more specifically literatures around collaboration (MacEachren, 2000, 2001; Ramsey, 2008), sociality (Dave, 2007; Paay, Dave and Howard, 2007), and technological mediation (Wilson, 2011; Kinsley, 2013; Leszczynski, 2014) I had drawn out and reflected upon a series of thematics that helped characterise GIS as a practice. That is, GIS was:

- Social and Collaborative – This thematic refers to the ways in which GIS practitioners at Environment Systems work together to do their job. MacEachren’s (2000, 2001) reports on GIS focuses specifically on this theme of collaboration in GIS. Similarly, I sought to address how decision making, generating shared understandings, establishing common goals, and building comradery was facilitated by intermittent discussion and small talk between employees (in person, via *Skype*, and email), but also how GIS practitioners described negotiating and collaborating with stakeholders and partner

companies (sharing resources, organising logistics, presenting updates). Furthermore, I paid attention to how individual employees at the offices of Environment Systems are grouped in a way that ‘makes sense’ in terms of different skillsets and expertise so that they know where to go for help.

- Digital Work – Here I looked to extend Richardson and Bissell’s (2017) discussion of the micro politics of digital work. I looked to cast the work of practitioners at Environment Systems as engaged in ‘digital work’. As shown below, a consideration of these issues led me to draw out how GIS practitioners negotiated working with large amounts of data as part of their job. This data takes many different characteristics such as file size, file format, sensitivity of content, level and type of aggregation. The data is uploaded, downloaded, and processed in different ways according to these characteristics. In particular projects a lot of work is put into cleaning data – such that computer script is written, or workers have to spend time deleting unreadable data, adjusting the formatting of tabulated data so that it is useful. As such, ‘digital work’ at Environment Systems is characterised by activities involving perfecting workflows, creating automations, doing ‘boring’ or monotonous work and so on. Following, Richardson and Bissell (2017), I looked to foreground how practitioners became familiar, and intuitive, but also how they negotiated demands on time, felt reassured in success, and exercised an individualistic sense of agency by taking ownership of their intellectual contributions to the company.
- Mediated –Here, I focused on how the activities of GIS practitioners at Environment Systems are technologically mediated. This involved human interaction with a computer, screen, mouse, keyboard and other computer peripherals, as well as the ‘invisible’ paraphernalia of operating systems such as *Windows* and *Linux*, software packages such as processing software *ARCGIS* and *QGIS*, statistical analysis software like *R-Studio*, and presentation software such as *PowerPoint*. These interactions in turn depended upon embodied skills such as typing as well as forms of visual, textual and numerical literacy that simultaneously allowed data to be worked with and the media to fade into the background. In what follows, I pay attention to the ways in which GIS practitioners at Environment Systems articulated their relationships to the technologies of the GIS office. I draw attention to how practitioners responded to and made sense of the technologically mediated sensations and trajectories of interfacing materials (Barratt, 2011) they encountered in the everyday of their job. They are conscious of their own workspace, how they lay out software applications across multiple screens,

configure their bodies, and order their thinking processes to make best use of the materials available to them. I was also interested in how the GIS office at Environment Systems, “shape[s] the bodily capacities (and bodily shapes) of ... users” (Ash and Gallacher, 2011, p. 361). Furthermore, I paid attention to how the vision of practitioners is constructed in tasks that involve becoming familiar with landscape via aerial imagery, EU codes and categories. This is a governmental technocratic gaze; or as Wilson explains, “the technology of assessment becomes implicated in their visioning of the urban scene” (2011, p. 370).

- Assembled – I take the situatedness of GIS practice to emerge from within an assemblage of types of skills and proficiencies, objects and their capacities to affect, and the relationships between humans and non-humans. GIS practice emerges from the performance of all of these elements. As shown below, there is no singular GIS skill set. Rather is it made up of a range of proficiencies relating to various types of computer technology (e.g. programming, the operation of specific hardware, familiarity with software), scientific thinking (e.g. marine biology, ecology), data analysis techniques (remote sensing, statistical analysis), and so on. This thematic casts GIS practice as an assemblage similar to Barratt’s (2011) climbing body. At Environment Systems, this assemblage is co-constituted of situated interactions between GIS software applications, computer hardware, disciplinary knowledge and proficiencies, human bodies, office furniture and so on. As such GIS practice is not what the user does to the computer, but what the entities that constitute the assemblage co-produce. GIS practice emerges from multiple agencies and affects, notably antagonisms such as the tediousness of repetition, and the discomfort expressed in having to correct errors in programming. Therefore, this assemblage of GIS practice emerges from the co-functioning of differently constituted elements to manifest agency and affects in ways that are more than the sum of their parts, and often in unanticipated ways (McFarlane and Anderson, 2011).

After I undertook more interviews, what became visible were the more nuanced qualities of GIS practice. That is, these dialogues revealed the doing of GIS practice as much through what was not talked about, as what was. Notable absences revolved around the following:

- Accounts of doing. The practitioners reported endless chains of “and then... and then” type procedures. There were accounts of active process, where things were ‘run’ and ‘analysed’, and more passive doings, such as sitting and staring. Nevertheless, there was

an absence of depth and detail in the interviewees' reflections as to what they were indeed doing.

- Repetitive decision-making. From my perspective, the interviewees spent a great deal of time making decisions about how to process data. Yet what was particularly interesting was the way in which these particular decision-making processes seemed invisible to the interviewees.
- Accounts of components. Despite the fact that the GIS space that they were working with was rich with objects (desktop computers and servers, networks and terminals, people and teams, workflows and tasks) all intertwined with each other, these were not commented upon until considerable prompting from me.

These themes – i.e. what is absent – are very much part of an embodied knowledge of GIS that would gradually become visible, and subject to active reflection, through my questioning of participants.

In what follows, I narrativise some of the dialogues undertaken. There are a number of reasons for using this particular method to present my research data. Firstly, narrativising allows the reader to encounter these dialogues in a way that somewhat emulates the processes of events unfolding across time and a particular space. Narrativisation of these dialogues also allows me to isolate specific chunks of time, such as moments of intensification, around a particular practice. Additionally, narrativising allows me to tell the stories of these dialogues as the emergence of something new (Lorimer, 2003; Mitchell, 2003; Wylie, 2005; Lawson, 2011; Cameron, 2012; Parr and Stevenson, 2013). Moreover, by explaining and framing these dialogues in a narrative, my intention was to eradicate the sense that these are “types” or caricatures of GIS practitioners. The following are participants I have chosen to expand upon.

- Jamie is a technical manager and remote sensing specialist. Jamie has a PhD in radar remote sensing and an undergraduate degree in archaeology. Jamie is responsible for most of the digital processing carried out by Environment Systems.
- Colin is a data analyst working in agricultural remote sensing. Colin has an undergraduate degree in geography and a masters' degree in GIS and remote sensing. Before working for Environment Systems, Colin was a research assistant working for a local authority surveying its coastlines.

- Rachel is an Environmental GIS consultant working for the GIS consultancy. Rachel has worked for the company for five years following her undergraduate degree in environmental earth science. Rachel learnt all that she knows about GIS on the job.
- Mike is a GIS analyst at Environment Systems. He is responsible for GIS support. He helps generally with queries relating GIS software. Mike does not have a degree; instead, he became adept with GIS working for local government before working for the GIS consultancy.
- Steven is an IT manager. He is a computer science graduate but has no specific training in GIS technology. His day-to-day tasks include such things as making sure backups and servers are running and installing updates and software patches.

Importantly, I have anonymised to a degree the identities of the individuals in these narratives for a number of reasons. Firstly, I am concerned to ensure that I only draw out what is necessary for the study. Although I have included a brief biography of the participants involved in this research as it is useful to know the backgrounds of my participants, I have made sure not to include more detail than is necessary to establish their significance in this research project. Furthermore, for some organisations that took part in my study, the protection of their intellectual property was of significant concern. Therefore, I must bear this in mind and be respectful of their IP.

I recorded interviews using a sound recording device so that they could be transcribed later. To accompany these sound recordings, I took photographs of the participants and their workspaces using a DSLR camera and, in some instances, I set up my smartphone to take photographs at regular intervals throughout the interview. These collections of time-lapse photos focused on very intimate spaces such as the space occupied by the participant's hands on the desk or their face. I also took extensive field notes pertaining to participants' actions, descriptions of the day-to-day working of the various sites (paying attention to hierarchical structures and more general observations framed as snapshots in time of specific sites), lists of materials at work, and sketch maps of the site.

SECTION TWO - Three Hours of Things Not Working for a Remote Sensing Specialist and Other Stories

Jamie

Jamie is a remote sensing consultant who, as an undergraduate, studied archaeology. Jamie became involved in remote sensing when he undertook a GIS module as part of his undergraduate degree. Following this, he decided to embark upon a master's degree in remote sensing in order to complement his academic qualifications in the field of archaeology. After a PhD Jamie worked as a freelance remote sensing consultant before moving to his current job just over three years ago. What Jamie particularly enjoys about his current job is the opportunities he has to do many little projects.

In total, I spent about three hours talking with and observing Jamie working with his computer. For the duration of our discussions, I sat alongside Jamie as he worked on a number of tasks. As we began our session Jamie introduced me to the software that he would be using today and by explaining that we would be “doing some mosaic work” (Jamie, Remote Sensing Consultant, 20/08/2014) today. He noted, “It just gives the best results.” (ibid.) Jamie has a corner desk in a room that he shares with the three other members of his team. He sits on an average-looking office swivel chair with his shoes removed. His desktop setup – from first appearances – seemed quite typical of an office worker. It consists of a desktop PC, a full QWERTY keyboard and a mouse. The only exception to the norm is the addition of an extra monitor, an extra that seems to be quite common upon looking around the offices. I am later informed that this makes that require the use of multiple applications easier to manage.

As Jamie talked me through his activities: open this software package, find this file, access files from such and such server: his descriptions are interspersed with moments of silence when Jamie does not narrate his actions. During these periods, I become aware of the other sounds in the room. There is the sound of other workers talking as they enter the room, or the sound of the team manager in the background speaking to a client on the phone. He is adopting a tone I interpret as very business-to-client. Infrequently, I can hear the sound of sirens coming from the main road that runs adjacent to the science park. It is worth noting that this routine ebb and flow of the office felt like a significant part of Jamie's situation. Jamie and his team have a very particular focus, that of agricultural remote sensing. As such, this office is a collection of skills and proficiencies embodied and mediated by their proximity. However, it is important to note that the space of the office has other accidental qualities that might be considered fallout from the primary function of this arrangement of people. In other words, the objects that mediate

and facilitate work also do other things to the environment, for instance make noise, distract attention, and hurt eyes. A good example of this is how I experienced Jamie's interactions with the mouse through the sound it made, as he flicked the scroll wheel, grabbing and dropping as he dragged the cursor right across the screen.

Early in our exchange, it became apparent that the theme of our discussions would be that of things going wrong. It emerged that, while Jamie manifested a number of emotional responses to the software generally not working or not responding the way in which he expected. Jamie was in fact quite prepared for this. As much as he complained how embarrassing the situation was- that I was here to observe a professional and that he could not get the software to work as expected- he seemed to be quite composed. He was able to adapt his workflow with ease, which lead me to believe that he was used to doing this kind of problem solving work.

However, throughout our conversations Jamie would make comments under his breath often referring to his frustration with the software he was using. Sometimes he would explain relatively calmly the technical reason for his difficulties, on another occasion he put his face in his hands pretending to cry (Figure 38). I noted in my fieldwork journal that I felt Jamie's manner of sharing with me his frustrations with whatever piece of software he happened to be using as well as a general less-than-optimistic demeanour towards his whole set of computerised tools was actually part of an overall coping mechanism or essentially an integral part of how he performed GIS. An interesting thing about Jamie's performance was the way in which he managed to fuse this emotionally stressed disposition with a methodical and focussed approach to problem solving.

Without prompt, Jamie told me that his favourite thing to do at work is coding. He explains that he enjoys making things work.

“My favourite job is almost not doing this, it's coding because I just enjoy that feeling of just battering through something, solving a problem, and you know you're almost kind of creating something when you're doing that. You know it's so satisfying when it just runs.”
(ibid.)

In this quote, what Jamie is alluding to is how he enjoys the process of writing computer script. He enjoys the hours spent paying meticulous attention to lines of code, learning how to do new things with the code, how to be articulate with the code, how to be precise; in sum, becoming absorbed in this very singular and focused activity. This passion for making things work seems to extend into his attitude towards efficiency tasks such as reducing time wasted repeating tasks that can quite easily be automated. Jamie is always looking for an opportunity to streamline his



Figure 37 - Panoramic photograph of Environment Systems office

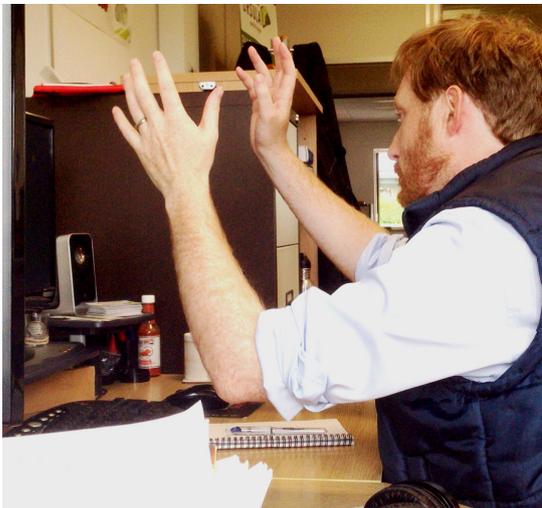
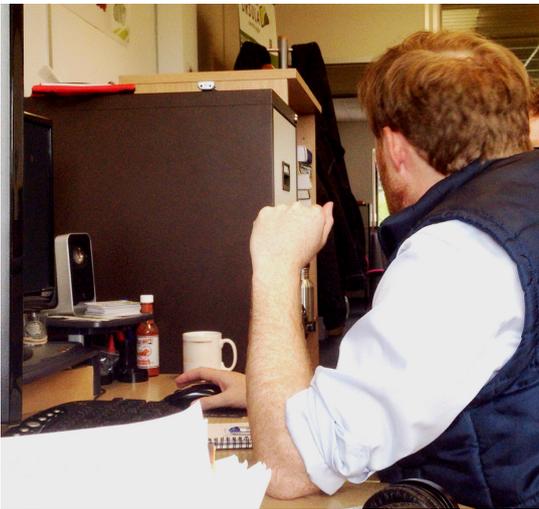
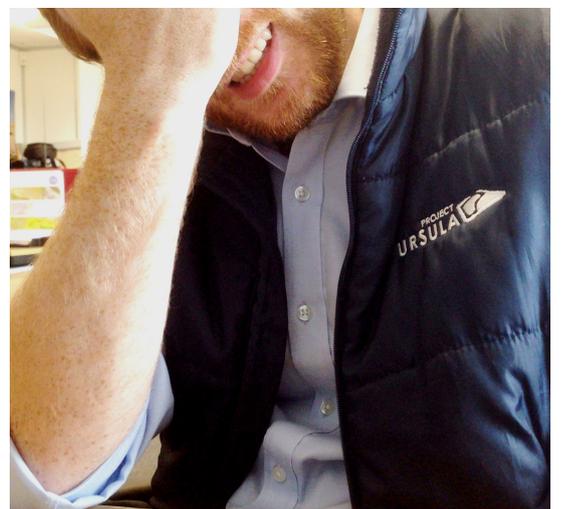


Figure 38 - Stills from Time lapse Photography taken whilst interviewing Jamie



workflow and reduce wasted time and energy. He has an insight into how tech can assist automation and he enjoys deploying these skills. Jamie even describes to me a scenario in a previous job where he could not resist the urge to design a better system for himself and his colleagues, a new system that did not require our hours of human labour. One thing that was later interesting to reflect upon in my fieldwork journal was how Jamie and I found common ground in this passion for making things work. We shared stories about how we found this extremely satisfying but also frustrating as our colleagues sometimes resented our efforts.

Jamie often fell into periods when he would not talk to me very often but would talk to himself. To observe this was rather interesting. It felt to me as though pieces of his thought processes were sometimes falling out of his mouth. They did not seem to make much sense to me. In amongst this patchwork of utterances were statements like “this folder here” “see what that gives us” and “just do a final check” (ibid.). Frequently he would punctuate this stream of consciousness with words like “okay” (ibid.). I could tell that these “okays” did not denote solving a problem but served as a mental place marker for a piece of information identified, a piece of the puzzle located, even if he did not yet know where it fitted.

For me, comments like “okay” and “this folder here” (ibid.) exemplify the body becoming a site where GIS is done. It was as though Jamie says these things to serve as verbal markers to himself. Some of these utterances seem to serve as a kind of reward to himself, and he appears to be congratulating himself; some utterances seem to mark a point in time where something is done, by saying it aloud, perhaps he is more likely to remember it.

Utterance Spoken	Emotional coding
“If I edit...” (ibid.)	Assertive “I have the answer”
“I know what we’ll do” (ibid.)	Hopeful
“Try the other two” (ibid.)	Be patient “there is a solution”
“This is really baking my noodle now” (ibid.)	Accepts frustration

Table 4 - How I understood Jamie's utterances

In some instances, the utterances that Jamie makes to himself are a way for him to employ some level of control over a situation. By saying something aloud, he appears to be telling his body things are under control. When someone talks to himself or herself in this way, I imagine they are making a mark in time — almost leaving breadcrumbs along a path. The reason for doing this is that often the user gets lost in the process without clear signposts. It could be argued that this verbal signposting, leaving breadcrumbs, is a way of constructing an embodied archive. Jamie is leaving a mark on himself by uttering these words. One might, perhaps, read these short

utterances as different ways of coding instructions to the body. In Figure 39 I sketched out my thoughts on the kind of things that Jamie might be telling his body.

Similarly, whilst concentrating on his work Jamie would frequently mutter numbers under his breath, reading them from the screen and sometimes noting them on a piece of scrap paper. Later, in reflection, I played with the idea that in these moments Jamie is caching the information away from his short-term memory so that he can concentrate on the problem-solving exercise at hand. Here Jamie is, writing down a number so that he does not need to concern himself with the act of remembering in the future, freeing up cognitive resources in his brain in order to better utilise them for problem solving.

This is another example of how different objects mediate his practice and it also shows that such objects range from the computerized (software such as notepad) to the extremely low tech (a pen and piece of scrap paper). What is more, I found it intriguing to wonder how Jamie makes the decision to write down a number on a piece of paper, try and remember it in his short-term memory, copy it into a text document, or just say it out loud. Figure 39 shows how I imagine this thought process or how the decision is made. However, what I find most interesting here is how these kinds of decision-making processes are almost invisible when observing the GIS practitioner. Logical decisions similar to that explained in are made almost constantly, yet the active reflections each demand seem so internalised as to be invisible.

At one point Jamie warned me that, “if we don’t get them right then we’ll have more pain later on in the process.” (ibid.) Here, Jamie is referring to the frustration that he anticipates later in his workflow if he does not do his work properly. He must be accurate with the details to prevent the likelihood that any mistakes will hinder progress later in the process. For instance, if he forgets to enter one line of code this may mean that when he goes to run the programme later, there may be a number of consequences all of which may result in a frustration. Practicing GIS does have the ability to inflict pain on the user in a number of different ways. For instance:

- i. If the program does not run, he will not experience the satisfaction usually experienced “when it just runs.” (ibid.)
- ii. This may lead to more hours of frustration sitting trying to troubleshoot the issue.
- iii. He might not have time to finish a job to make a deadline.

These are just three examples that could cause increase the likelihood of stress. Other risks include physical injury from sitting in one place for prolonged periods. On this subject Jamie is particularly well versed and talks for some time about the practical considerations that he feels he needs to take in order to work as a human, a body (obviously not with this terminology),

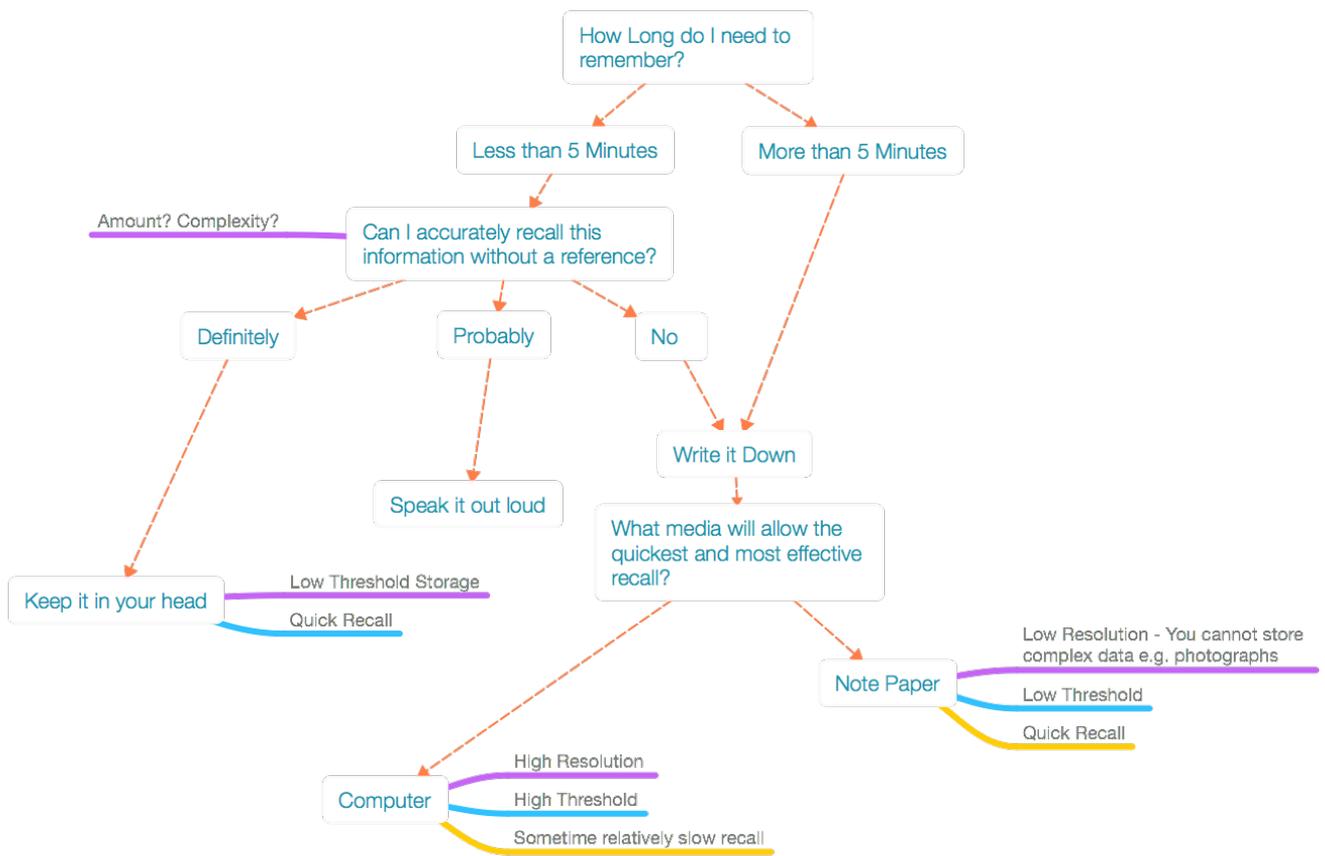


Figure 39 - Flow diagram to illustrate how I imagine these invisible decision-making processes

with a desktop computer. Jamie mentions certain considerations he has to make in order to look after his eyes. For instance, his workstation is orientated in relation to the window so that he does not get glare from the window. Because of this potential of physical damage, Jamie told me how he has learnt over time to mitigate the risk of being injured when doing his work.

“I’m quite funny about getting my chair set up right. Yeah, about getting my set up comfortable. I have had a bad back in the past so, erm, yeah, I guess that’s why. I’ve just learnt over time how to make it as well set up as I can.” (ibid.)

Jamie made a point of telling me how distinctive his skillset is in the company. He tells me that, “I’m the more, my role here nowadays is kinda being the more technically minded ‘cos of my background.” (ibid.) He explains that he is not an ecologist or a geographer and that he is just trying to make a measurement. He is keen to tell me that he does not care about habitats or ecosystems; to him the images that he analyses are just grids of numbers. His job is just to make sense of that data. Jamie tells me that the nature of his skill set, unlike others in the company, means that he is always approaching his subject material “through abstracts” (ibid.). He elaborates, explaining that he is simply, “taking measurements through the electromagnetic spectrum of what’s happening on the ground.” (ibid.)

I asked Jamie does it matter, in his mind, whether the material is spatial. I explain that I have observed some of his other colleagues working, and in some instances, it seems that the spatial aspect of their data seems completely incidental and the main challenge of their work is either pattern recognition or cleaning data. To which he responded, “It doesn't matter what the image is. What I'm looking at is its colour, shape, you know, of features, trying to get aligned with the control points ... It doesn't matter that it's spatial.” (ibid.) This quote goes a long way to explaining a significant proportion of Jamie’s particular skill set. There seems to be some elements of logical problem solving in relation to making his workflow more efficient but also a significant proportion of what he describes as analysis. This involves a great deal of time spent of negotiating the relationship between the received imagery and the reality of the real-world flight path of the drone that collected the data.

It is in this type of work that Jamie must work with his computer and other technological objects. Here Jamie, in effect, shares the task, the production of knowledge with the machine; Jamie’s work here is mediated through an array of technological tools. In some instances, Jamie’s human knowledge of the world or environment becomes useful in completing the task. For instance, at one point Jamie must align a series of drone images of a farmer’s field. Jamie uses his knowledge of the world, knowledge that the computer does not possess, to identify points where the images overlap. In this instance, he understands that tractor wheelings in a field have

the potential to be distinctive enough so that he can recognise where the images might overlap. Here Jamie has deployed skills not just in pattern recognition (something that the human brain seems adept at doing) but also in knowing that the tractor wheelings would be distinctive enough. Jamie understood that the tractor wheelings are unlikely to move, there are consistent and distinctive enough i.e. different from the general rocks and soil enough that the human eye can recognise them in a number of different images likely to be taken from a number of different angles. In this situation, the computer would have difficulty doing this on its own and therefore relies on the pattern recognition ability of the human brain. Whichever way you look at it whether the human is assisting the computer, or the computer is assisting human he/she becomes a kind of cyborg in the process.

Jamie's work is mediated by his use of two monitors. All colleagues working in the office have two monitors connected to their desktop computer. Different colleagues expressed different attitudes towards them. I noticed that Jamie rarely used his second screen and asked him about it. He told me that, "I don't like being spread across two screens." (ibid.) On reflection, I thought this an interesting response for the reason that he chose to say that *he* did not like to be spread across the screens, rather than he did not like his *work* to be spread across two screens. As if he himself might be literally spread out, spread thin, without focus across the two screens. Perhaps I can take from this that Jamie much prefers to have his attention on one thing at a time without distractions. Jamie has chosen to use the second screen to house anything that he sees as separate from the current task. Jamie uses the second monitor to display his emails, his *Skype* window, and his calendar. In this way, the second screen mediates his organizational materials by allowing a spatial arrangement that also allows him to focus when he needs to.

For most of our time together, Jamie seemed focused on one task. However, it would be misleading to imply that his practice was therefore simple. Jamie's workflow is not one of a constantly planned-out chain of events but, rather, a semi-chaotic arrangement of tasks, some expected, some unexpected. For instance, incoming emails often interrupted the flow of our conversation; this in turn would often initiate some kind of emotional response depending on the subject material of the email. He would sometimes shout across the office asking his colleagues for their opinions on the email. Indeed, the main reason for Jamie to stop working would be to converse with his colleagues. Communication was mediated via a number of different platforms: sometimes a colleague might ask a question via a *Skype* instant message, sometimes an email. Infrequently, light conversation would break out amongst Jamie and his colleagues. These conversations were very limited in scope, but it was apparent to me how they

contributed to Jamie's emotional disposition. Short conversations usually only lasting two to three exchanges would involve the following:

- What people were eating
- Sharing collective dislike of a camera manufacturer
- Asking a colleague if they had seen an email
- Saying hi to someone coming from another office

Although some of the conversations Jamie would have with his colleagues were about work, quite often they would be arbitrary. This led me to believe that for the most part the primary purpose of these exchanges was not to gather information that would assist in whatever GIS or remote sensing task he was doing at the time but rather just as a way of breaking up periods of intense concentration. That is, social activity often served the purpose of improving Jamie's emotional disposition. Moreover, Jamie's conversations with his colleagues show how the office space mediates a pleasant working environment because of proximity to other people and, furthermore, facilitates the coming together of different skills and proficiencies so that they may be drawn upon by others.

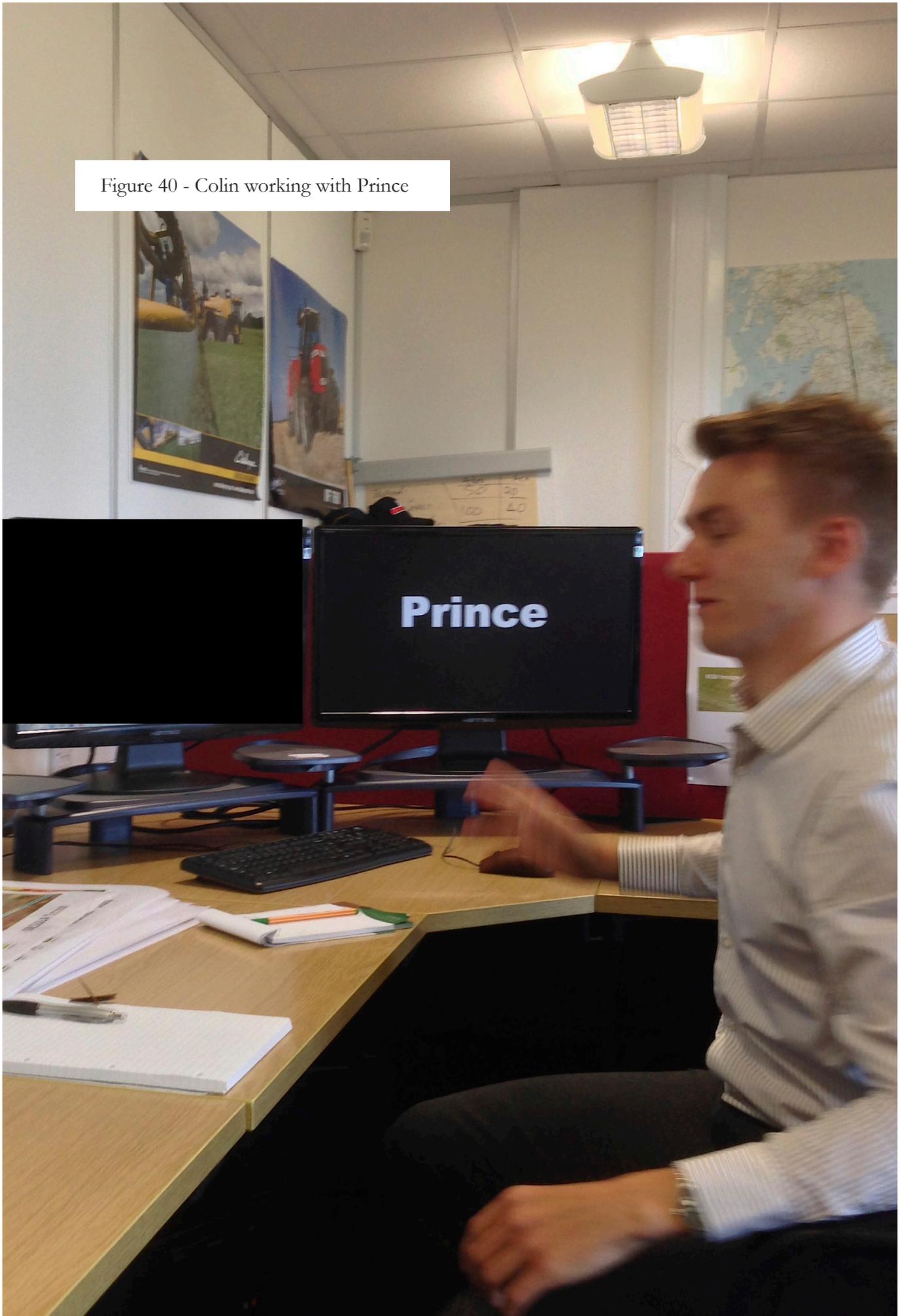
Colin

It is all its very innovative, you know, sort of on the forefront of a new technology, so it's quite exciting. People are very enthusiastic about what we do, oh you know, it's great. You feel like - oh I don't know how to describe it - you feel like you're doing something quite good in terms of bringing new technologies to agriculture. (Colin 15/08/2014)

During my time with the company Colin was the first person that I interviewed. He had come to work for the company after studying remote sensing at the local university. He told me that it seemed like quite a natural and sensible progression. He studied geography at A-level then did it at University. After particularly enjoying a human geography-based GIS module as an undergraduate he decided to do a master's course in GIS.

When I was introduced to Colin, he was sitting on a regular office swivel chair at a desk working at a computer. His posture suggested to me that he had just arrived at the desk having pushed himself across the office on the chair. This was a fitting introduction as it seemed that much of Colin's time is spent skidding around the office in this manner. Today Colin was working with the three main analysis computers in the office. Dusty and Prince (the computer he was currently sitting at), were on one side of the office and Elvis was on his own on the opposite side of the room. What was interesting to me was how such an array of objects had immediately

Figure 40 - Colin working with Prince



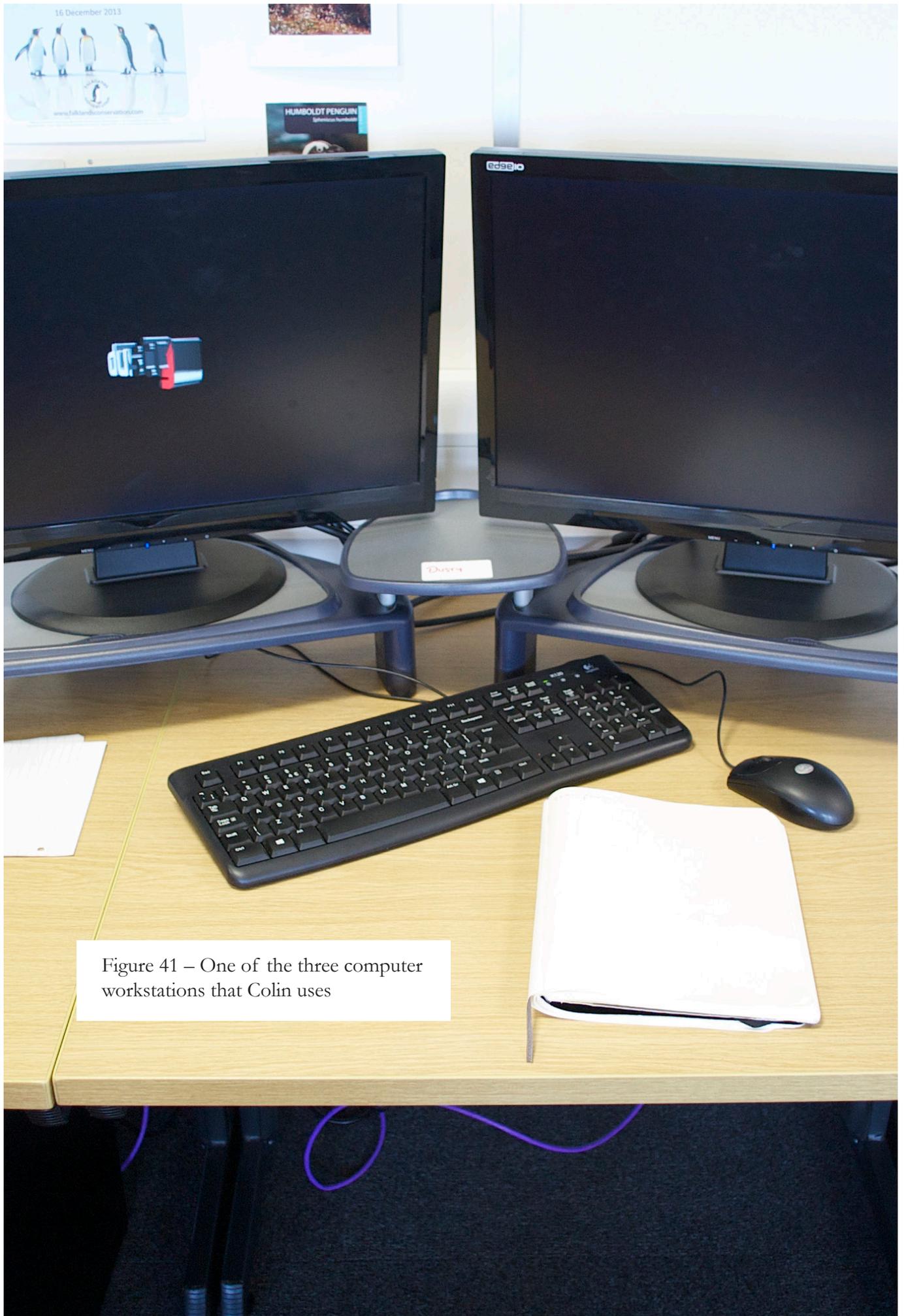


Figure 41 – One of the three computer workstations that Colin uses

come to the foreground as mediating Colin's practice. We had a swivel chair, some desks, many computer monitors, computers themselves (with names, Figure 41), keyboards, mice, the floor, the carpet tiles, Colin's body all coming together to do GIS. This is how Colin explained it:

I'll do some analysis on this machine, for example, and then once the analysis is complete on this machine, I'll go to that machine and do some more analysis ... the main reason for that is the processing is quite intensive on the machines and those machines are slightly differently specked for different operations. So these are more for processing, these are more for GIS analysis. (Colin 12/08/2014)

In Colin's current workspace different types of computer processing tasks are dispersed spatially by design. Each computer, which has a fixed location, is always assigned a particular task in the workflow according to its specification. This means that users are required to physically visit, that is, move their bodies through space, in order to access and make use of them. Most other users made use of headless computer units, gaining remote access to files and processes via the network or through a server, sometimes even via the cloud. Therefore, we can say that Colin's manner of interacting with these three computers was unique in the office.

Despite moving from computer to computer, most of the tasks that Colin performed seemed to be quite repetitive. He told me "everything is essentially run through Arc Map." (ibid.) However, later he does note that a great number of other types of software are used. Colin told me that alongside the usual proprietary GIS software *ArcGIS* that is on all computers in the office, he often uses free-to-use software such as Google Earth and Street view. He told me Google Street view is particularly useful to check access when tasking the flight team.

Colin gave the impression that he enjoys the logistical parts of his job. However, Colin found it difficult to hide his fondness for fieldwork. Colin spoke fondly of his previous job working as a research assistant for a local authority looking at the sea defences. He told me he enjoyed doing lots of outdoor work. Throughout the conversation I noticed that Colin frequently speaks more enthusiastically about the time he spends outside the office.

After my introduction to Colin, I explained that I would just like to get a sense of what he was doing in the field of GIS, I told him that I would observe him as he worked and ask a few questions. Colin returned to his work, frequently feeding me explanations. He would tell me he was just processing some aerial imagery using a particular piece of software and would often check my knowledge with questions like, "are you familiar with Arc?" (ibid.) Colin's job seemed quite varied. He would spend periods not saying anything. During these moments, it was obvious he was concentrating deeply. As opposed to Jamie, Colin seems to be more heavily

involved in the delivery of the final ‘data products’. Colin demonstrated this with the enthusiasm he expressed when I asked to see examples of these ‘data products.’ Colin spoke more about working towards deadlines and being in close communication with the client than Jamie did. He also tells me that he is in charge of tasking the sister company who fly the drone. He told me how he liaises with aviation control and then sends the job to the company. More than anyone else in the team, Colin seemed particularly concerned with the overall workflow and how they, as a team, deliver products to the client. I asked Colin to describe, in simple terms, how the team does work. I asked him to describe the workflow. The following is what I noted:

1. Information arrives from flight team on the hard disk.
2. That data is uploaded onto the server.
3. That will then get disseminated.
4. It will get split onto different machines.
5. Then they will go through the different tiles on the computer called Dusty. This is stitching. This might take about two hours.
6. They then use a different this computer (Prince) to do analysis on it.
7. That is then packaged up.
8. And sent to the client.

Similar to Jamie, Colin’s described workflow seemed to contain hidden actions. After noting down the preceding set of activities, I asked Colin to elaborate on certain elements. I asked, what does it mean to ‘do analysis’? I noticed that all participants frequently reported carrying out analysis on data. From my perspective, this activity – ‘doing analysis’ – seemed like an integral part of practicing GIS. The following, taken from the transcript of Colin and my discussions, demonstrates my attempts to get Colin to unpack ‘doing analysis’. Furthermore, this passage shows Colin’s reluctance or difficulty in doing so:

- Colin: ...then basically on to that computer over there and put it through the analysis.
- Philip: Yeah, that’s a thing that keeps being mentioned: ‘so like what we can do, is do analysis.’
- Colin: Yeah.
- Philip: What does that actually mean? What are you doing when you're doing analysis?
- Colin: Well it’s sort of deriving the data products from the imagery. So, like this multispectral data shows a different productivity.
- Philip: Yeah.

- Colin But we never send that that layer to the client because they're not remote sensors. They won't understand it. So, we're basically, we sort of interpret it and give it to the client in a format that they can use and understand. So, it will be like a vector layer, essentially, of say, one five by ten metre grid, and then with an average productivity score for that area.
- Philip So you're saying, I guess you having done this a number of times, you can look at that and kind of go: 'ah that's that, oh I can see what's happening there,' and stuff?
- Colin: Erm.
- Philip: To an extent?
- Colin: Yeah essentially, erm, you can see it is not a great image to look at but obviously it has not been put together. But I mean I think you can see river channels coming through this, these fields' old river channels.

Throughout my time speaking with Colin, he spoke positively about his job. Both Colin and Jamie describe how their job gives them satisfaction. When I asked Colin to tell me what found most interesting about his job he told me how liked being 'at the forefront of a new technology'; he also explained how rewarding it felt to have his work recognised in the industry. What is interesting, and perhaps downplayed by other interviewees, is how important it was to feel as though their work is worthwhile. In one instance Colin even goes as far as proclaiming that he feels as though he is doing something overtly good by bringing 'new technologies to agriculture'. For me, these practitioners finding emotional attachment to or ownership of their work is an important part of a fruitful GIS practice.

Rachel

Rachel is an Environmental GIS consultant working for the GIS consultancy. She has worked for the GIS consultancy for five years following her undergraduate degree in environmental earth science from the local university. Rachel learnt all that she knows about GIS whilst working here.

...you collect lots of data, do lots of cleaning of the data and then build a big broad base where you score it all, rasterise it, combine it, and end up with various outputs. Then have lots of fun presenting to stakeholders again, getting people on side, getting people to understand and actually try and get them out there ... (Rachel 19/08/2014)

When we began our session discussing her practice, I could see that Rachel was doing some work with *ArGIS*. She told me that she was doing a little data cleaning. I asked what this data was for and she replied, "I'm thinking of the environment in terms of services rendered to man"

(ibid.) and getting people to understand “multi benefits” and “recreation resources.” (ibid.) Rachel used this manner of speaking frequently and I found it difficult to understand. I found the terms Rachel used dizzying but insightful. For example, I would imagine that “recreation resources” means parks and nature walks etc. In this instance, I think Rachel is so used to a certain mode of talking that it has become integral to the way in which she thinks about the environment that she studies.

As well as frequently using such words Rachel tended to describe her work in terms of scientifically testable statements such as, “There are more birds here because it had lots of natural habitat anyway.” (ibid.) This constant hypothesising was relentless. In this instance the way in which skills are assembled, that is, via certain manners of communication, causes friction in our exchange as an outsider interviewer and insider interviewee. It did not make things impossible, or particularly difficult, just awkward. However, I began to think, how does Rachel’s conceptualisation of the environment she is studying differ from how I or someone else would encounter it?¹

The way in which Rachel described her activities often required a little unpacking in order for it to make sense to me. In some instances, I would ask her ‘what are you doing?’ and not unlike Colin she would respond with words such as ‘spatial trends’ and refer to specific software actions such as ‘using a spatial select’. Sometimes more could be revealed by slight verbal prompting such as just saying ‘okay’, encouraging her to elaborate or just talk more on the subject. In this way, I found that my participants’ practices became more visible not just by asking them to explain what they mean but by adding more context. The following excerpt from my transcripts details a discussion that Rachel and I had about how she prepared her data for analysis:

Philip What are you doing?

Rachel Currently I am, say, the Scottish agro-environment thing, we're looking at spatial trends in the data as well.

Philip Okay.

Rachel So I'm just tagging the farms with whether they're upland, lowland, or marginal. Erm, so then I can join that to the data to pivot it again, and see trends appearing across.

¹ The question here is how does the world that Rachel describes as made up of ‘multi-benefits’, ‘recreation resources’, and defined according to formulated hypotheses compare to the world experienced by a hill walker, or a runner, by an HGV driver, a farmer or a bird of prey? Or even a trout in the stream or toddler on the swing or an airline pilot or a blind man with a cane?

UK & BATES
12th Aug 2019

Use to
address
usability
needs
and
itself

Data	Arch imag	Host imag	DTM	AP ESB CIR	4 2	PK P D	habitats	UKS.
Scotland	✓	✓	✓	✓	✓	✓	X	X
NYM	✓		✓ <i>Airbus</i>	✓	✓	✓		<i>rivers hops graps 1st 1/2 Aug</i>
York dales	✓	✓	✓	✓	✓	✓		X
N/umb	⋯	⋯		✓	✓	✓		3 sites test

Figure 42 - Table written on the whiteboard to track the procurement of data of different types, from different sources



Figure 43 - Rachel demonstrating how data is sometimes received

- Philip So what sort of actions does that involve? Like with the, if you could show me what...
- Rachel Yeah well what I've done so far - because this dataset, the background datasets a bit broken - I can't work out why. Tried doing a clean and it did some funny things to it. Hello you. Alright. Broken, and I can't see an easy way to fix it, so decided it was quicker to just go for a manual, and there's not many classes, so use a spatial select to tag all the, erm, the polygons that are clearly within, so now just going and cleaning up the ones that are overlapping between several areas. Yeah could probably find - well yeah, couldn't do a union, or any actual, erm, proper geo-processing on it because the datasets - the underlying datasets broken.
- Philip Ah okay.
- Rachel The background datasets broken so...
- Philip So you're going to have to just do it?
- Rachel I did a - yeah - did a big chunk of it, erm, with the spatial select.
- Philip Mm.
- Rachel Erm, and then I've just been left with 76.
- Philip That's not too bad.
- Rachel Nah it's about a hundred and fifty. They're all kinda clustered together around the edges, so that's just taking a call, and doing it.
- Philip Yeah.
- Rachel It's not the end of the world, it's just indicative. So we can catch - can go in to a marginal category.
- Philip I think that's just the case with things like this - you've just got to either spend, you know, an hour tryna work a quick way of doing it, or...
- Rachel Just get on with it. Yeah, there's always, there will be a clever fix, but it's always taking the call on which is suitable for use, rather than beautiful, just making it good.

Rachel's reputation as a GIS whizz preceded her. Her colleague had told me in the corridor that I should speak to Rachel about GIS because she was the most proficient in the company when it came to know how to use many different packages. I asked Rachel about this, I asked her what software packages she used and how it felt to flit from one software package to another. To which she noted:

...yeah and GVSIG and SAGA and things. Yeah, it's just putting different hats on isn't it ... You're just remembering the nuances that make it work properly, isn't it? Erm, yeah, you know everything's there. It's just remembering exactly where it is and hunting it down. (Rachel 20/08/2014)

It seemed that Rachel favoured this kind of variation in her work. I got the sense that Rachel valued the challenges associated with using different software packages in the same way that

Jamie enjoyed writing code. It was essentially a big problem-solving exercise. Challenges might include the following:

- Working out how to get one programme to export a file type that another would read.
- Finding the right software to performing a certain type of statistical analysis on a specific data type.
- Working out how to perform tasks on open source software when licenses for the familiar proprietary software packages are not available.
- Learning how to write a Python script so that you can save time by automating tasks.

I ask about how she insures she is comfortable at her desk and she told me, “I jump around from various bits and pieces.” (ibid.) Rachel told me she makes sure that she is not sitting staring at the computer screen doing data heavy work for extended periods. This is partly to ensure that she is not simply sitting in the same spot for extended periods, staring at a screen, but it is also down to the nature of how things are organised in the company.

A lot of Rachel’s time is spent making sure the data that she receives is appropriate or fit for purpose. She explained because of the enormity of some projects, spanning many local authority boundaries, she and her team have to spend a lot of time negotiating with these different local authorities in order to secure the correct data. However, in order to get this data needed, it is not a simple case of requesting the data from the supplier; it requires having a working knowledge of the kind of structures and systems that might be at work both politically and technologically within different institutions. In negotiating the procurement of the necessary data Rachel and her team must know whether specific data formats will work with the software available, and they must anticipate how they might use the data in the future. Although there is IT support on hand, colleagues are expected to be able to handle their own data use. This is an example of something that all GIS practitioners must be proficient in, though no one tends to specialise in.

Rachel explained some of the issues that they face when trying to obtain data from other organisations. She tells me that some of the data might come in broken with missing tiles. They also must deal with various different competencies from other IT systems. Councils may have old systems or a lack of training in data or all of the above. Rachel also expresses frustration in that, “some are quite protective of their data” (ibid.). Rachel and her team have to negotiate a number of different admin tasks in order to obtain the data. Some issues to do with the failings

of local authority IT systems, and many of the difficulties come down to how each organisation manages their own data. For instance, some organisations allow a simple file transfer over the internet, while however others will insist on sending the data via physical media (for instance hard drives, pen drives and CDs) (Figure 42). It is up to Rachel and her team to negotiate these things. At the point it became apparent that it requires a team effort to negotiate all of this data and its various difficult qualities. For instance, there was a chart (Figure 43) on the wall behind Rachel's desk drawn on the whiteboard. The chart explains how they organise the collection of data. Here, skills in data collection are assembled by deploying specific personnel mediating their focus via chart on the wall:

Sam's very good at image processing and finding the data when you need it, and then Hannah and Gemma, they do lots of the image analysis and processing as well. So, the actual classification and the - erm yeah - different projects involve different mixes of people. (Rachel 19/08/2014)

Mike

Mike is a GIS Analyst at the GIS consultancy. He is responsible for GIS Support. He helps generally with queries relating to GIS software. Mike does not have a degree; instead, he became adept with GIS working for local government before coming to work for the GIS consultancy.

When I began talking with Mike he was working on a task comparing farmers declared land use with remote sensed images. This activity involved what seemed to be quite simple pattern recognition on the behalf of Mike. The work involved looking at aerial photography and using a piece of software to check that the way in which a farmer had described their land was correct. For instance, was there a stream where the farmer said there was a stream, and did the stream occupy the area that the farmer claimed? In order to do this Mike had to apply certain codes to specific features on the landscape. I was curious as to how Mike remembered how the codes related to the environment. I asked Mike how he remembers all the codes and told me he has done this type of work before, so he is familiar with the codes. I am curious as to whether these codes become part of his conscious reality. I wonder do the codes become synonyms of the object that they define; does ZZ89 mean the same to him as the word scrub?

“The codes, that's just another way of saying that's a tree, that's some scrub, I won't look out the window and think specifically well that's ZZ89.” (Mike 12/08/2014)

What was unique about Mike among my other participants was the fact that he was not a graduate. He was, however, particularly adept at understanding different GIS software packages, so much so that his role as GIS support meant that it was his job to assist any member of staff

with specifically GIS related queries. With Mike's particular proficiency in the use of many different GIS software packages I ask him how he, being an expert to many, finds moving from one software package to another. I elaborate: at face value one could be forgiven for thinking that all GIS packages are alike, most consist of one primary window where the imagery is displayed, where the user scrolls, pans, snaps and clicks through maps. However, each software package differs slightly, some differences are quite subtle i.e. to zoom in on one package is to scroll forward but on others is to scroll back, and some differences are more pronounced, only certain file types are accepted by the software or the software requires more powerful hardware. Mike tells me that sometimes it takes a while to get back into the software, sometimes it may take half a day of pressing the wrong keyboard command or finding that he's exported the wrong file type before what he describes as "muscle memory or something" (ibid.) kicks in. The following is a list I made of the ways in which these proficiencies in specific software tools become known to Mike:

- Time to remember
- Making mistakes
- Embodied knowledge - 'muscle memory'
- "Having done the same thing over and over again" – Repetition

As well as doing data entry tasks such as the one that I observed, Mike told me that he often deals with software specific queries from his colleagues. My impression was that Mike was hired because of his proficiency, familiarity, and aptitude for learning new GIS software packages. If the main theme of this chapter is making visible the invisible practices of GIS, then what observing and speaking with Mike brought to the fore were the intricacies of working across different software packages. In the following passage from my transcripts, Mike and I discuss the difficulties one has when moving from prolonged use of one software package to another. Mike explains how sometimes he has to interrupt these long periods of familiarity with one software package, with particular ways of navigation, specific keyboard commands, or methods of data visualisation, to have brief encounters with another employee's computer, which is running a different package:

Mike But this is the first time we've worked on it, so we don't know if we will next year. Erm, next project I'll probably using *ArcMap* and *QGIS* and that will be more, erm, sort of preparing data to be delivered to the customer.

Philip Mm.

Mike So it's that this is more data capture and sort quality assurance, whereas the next sort of project, I will be working on will just be more ensuring the data is correct,

- as opposed to- there's no - erm - inaccuracies in the data, there's no problems any such things like that so it's all geometrically correct, there's no sort of, like, overlaps.
- Philip Why would you use - like you say - either *QGIS* or *ArcMap*? Erm, why would you choose one over the other. I mean it seems that they're quite similar packages.
- Mike Yep, erm, well, *ArcMap* is sort of more - it's a commercial product - its more well-rounded, should we say, whereas, obviously, like *QGIS* is obviously still chance to find its feet. It's still not at a strong enough level to compete at the minute, but it can - it's getting closer - but the reason why - another reason why - I said either *Arc* or *QGIS*, erm the project that's coming up, they erm, the member of staff who'll be working that project may well be doing the data capture within *QGIS*. So if they do it in *QGIS*, I may - might - follow along. It all depends on how everything gets set up.
- Philip So between - obviously - so you 're using this err Italian software.
- Mike Yep.
- Philip and you use *QGIS* and *ArcMap*? Do you find that from project to project...? For instance, I personally use a lot of adobe programs, for images and video, and things like this when I'm collecting data for analysis and stuff, but sometimes if I go back to a piece of software - for instance I haven't used Logic in years. I would say to someone, yeah, I can do logic, and then I'd go back to it two versions later, and there's a bit of a learning curve gonna happen. It might take me a couple of days to actually get my head into it again. Do you ever do you find that?
- Mike Yeah unfortunately.
- Philip ha-ha
- Mike Erm, so I've been working on this project now for a couple of months and pretty much almost solid been using this software. Someone came to ask me, you know, something relating to their project they were doing and so I opened up *Arc* and then whenever I wanted to move - 'cos in this, you have to hold down control and you can pan - I did that in *Arc*, wondering why it didn't do anything. So, it's just - it's just things like, you know muscle memory or whatever.
- Philip Mm.
- Mike But err.
- Philip Yeah?
- Mike So something similar, yeah.

Except for Colin, most of my participants were quite sedentary, in that they barely moved from their desk. I asked Mike whether he moved around the office very much. I asked whether he used other computers in the office. He told me that mostly this is his computer, and he does most of his work in this office. He did however note that there is another computer that he often needs to "Remote into it and get things going." (ibid.) It seems significant enough to note

that the objects that play such a key role in mediating each participant's work, i.e. their desktop computer, also serves as the resting point for each individual.

Whereas Jamie saw his data as grids of numbers, Colin found his background in geography useful, Rachel constantly hypothesised and interpreted the environment through geochemical processes and river systems, and Jessica saw real potential for the application of GIS in marine biology, I felt that Mike sometimes lacked the critical perspective that came with training in an academic discipline. Mike never discussed his data in terms of how it had been collected, or what the discrepancies might be, or particular bias might be present; he seemed only to interpret the data at face value. It seemed that, unlike others, his way of working is mediated by the software that he uses. For instance, in a specific task Mike is assessing how a farmer is using their land. Mike has been given a variety of specific pieces of software. From what I understand, it is an Italian piece of software used to assess what kind of subsidies farmers are owed from the EU. (I imagine specifically designed with the EU criteria in mind.) So, the software itself already has that bias; furthermore, the main tools within the software package that Mike was using seem to have been limited to 3 Windows, they being the main Ordnance Survey data with the fields marked by the farmer in a map form, a window with a list of EU codes and the farmers declared usage. This entire interface has been designed to lead the user in a particular direction and to read the data in a very specific narrow way. In Mike's case, this is almost largely defined by the way in which information is represented on the screen.

Steven

Steven is the IT manager at the GIS consultancy. Steven is a computer science graduate but has no specific training in GIS. His day-to-day tasks include such things as making sure backups and servers are running and installing updates and software patches.

The first thing I asked Steven was, what does his job involve? To which he replied in a rather impatient but joking tone "It changes every day!" (Steven 13/08/2014) In the hope of extracting a more comprehensive answer from Steven at this point I asked him, so what are you doing today? To which he replied, "Reading through PDFs and reading a lot (laughter)." (ibid.) I could not tell whether Steven was being impatient with me or was just generally unhappy with the boring task that he had been assigned. This job was to check the terminology that he was using to create an app matching the Inspire (European standard) names. Judging by the lack of time and effort he gave to answering my questions it was obvious that Steven was finding this task particularly tedious.

When I later reflected on my time spent talking to Steven I realised that the reason for Steven's manner was that he was probably just deep in concentration. I noticed, along with the varied activities I observed in the office that contribute quite liberally to what is termed GIS practice, there is one specific behaviour that I have observed across all participants. It is that of sitting usually for at least five to ten minutes in relative silence, ignoring all other distractions such as emails, me talking, other people moving, *Skype* notifications, calendar reminders, and the time of day, just ignoring all of these things and working on getting one thing done. In these periods of little conversation — sometimes five to ten minutes — all that can be heard is the sound of mouse clicks and the constant hum of a petrol lawnmower outside.

The following transcript gives some sense of the awkwardness I felt talking to Steve. In this instance one gets the sense that unlike Colin and Rachel who responded to prompts by providing further context, Steven makes little effort to elaborate on his answers. In this instance, I believe Steven is just too busy concentrating on the task to give me an in-depth explanation:

- Philip What is it that you do on a day-to-day basis?
- Steven Changes every day. Err, at the moment I'm trying to match field names hidden in various outputs from err, these apps to Inspire names.
- Philip Inspire, ah being the standard yeah? Erm, so what does that involve?
- Steven Reading through PDFs and Googling a lot to try and find something in the Inspire documentation - which is vast and unending.
- Philip And, erm, then you put that information into this spreadsheet?
- Steven Yeah, I'm putting a spreadsheet with the data. It's going to be fed back to the consortium, and then probably going to use the Inspire names, instead of whatever random names we're picking at the moment in the system for this.
- Philip So what do the names correspond to?
- Steven Err, whatever they're capturing. Like accuracy of the GPS. Err what OS version is running on the phone. What picture - if they took a picture - and so on. So, if whether or not we call it picture tilt, or something else.
- Philip So you're looking at inspire obviously there's been there have probably been established terms. Are they just used within this company and then you you're kinda updating them, or are they like conventions that have existed?
- Steven No, this is for a specific project that we're working on. But err - yeah - that's something we're looking at establishing the Inspire scheme somewhere. I just find ones that match what we're doing.
- Philip How do you identify those? Is it pretty complicated?
- Steven Err. I'm just scanning through PDFs and googling. I'm just trying to find anything that actually looks useful.

As with other participants I asked Steven to just carry on with his work and told him that I might ask questions along the way. I asked Steven what else his job involves, and he told me

that he is in charge of the IT side. Throughout Steven and my encounter, I found it difficult to get a response from him that was anything but terse. I asked Steven what else he was doing today, and he pointed toward a second screen, which was completely covered in digital post-it notes.

Spending time in the office with Steven I could see his job was far more varied in terms of the materials with which he interacts. He is responsible for doing bits of computer programming, making apps, ensuring that limited resources such as software licenses are properly administered. Steven is also responsible for maintaining and designing the network and system of servers, ensuring that data is in the right place and is easily accessible by the other members of staff. Part of Steven's job is also to be on hand to deal with technical issues. I asked Steven what sort of queries he responds to in his role as IT support. He told me sometimes it is a broken piece of software and in that case, he might have to install a patch or spend some time troubleshooting the problem. What Colin refers to as the 'Geek Room' contains both Mike and Steven. Amongst others that I spoke to, Steven and Mike seem to have quite clearly defined roles, IT support and GIS support respectively. However, from my experience of spending time in their office, most queries were addressed to both of them quite informally, and then it was up to the two of them as a team to decide who was best suited to solve the problem.

Steven told me that he sometimes gets involved in some of the project work doing bits of data analysis. I asked, to what extent did his job require him to have overview of what everyone else is doing. He told me he does a bit of GIS work, though he has a bit of understanding but generally, it depends on the package. He told me he has a good understanding of how Arc works as a server but no idea how to use it as a user.

I know how to do all that. But I haven't got a clue to actually, how to use it from an end user point. Whereas with, I suppose with Arc, I can do bits and bobs, but I can also, I've written a few plugins, python plugins for it ... or we spot something that someone's doing over and over again ... I've gone through Mike a lot of the time asking for some of the plugins. He'll spot something that's needed by talking to people. (ibid.)

Here Steven also demonstrates how he works with his office mate Mike. It is interesting to see how skills and proficiencies are grouped at so many different scales. We can see that individuals are collections of skills and proficiencies but also how groups of individuals are often grouped spatially (i.e. in the same office) to better deploy those skills or make them accessible to others. At this company, these groupings of individuals with particular skillsets are arranged in a number of different ways. Some are grouped permanently, in the case of Mike and Steven, and some are

grouped together on a project-by-project basis depending on the specific requirements of the project.

SECTION THREE - Concluding Remarks

In the above, using an array of fieldwork techniques of data collection, such as DSLR photography, sound recordings of interviews, time-lapse photography and detailed field notes, I have composed a series of narrativised dialogues, or snapshots, of the daily lives of a selection of GIS practitioners. These dialogues have been narrativised in an attempt to capture something of the 'doing' of GIS from the perspective of those involved. Furthermore, in narrativising these dialogues I have been able to think about individual practices as being defined according to particular moments, or instances, rather than an endless series of tasks. This means that each activity has its own singular meaning to the practitioner rather than a succession of empty procedures. Additionally, by narrativising this relatively small but intentionally selected sample of dialogues, I have been able to present the activities of these individuals as singular experiences rather than exemplary of types of GIS practitioner.

As such, the preceding pages serve to illuminate a number of themes that emerged from the interviews and related data. Most prevalent in these narratives was the theme of repeated decision-making. All participants seemed affected by this to some extent. Jamie's dialogue, for instance, detailed his attempts to try to reduce this kind of labour. Jamie chose to spend his time designing automated processes that would eradicate the need for him to make decisions. However, this led to further differently constructed decision-making processes, such as how to best troubleshoot those automated processes. These narratives also offer an explanation of how these decision-making processes might be constructed and furthermore how they might appear invisible (Figure 39). Rachel described instances of her repeated decision-making as being almost entirely performed by computer software, as she explained that the GIS would score her data, telling her whether it was fit for use. Additionally, not a single discussion with these individuals was without mention of a vast number of objects: computer components, software packages, scripting languages, office furniture.

Collectively, my interviews reiterate the assumption that GIS practice is mediated via an array of objects. However, what was not expected was the extent to which more mundane objects, such as chairs, desks, and carpet tiles would become so significant. From Colin's swivel chair glide across the office space, mediated by feet, carpet and swivel chair, to the demands of hardware needing to be configured strewn across Steven's office, to Rachel's negotiation of different software packages, some on her desktop, some on a colleague's laptop, some on a

remote headless computer, all had developed an approach to dealing with these objects in a particular way. The theme that became most evident in the narrativisation of these dialogues, then, was ‘doing’. These accounts of doing involved many different types of activity. Some of these activities were quite mundane, for example staring at the screen or sitting in a chair. Other doings were more complex and involved many steps, and some were more sustained requiring extended periods of concentration. These periods of extended concentration were observed invariably in most of my interviews and involved sitting usually for at least five to ten minutes in relative silence, ignoring all other distractions such as emails, me talking, other people moving, *Skype* notifications, calendar reminders, the time of day, working on getting one thing done. Most frustrating but certainly most illuminating of these doings were those that resisted my enquiry, those that the participants were unable to unpack, for instance my attempt to get Colin to tell me what he meant by ‘doing analysis’. On the one hand, I do not want to assume fixity of meaning. But, on the other hand, there is a routinisation that takes place as colleagues work alongside each other, read the same kinds of blogs and industry publications, and as they listen to each other at conferences. Not fixity per se, but a routinisation of articulations of a GIS practice

In Figure 44 and Figure 45 I play with the verb and noun use of my participants. In this *Gephi* method, derived from the digital humanities, recurrent usages of words are tabulated, establishing graphic relationships between individual participants as connected via the words, specifically objects (nouns) and actions (verbs), that they share. For example, both David and Rachel said the word ‘Scotland’. Therefore, we might assume that both Rachel and David, in their daily practice of GIS, are concerned with the political object that is referred to by the use of the word ‘Scotland’. Furthermore, we might also make assumptions about the significance of ‘Scotland’ according to the frequency with which each participant uses it.

What is distinctive about these diagrams is that they assume a common or shared meaning across different GIS practices. Here, the more embedded meanings that emerge from dialogue, speech or the text of the transcribed interviews are reduced to more atomised bundles of relations. In the interview transcript excerpts placed above these words are understood and represented as immersed in a complex network of relations; in Figure 44 and Figure 45 these relations are simplified. The former is reliant upon the conventions of narrative - i.e. situated and contextualised – while the latter emerge from very software heavy process of establishing meaning.

It is troubling to me that these models rely heavily on the assumption that one person’s use of a word is the same as another person’s use of the same word. Yet, by flattening the relationships

between these words and their utterer's one can gain a sense of what might be termed the 'epistemological ecosystem' within which GIS is performed. Indeed, when read against the transcript excerpts the way in which these diagrams arrange data does offer insight into the objects (Figure 44) and actions (Figure 45) involved in the practice of each individual and the overlaps between those different practices. What is more, they provide some insight into how practitioners presume a shared way of knowing that I, as an outsider, found so frustrating in my interviewing efforts.

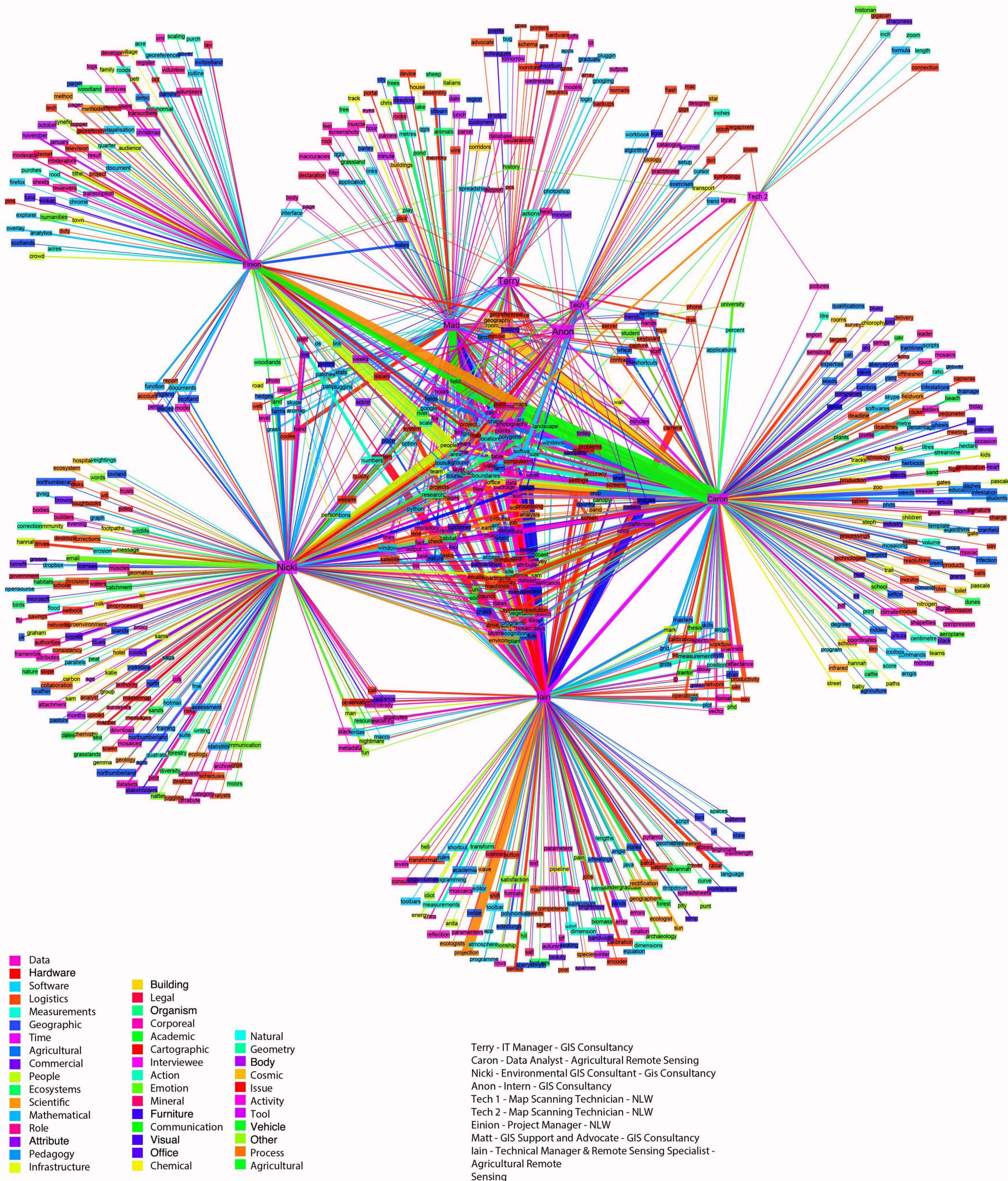
Figure 44 - Graph to show use of verbs (actions) in interviews with GIS practitioners



Figure 45 - Graph to show the use of nouns (things) in interviews with GIS practitioners



Graph to show the use of Nouns (Things) in Interviews with GIS Practitioners



Terry - IT Manager - GIS Consultancy
 Caron - Data Analyst - Agricultural Remote Sensing
 Nicki - Environmental GIS Consultant - Gis Consultancy
 Anon - Intern - GIS Consultancy
 Tech 1 - Map Scanning Technician - NLW
 Tech 2 - Map Scanning Technician - NLW
 Einion - Project Manager - NLW
 Matt - GIS Support and Advocate - GIS Consultancy
 Iain - Technical Manager & Remote Sensing Specialist - Agricultural Remote Sensing

CHAPTER FIVE: Working With GIS

SECTION ONE - Introduction

The preceding chapter described my exploits at capturing something of how GIS practitioners articulate what they understand to be GIS, and their engagement with it. With reference to literatures concerning collaboration, sociality, technological mediation, assemblage, and work, and a selection of unstructured interviews undertaken with these practitioners, I sought to understand how solicited reflections on these individuals' daily practice provided a more nuanced rendering of GIS practice. That is, the interviewees were encouraged to describe their activities according to their own perspectives. For the most part, words centred around accounts of doing – specific tasks, and procedures – repetitive decision-making, and accounts of particular components. In the preceding chapter, these interviews were narrativised so that the voices of these individuals and their perspective on GIS practice came to the fore, with my own position being that of a discrete recipient of knowledge.

The intent of this chapter is to critically reflect and apply literature (discussed in Chapter 2) on embodiment, affect, and emotion to my own experiences of working with GIS, either alone or in concert with others. According to Davidson and Milligan (2004), studies of embodiment, place the body as the primary site of emotional experience; that is, thinking is done via the feeling body. For Davidson and Milligan (2004), emotions are spatially mediated; they colour our experiences and have material consequences. Furthermore, we make sense of our emotions spatially and make sense of space via our emotions. Longhurst, Ho and Johnston (2008) call for space within geographic scholarship to discuss those emotional responses often glossed over in analysis, such as more banal emotional reactions and behaviours like gagging in disgust, and that this may reveal more significant, even problematic, themes that constitute the researcher. GIS scholars have tentatively paid attention to the emotional dispositions at play in GIS practice (Kwan, 2007; Aitken and Kwan, 2010). Kwan specifically asks us to “bring emotions back to bear up on GT practices” (2007, p. 23). In methodological terms, Woodyer (2008) explains that embodied information is difficult to capture; it resists representation and therefore must be directly experienced. As such, she advocates a performative approach to research that looks to understand embodied practice. This involves: becoming immersed and participating in practices; becoming attuned to “flow and contingency of social life” (2008, p. 352); and paying attention to the sensory, rather than the, “privileging of discourse” (ibid.). Relevant here is how geographers have noted how embodiment is manifest in practices of image making (such that mimesis is not about imitation but about embodied understanding of the world (Hawkins,

2015)), geocoding (Wilson, 2011) and interactions with screen-based technologies (participants embody the practices taking place onscreen (Ash, 2012a).

These interactions are composed by affects. For Dewsbury, affect is “the medium through which the body relates to the materiality of the world” (2009, p. 21). The work of James Ash (2013a, 2015a, 2015b) has been particularly significant in relation to the affective capacity non-humans objects, particularly technological objects. That is, Ash (2013a) extends Bissell’s (2010a) work on affective atmospheres in relation to how they influence non-human or inorganic objects. Here, Ash discusses perturbation as, “the ability for aspects of one object to affect another in some basic way” (2013a, p. 22) to produce affective atmospheres that encapsulate both human and non-human. According to Bissell (2010b), affective atmospheres operate in the circulation of mood or feelings or as dispersing as contagion. As such, attention to affect can help us understand, the project of a ‘creative GIS’ (Elwood, 2017), and according to Anderson (2006), emotions as affect moving through the body.

Taking these arguments together, we can understand emotions as the qualified, personalised and narrativised progression of affect through the body (Anderson, 2006). Of particular relevance to geographers is how emotions locate individuals (Wood and Smith, 2004). Indeed, Kwan (2007) encourages us to actively recognise emotive and affective dimensions of GIS practice, particularly in practitioners’ motivations and subjectivities relating to research, including passion, caring, commitment and involvement, and the subjectivities of the researcher. Relatedly, Aitken and Kwan call for attention to emotional reactions to GIS, for example, “the thrown-chairs, the put-downs, the red-faces and the hugs” and “the anger, the frustrations, the sadness and the joys” (Aitken and Kwan, 2010, p. 300).

Grounding these ideas, this chapter documents my taking part in FOSGSS at the University of Girona, and spending time at NLW, as they prepared materials for a crowd-sourcing project to georeference historical maps of Wales. I also outline what might be termed a more ‘experimental’ series of practices undertaken in my office at the University of Glasgow, and at home, wherein I attempted to familiarise myself with some of the software and technologies of GIS. I ‘learned’ various tasks, from analysis of remote sensed images and scanning of historical maps, to creating my own web-based applications.

These field sites were chosen because they show pedagogy in GIS in different ways. The teachers, workshop leaders, and instructors at FOSGSS took quite a conventional and hands on approach to teaching GIS. Participants of FOSGSS were taught the practical skills and knowledge via mostly hands-on workshops and activities. For the duration of the summer school programme we worked at computer workstations distributed in rows of five desks in a

university teaching lab. The itinerary for the summer school was split into four separate workshops over the five days. These workshops were taken by different instructors, and involved working through worksheets, listening to the instructor give short explanations to the class, and independently directed exploration of the teaching materials. Most of these activities required intensive hands-on engagement with computer software, either under the direction of the instructor, online worksheets, or independently exploring the software and tools.

At NLW, the staff took quite a different approach to pedagogy. Here, a team of three, a project manager, and two technicians, were involved in preparing materials and software for a crowd-sourcing project to encourage members of the public to engage with historical maps of Wales via an online project. The work of the two technicians involved using a custom-built photography studio to digitise old paper maps of Wales, turning them into something that was appropriate for the web-based project. I observed and spoke to them about the methods they employed dealing with these difficult materials – in the sense that they were both culturally and financially valuable, and physically delicate and cumbersome – to make them suitable for the digital method of dissemination and education. I also spoke with the project leader who walked me through the web-based software application that would ultimately serve as the means for the public to interact with the digitised maps. He explained how the web-based GIS application (WBGA) had been set up to allow users to manipulate and explore the materials and yet preserve the original scanned image. In this sense, the WBGA was quite basic, allowing users only rudimentary control of a small selection of predefined tools to manipulate the scanned map images. In pedagogic terms, this group of individuals were involved in implementing a system that allowed members of the public to access educational resources without in-depth knowledge of GIS, and yet allowed users to gain some level of familiarity with GIS.

Coinciding with these field studies I also spent a lot of time in my office and at home to familiarise myself with GIS technology. Here I adopted a more unstructured and experimental approach to understanding the doing of GIS. Some of my time was spent reading through blogs written by self-proclaimed ‘GISers’ in an attempt to get a sense of the kinds of activities that their work involved. Social networking sites such *Tumblr* were particularly insightful, as individuals would often post work they were particularly proud of (often in the form of maps), write short posts about their daily life as a GIS practitioner (Figure 46), or sometime use the platform to vent their frustrations with the software accompanied by humorous animated GIFs to illustrate (Figure 47).

As mentioned in Chapter Four, it seemed that the skills and knowledge uniquely attributed to the doing of GIS tended to focus more around hands-on experience with certain types of



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What I actually do at my GIS Analyst Job

I've probably mentioned it here and there, but since late 2014 I've been working at USC (University of South Carolina - Columbia) as a GIS Analyst. I'm not just doing GIS for the campus or whatever, I'm actually at a research institute that works under the umbrella of the university. It's called the Institute for Families in Society (ifs.sc.edu if you're curious...you can find my hawt bio on there where my hair is still wet), I believe we're technically a part of the College of Social Work here. My research institute has a few different divisions, and the one I work in does Medicaid policy research. So like, we get Medicaid data for SC from the state, and we analyze various things like disease prevalence, access to doctors, clinics, areas of high need, etc.

Even though in practice I do GIS analyst-type work, in the office it feels like I'm more of a research assistant. I get work from senior researchers, and my bosses are professors and researchers with PhDs who deal directly with the

Figure 46 – Screenshot from rachelpasser Tumblr blog (available online at rachelpasser.tumblr.com accessed 31/12/2016)



fyeahgis  drunkengeographer



 drunkengeographer

ArcSDE as a sandwich. One or Ten layers its fine, Hit Spinal Tap's coveted Eleven, and it shits the bed.

10 notes



Figure 47 – Screenshot from Fyeahgis Tumblr blog (available online at fyeahgis.tumblr.com accessed 31/12/2016)

computer software rather than on a particular set of academic qualifications or expertise in a scientific discipline. Therefore, I felt it would be beneficial to spend some time using the software. To do this I worked through a number of *YouTube* video tutorials that gave step-by-step instructions on how to operate the open source GIS package *Quantum GIS*. One particular tutorial walked me through the process of downloading data on leased and active North Sea oil wells from a public repository, loading that data into the software. It then helped me to analyse that data according its distance from oil refineries. I have no particular interest in the spatial distribution of oil wells in the North Sea; however, what I found was that this did not matter. The data, in this case, was arbitrary to the doing of GIS. It was necessary to get a sense of what the software can do and how it felt to execute various processes, to get a sense of the satisfaction one feels when one particular command yields a result in the form of a colourful graphical representation.

Following this period of teaching myself how to operate a GIS package I took it upon myself to archive my fieldwork data using *QGIS*. I decided to do this, partly because the amount of fieldwork data that I had accumulated in the form of photographs, videos, audio, interview transcripts, and handwritten notes required some kind of data archive and retrieval system, and partly because I was keen to test my knowledge and skills and generate further insights into this practice. Background reading, workshops, and courses I had taken on digital humanities work that employed GIS to work with this kind of data inspired me. However, for this task there were very few walkthrough guides. Instead of looking towards structured software tutorials online, I embarked on the more daunting task of googling phrases like, “import and display photographs in *QGIS*”. The results were piecemeal, and for the most part this approach to learning was very much by trial and error. Nevertheless, I believe I learnt a great deal more about the workings of the software, trying to carve a way through, than I did following instructions. The approach I took to learning GIS in this way can be summarised in four steps: follow, repeat, imagine, and create. First, I followed instructors, second, I repeated their actions – in a similar manner to that at FOSGSS – third, drawing upon the skills, knowledge, and experience, I had gained under instruction, and carrying out those instructions, I imagined what was possible, until I was finally ready to create my own project – albeit frequently returning to instructions.

Relying upon techniques drawn from participant observation, ethnomethodology, and autoethnography, my intent throughout was to understand something of what it was to be immersed in GIS, in terms of its infrastructures, its operating guidelines, its analytic and representational possibilities, and its plethora of hand and eye-focused peripherals.

Furthermore, I set out to frame these fieldwork activities as a kind of flaneurie that also cast attention to the disjunctures in these practices as generative. In 1986, Susan Buck Morss [following Adorno] likened the behaviour of television channel surfers to that of the “distracted, impressionistic, physiognomic viewing of the flaneur” (1989, p. 105). This kind of fleeting gaze embodied by the flaneur is useful when decoding hyper-mediated environments (Soukup, 2012), and offers a useful perspective from which to observe GIS practitioners in their daily practice. GIS tends to draw in its users, encouraging them to accept certain ontological assumptions inherent in the software and coding language, encouraging an immersive experience mediated by hardware and software, and the seeming disappearances-in-practice of peripheral objects and processes when absorbed in the doing of GIS. For me, flaneuring offered me a more ‘mobile’ perspective, an opportunity to resist total immersion in one particular practice. In this regard, I take inspiration from Soukup’s ‘ethnographic flaneur’ who,

is a mindful observer of contemporary culture shifting between a careful attention to cultural micro-practices and abstract conceptualizations of macro-structures. (2012, p. 240)

This kind of attitude towards observation allows me to move between those moments of GIS practice that are very focused, immersive and singularly engaged, to those that involve broader corporeal experiences of a hyper-mediated environment. For example, flaneuring allows me to contemporaneously be enthused by the rewards of successfully running a particularly tricky piece of code or process and yet be mindful of the technologies and spaces- the computer, software, the office environment, the remote sensing company- that mediates that effect.

I noticed that there were many instances of miscommunication and moments of awkwardness. In these moments new insights can be formulated; we can learn something new about a process or object or reveal something ordinarily hidden from view. There is something generative about these breakages. When something does not work, when it breaks, it creates a space that one can almost peer into, an interstitial space, between the cracks where we can learn something new about processes, objects and systems. In this regard, it is useful to consider the creative undertakings of ‘glitch art’ to peer into the inner workings of computer software:

“a glitch is this (unexpected) moment in a system that catches us off-guard && when it does that, it (more often than not) reveals aspects of that system which might otherwise go unnoticed” (Briz, 2015, p. 9)

After reading literature relating to embodiment (Cresswell, 1999; Davidson and Milligan, 2004; Woodyer, 2008; Wilson, 2011; Hawkins, 2015), affect (Anderson, 2006; Dewsbury, 2009; Bissell,

2010a, 2010b, Ash, 2013b, 2015a, 2015b), and emotion (Davidson and Milligan, 2004; Wood and Smith, 2004; Anderson, 2006; Kwan, 2007; Longhurst, Ho and Johnston, 2008; Aitken and Kwan, 2010; Young and Gilmore, 2013) I sought to investigate how the *doing* of GIS was:

- Embodied – This refers to the ways in which human bodies involved in *doing* GIS are configured and shaped by the technologies. This thematic understands that the body as primary site of experience. As such, it has been noted embodied practices are difficult to capture (Woodyer, 2008) and therefore calls for participation, or immersion in the practice of doing. Therefore, throughout my time conducting this research I took extensive notes, paying particular attention to how I and others interacted with the graphical user interface in GIS; specific embodied interactions between the hand and screen; the relation between body and the computer, and groups of bodies and clusters of computers; and how the everyday practice of GIS was enabled by the coming together of people, computer software, computer hardware and particular spaces. I focused on the spatialities of enrolment and interaction, thinking through how and with what computer hardware, software, and people come together to manifest particular spheres of activity (Anderson, 2009; Adey, 2013; Ash, 2015b).
- Affective - Underpinning each method of data collection was an interest in what it felt like to do GIS, as a person, a body, with a mind, interfacing with technology but also with other bodies, in physical proximity and/or virtually. And an interest in the question of how this interfacing in turn affected those technologies and individuals involved in the doing of GIS. In what follows, I draw together a range of observations, image as well as text-based, that foreground a specific, ‘felt’ situation in my fieldwork. David Bissell (2010a) notes that certain spaces, because of the way in which they are configured, who is there, what they are doing, can in fact ‘prime’ a person to act in a particular way. What I was interested in here is how the practice of GIS might operate according to this idea of affective atmospheres (Anderson, 2009; Bissell, 2010a; Ash, 2013a). What are the qualities of these spaces of affect that facilitate practice? How do I and the GIS practitioners become immersed in the practice of GIS? Is there something about the way in which these spaces are configured –the layout of offices, the rows of computer workstations in teaching labs, or the way in which processes are selected from drop-down menus within the GIS software – that produces these ‘affective atmospheres’?
- Emotional – Here I pay attention to how emotions are qualified, narrativised, personalised, socially situated, and spatially mediated. I follow Kwan’s call to “bring

emotions back to bear on GT practices” (2007, p. 23) This involves recognising the motivations of GIS practitioners and understanding what it means to get caught up in emotional dispositions and noticing how they colour experiences. As Wood and Smith note “it is hard both to ‘do’ research and to ‘be’ in the audience”(2004, p. 540). There is a difference between thinking and feeling and perhaps a discrepancy in rationalising and articulating and making sense of emotions. I made notes on the emotional qualities of working with GIS, writing down how working with GIS made me feel, but also noticing how others display and communicated emotions. This meant, for example, writing down when I felt anxious that I was running out of time to complete a specific task, or noting my frustration with not being able to get a specific plugin to work.

Following consideration of these perspectives concerning my fieldwork data, a number of recurrent themes became more apparent, and I have used these to organise my reflections in this chapter. These themes are:

- Testing limits of the technology – This was something I became more aware of in my own pursuits to familiarise myself with GIS technologies. When I set myself the task of using the open source desktop GIS package *Quantum GIS* to archive my fieldwork data – this included mostly transcripts of interviews and photographs from the field sites – my main question was ‘what can this software package do [and not do]?’ As a result, I found myself challenging the software, asking what are its limits, and how does it behave at these limits. Often the result, whenever I tried to import all of my fieldwork photographs in one go or tried to move through the interface too quickly – zooming out by five notches of the scroll wheel, then panning one whole swipe across the screen, then proceeding to select through three levels of a dropdown menu- that the system would just grind to a halt for perhaps five minutes or even crash altogether.
- Anxiety – I observed anxiety in a number of situations throughout my fieldwork. Anxiety was observed in a number of different forms, for instance, concern that one was running out of time to complete a task at the summer school, worry that one did not have enough prior knowledge to take part in classes, to general frustration that a particular process was not working, compounded by an awareness of an imminent deadline. At the summer school, I noticed students becoming restless when the terminal would not behave as it was supposed to. On other occasions, practitioners expressed concern that they had a lot of work to do with little time to do it.
- Reliance on disparate and existing knowledge – Each individual (myself included) observed during this period of fieldwork could be attributed one broad job title or

specialism. For instance, at the National Library of Wales, there was a historian, and a graphic designer; and at the summer school there were archaeology research students, a geospatial web engineer and a geospatial and remote sensing specialist. Regardless, all of these individuals' occupations required a particular level of proficiency in GIS. However, if we put to one side the generic core skills often involved in GIS (understanding maps, understanding image formats, working with software such as *ArcMap* and *QGIS* and so on), what is significant here is the more non-GIS specific knowledge that I observed being deployed. These types of knowledge included anything from the scanning technician working out novel ways to scan blank pieces of map so that they would correctly align in a computer-generated mosaic, knowing the correct way to phrase a query for Google to return the most useful results, to knowing that a rock is easier to recognise than a specific piece of mud in a farmer's field. In this way, the practice can be seen as more than people operating technologies that enact types of geospatial knowledge, rather it is this disparate knowledge embodied in the practitioners that goes a long way to making GIS possible in any meaningful way.

- Aggregation of bodies – From my perspective there were many occasions when everyone seemed to be doing the same thing. That is, sitting on a chair, wrists resting on the desk, hands typing on the keyboard, and, eyes and head pointing towards the screen. All participants were immersed in a task that is both embodied and intellectually driven- self and screen at the same time.
- Spheres of attention – It became apparent that many of the situations I witnessed and was involved in as part of my fieldwork could be characterised as specific and sometimes overlapping spheres of attention. For instance, the workshop instructor created a particular sphere of attention emanating from the front of the teaching lab and encompassing the rest of the class. However, a moment later that sphere of attention dissipated giving way to a multitude of spheres of attention focused on individuals carrying out instructions on a computer workstation.

SECTION TWO – Encounters Learning to do GIS

Testing the limits of the Technology

I have installed the *OSGeo Live CD* on my desktop PC in my office at the University of Glasgow. The task for today is to catalogue my fieldwork data. I have sound recordings of interviews and lessons at the GIS summer school, transcripts of those recordings, video of students working

at the summer school and workshop leaders taking a class, and photographs from all manner of things; office spaces, practitioners at work, teaching labs, corridors, a science park, and so on. It is important for my research project to have a data storage and retrieval system in place in order to organise such a large dataset. I have chosen to employ the open source GIS package *QGIS* for this task. There are two reasons for choosing a GIS to organise my data. First, *QGIS*, as with many desktop GIS packages, is centred around a comprehensive database system. This will allow me to store, catalogue, then search through and retrieve data when it is needed for analysis. Secondly, I intend to discuss GIS in relation to an (see Chapter Two), and therefore, in constructing a GIS archive of my own, I hope to gather insights. Following my insights in Chapter 2, specifically regarding the ontological assumptions of GIS software, I think it appropriate to explore how my data is represented in a modern GIS.

I load the *OSGeo* virtual machine from my desktop and wait while the operating system initialises. Once I am confident that the system is ready to use I load the *QGIS* application from the ‘geospatial’ menu at the top of the screen. Once the *QGIS* splash screen has disappeared I am ready to begin the project. I create a new project and load a base-map from the *OpenStreetMap* online repository. Now I am ready to start importing my data. First of all, I create a table for each location of my fieldwork. For each location, the application places a pin on a map of Europe. Looking at this first layer of detail, representing my data in this way seems somewhat arbitrary. I do not think it immediately significant that my field sites are distributed in this way. Nevertheless, when using this software, it seems the most sensible way to begin. I now have my first table, it contains three columns: the first is a reference number, the second is the name of the field site, and the third is its geolocation.

I now begin to refer to my fieldwork data relative to these tables. I create a new table. This table links to the second entry in the first table. It will contain two columns: column one, again, is a reference number, and the second refers to one day at that particular field site (e.g. day 1, day 2, and so on). I now create another table for each entry in table two. At this point I am not sure whether to create a further separate table for each type of data – for instance, one table for all photographs on this day at this location – or to reference all data files from this one table. It might be beneficial to have all data (regardless of format e.g. text file, photograph, video) searchable from within the same table. However, I decide that it could be confusing to attempt to fit metadata uniquely associated with one particular file type (e.g. duration of video) in the same table arrangement as a different type of data (e.g. photographs). Therefore, I create another layer, a further set of tables that each individually reference a particular type of data, related to a particular day, at a particular field site (Figure 48).

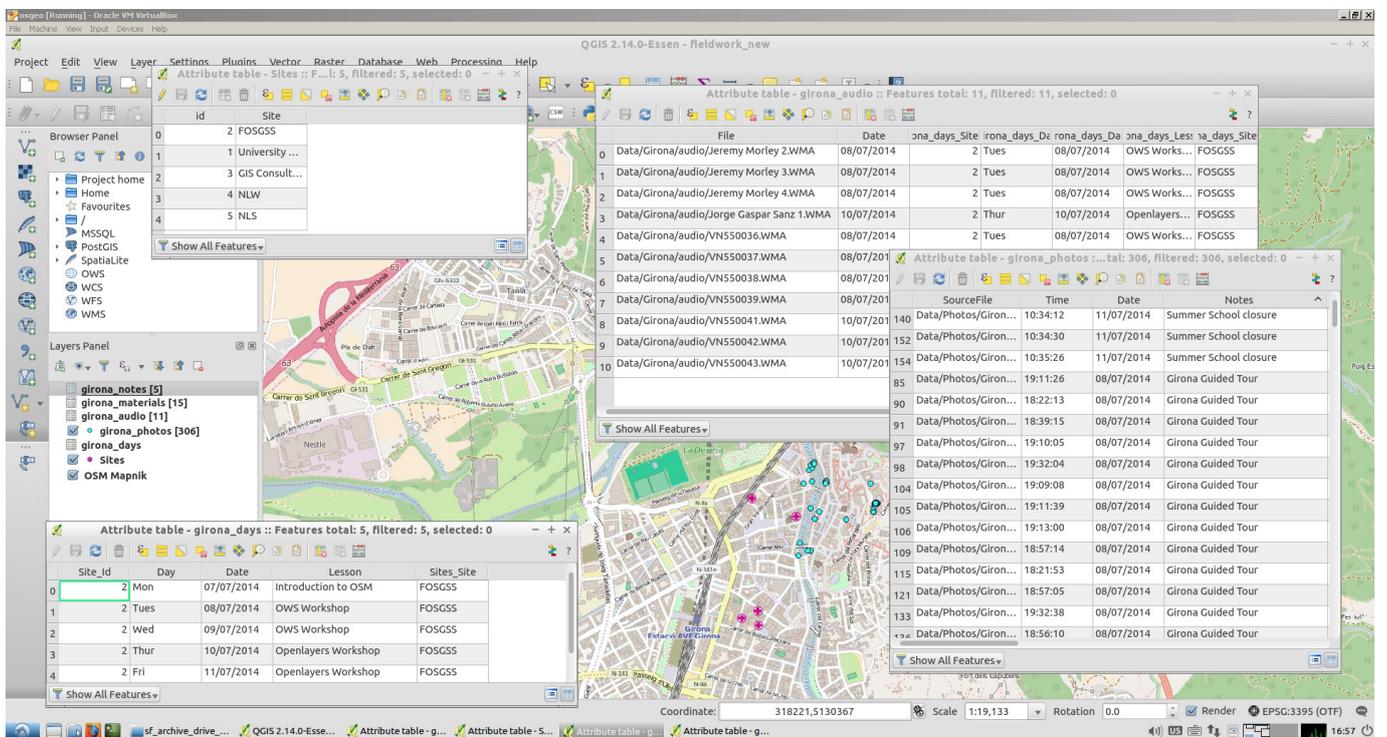


Figure 48 - Using QGIS to archive fieldwork data. This image shows a selection of tables used to catalogue audio and video files from my time at the Free and Open Source GIS Summer School (FOSGSS)



Figure 49 - Studio Technician with cardboard strips

As I work through this method of sorting and cataloguing my fieldwork data, I become distinctly aware that my decision-making process is being heavily influenced by the constraints of the software. It seems as though all of the moments of my fieldwork are being transformed into cascades of moments. Each is divisible by type of data, time of entry, geolocation and so on. I click on one field site on the map and I am presented with one table, I dive deeper, another table, and then another.

I have come to NLW to talk to staff working on a crowd sourcing project to digitise historical maps of Wales. Today I have an appointment to visit the studio where technicians are scanning physical maps to be uploaded to a web application. Here, the technicians had developed a bespoke approach to scanning exceptionally large paper maps. In the scanning studio, I am introduced to two technicians who have been employed specifically for this project. One is a history graduate and the other a photography graduate. Just inside the doorway is a large *iMac*. As I pass the threshold I can see a large concave wall in the middle of the studio. Approximately four metres from the wall is a digital camera mounted on a tripod and *GigaPan* mount. I can immediately get a sense of the method they are employing. They tell me that they have devised this setup specifically for this task. They hang the maps on the curved wall, the camera takes a series of photographs, the *GigaPan* mount automatically adjusts the angle with each shot, moving the frame across the map, until they have a mosaic of images for the Macintosh to stitch together.

What I can see seems to be quite an elegant solution to the problem of scanning such cumbersome materials. I find it difficult to believe that this has been an iterative process. One of the technicians tells me that when he began working on the project a few months ago, before this method was conceived, he would frequently daydream about ways of scanning the maps. Some, he noted, involved suspending a camera above the maps on a horizontal surface. I take a moment to imagine the other Rube Goldbergesque contraptions this technician dreamt up. The solution they settled upon appears to yield good results. The technicians explain to me the process of retrieving the maps from storage, hanging them on the concave structure, setting up the camera, waiting for the camera and mount to take the photographs, removing the memory card from the camera, inserting the memory card into the computer, loading the images onto the computer, and then running the image stitching software. For most of the maps this works well.

However, there are limits to this method. Image stitching is most often used to pull together many smaller and detailed sections of a landscape into one large image that incorporates all of

the smaller sections. The smaller detailed photographs individually become tiles in a larger mosaic creating one image that contains all of the detail. The technicians at NLW were using this technique to create high resolution digital copies of the historical maps. However, some of the maps they were scanning had large sections with very little detail.

This is a problem for image stitching software because the software looks for patterns in the overlaps of the smaller images to match them. If there is no information in the overlapping sections of the smaller photographs the software struggles to match the images correctly. To correct this the technicians developed a process that demonstrated quite a clear and hands-on understanding of the limits of the software they were using. What they did was to cut up strips of magazine so that they had strips of card with distinctive colours and patterns. They placed these strips of card on the map where they assumed the software would have trouble (Figure 49). This is a particularly ingenious way of recognising the limits of the software and also having a good understanding of how the software works.

We recently had a bunch that were just unusable, just simply because they had this decorative – like – Celtic braided border painted on it, just like a constant never changing pattern going around it, and it seems to throw off the software completely. It won't deal with it. It was like destroying the map, turning it in to like a star. It looked crazy when you looked at it (John, December 2014).

Anxiety

Again, the instructor at the front of the room delivers some background to the task the class are working on. Meanwhile, Marie sits square with the computer looking at the screen, right hand on the mouse. On the screen are a number of windows; on top of the stack of applications is a terminal window. She looks at the screen, releases her grip on the mouse and gives her attention to the instructor at the front of the room. Marie places her hand on her chin as she looks to the front of the class. After three to five seconds she glances back at her computer screen where nothing has changed. In the background we can hear a ruffling of papers. The student checks her mobile phone, stands up, and then walks away to seek assistance.

Marie returns to her seat just in front of me. She is followed by two men who are helping with the class. She is obviously having problems with the exercise. She later tells me that her computer or virtual machine isn't working properly. Both of these men stand behind her pointing and looking at the computer screen. At the front of the class the instructor is still talking, explaining the next exercise. She is being left behind. Marie does not appear to be listening to what he is saying. Nevertheless, his constant talking, perhaps explaining important

instructions, concerns her. She is surrounded. Behind her are two members of the summer school staff. They talk over the instructor and point at her screen. After a couple of minutes one man walks away. She now sits at her desk explaining her problem to the man crouched at her side. He stretches his right hand across her to touch her mouse. Facing him, she points repeatedly at the screen and talking urgently. Her right hand remains on the mouse. She is explaining that something is not working with her computer. The staff member crouches lower and points at the screen. She taps the screen a couple of times again as if to enforce her point that something specific is not working and hindering her progress. He moves away and the student leans back in the chair looks across the room and rubs her right shoulder with her left hand. She is no longer concerned with the computer screen.

Pete sits square with his computer workstation, the participant to his right slides closer on his swivel chair, and both start talking. It is not clear what they are discussing. Pete sits idly listening to the instructor talking about the current exercise. Another student in the class asks the instructor a question. When the instructor is concerned with answering the other student's question Pete begins touching the mouse, moving the cursor into position and then moving his hands towards the keyboard and then stops. The room goes quiet; the instructor has finished answering the question; no one is talking or typing. It seems as though the class are all reading something or using the mouse. Pete seems to be spending quite a lot of time doing very little. Every now and then he taps a couple of keys on the keyboard. Is he apprehensive to start work on the task? The tasks involved in this class require a lot of consideration. They require a clear understanding of the teaching materials, the instructions that the teacher has given, and the confidence to act. Is he ready to make a mark? Is he sure as to where to place a specific set of characters into the many lines of computer code on his screen? Pete is not sure: he raises his hand to attract the attention of the instructor, leaning forward to rest his chin on his hands.

At the beginning of each workshop the instructor asks us to download a zip archive from the internet to our virtual machines. These zip files contain all the resources that we need for each lesson. I have used *Linux* in the past and I am relatively familiar with it. However, I find managing the files that we download at the request of the instructor to be quite challenging. These files are usually downloaded via the web browser. So then, unfamiliar with the configuration of the operating system it took time to work out where the web browser had saved the downloaded file. Once I locate it, I already felt like I am behind time, so instead of

placing the .zip file in a well-ordered file structure, I unzip it in situ. I would like to imagine how I could have created my own friendly and easy to follow file structure, there would be a new folder on the desktop that was easy to locate. I would have called it “Girona Summer School” and inside there would be a folder inside for each day of the week. Inside each folder there would have been the documents for each day. Much to my regret, this was not to be the case: instead the fast pace of the workshops meant that I was left with an extremely disorganised file structure. Some files would make it to the desktop, others were left in the downloads folder. Very soon I would become reluctant even to open up the downloads folder. The disarray was too much to handle for my already stressed mind. There would be duplicated .zip archives (for when I had accidentally downloaded the same file twice) and then multiple versions of these uncompressed archives for when I had failed to troubleshoot an exercise and fearing that I had done irreparable damage to the dataset had decided to start again. Two days in, I had no idea which iteration of the folder “naptan” I was currently working on.

The instructor asks the class if the text on the projection screen is readable. On the screen at the front of the class is what looks like a text file. I recognise it as a kind of human readable computer code. This kind of document is essentially what defines the crux of today’s lesson. The instructor talks the class through what this document is, explaining that this is JavaScript and that this script refers to other files that are also in the zip folder that we are working from. The introduction of these materials is met with varying levels of anxiety from the class. Some are relatively blasé about working with JavaScript – perhaps they are used to working with computer code like this in their day to day professional practice – some are obviously concerned that this is going to be quite difficult. There is a perceivable spike of activity, a shift of posture. They ready themselves to give this activity their full attention, leaning forward in their chair, readying notepads, and squinting to ensure they can see the screen at the front of the room.

I have some experience of writing computer code but only in the most rudimentary sense. I remember lessons on writing html code at school to make a homepage (mostly consisting of animated gifs pulled from the internet) on the school intranet. I know that this going to require quite some concentration, but I am somewhat immune to the mystification of this practice. However, I am still a little apprehensive. Despite knowing there is nothing superhuman about those that can write computer code – for instance those that might talk about the subtleties of different coding languages – to the untrained, there seems to be something quite mystical about computer code. The apparently anxious atmosphere peaks at this point. Here, it is the anxiety

relating to an unknown future that grounds us in the present. Our confidence wanes, the assurance one ordinarily held buoyant by what we already know, dissipates.

I often find it difficult to both participate and observe. I am having to take in very specific and complex information along with the class, and then perform tasks requested by the instructor. This takes a lot of processing power, short term memory and concentration. Furthermore, the amount of concentration required, the type of thinking required to perform the tasks, require me to think in a very specific way. It is difficult to switch between the technical thinking required for the tasks (trying to understand programming language, navigating command lines and graphical user interfaces, checking for errors and problem solving this way) and thinking spatially and socially (trying to identify materials, identify actions and behaviours). I sit looking at a web browser window in full-screen mode. At the bottom of the screen, taking up approximately 30 percent of the window, is a text viewer that displays the computer code describing what is happening on the rest of the screen. At the same time, I can see two representations of the web-based GIS application, the text code and the graphical visualisation. My task is to identify relationships between text and image. I have another document that acts as a kind of crib sheet, giving me clues as to what each element of code does. I work through each element of the code, making adjustments, altering numerical values, changing text, refreshing the browser, to see if I can map out relationships. At the same time, I am curious as to what the other participants are doing. Can I notice anything about their behaviour? Is the room silent as everyone concentrates on this task? Are they giving any clues to how such a task makes them feel? My preoccupation with the other students' activities are partly a symptom of my anxiety relating to the task at hand, I need validation, but I am also interested in the purposes of my PhD study.

This is difficult. I cannot observe students and map out computer code within the same brain. I can feel the two hemispheres of my brain leaking into one another. I spend five minutes looking at the code, making adjustments, trying to notice changes in a very systematic and positivistic manner. I whisper to myself, "okay, if I change this, it changes that; this relates to that, therefore this is that." I construct a mental diagram of coded relationships in my head. When my attention shifts to the activity going on within the room it takes a few moments for my social faculties to re-engage. In the moments it takes for this to happen, my brain starts to imagine the classroom on the terms required by the coded task. I try to look for direct relationships between the known attributes of individuals and their behaviour in the space. I ask

myself what the known attributes of the space are. I even imagine a coded text document to describe the place, a repository of known behaviours, material qualities, spatial trajectories visualised as vectors.

Reliance on disparate and existing knowledge

One can anticipate a quantum leap in software development and applications when today's children, who have grown up with joysticks in their hands, reach college age. (Dobson, 1983, p. 141)

At the summer school I sit at the back of four rows of desks. At each desk, to my right and the rows in front of me, sits a participant of the summer school. In the first session we learn who these people are. Each participant takes it in turn to stand up and introduce themselves to the class. I learn that among this collection of people there are archaeologists, engineers, those who describe themselves as GIS consultants, and PhD students. Some work for NGOs, some for universities, some are students at the host university, others work for engineering companies. What I have already learnt about GIS practitioners and their work is that their expertise can be both disparate and specific – they may have academic training in a specific field, such as environmental science or remote sensing, but the knowledge and skills that they rely upon in the everyday of their work is often difficult to attribute to such a centralised disciplinary position. It is interesting that the doing of GIS can be centred around a number of different fields of study – such as marine biology, cartography, archaeology – each with their own established modes of thought. Further to this, the GIS practitioners I observe exhibit proficiencies beyond the skills and knowledge required to operate, for instance, a desktop GIS package (such as *ARCGIS* and *QGIS*). These separate and additional skills, proficiencies and knowledges include, for example, an ability to write computer code, experience of cleaning data in other jobs, a familiarity with the physical qualities of computerised data in the modern workplace – with wired and wireless networks, servers, wires, headless computer terminals, desktop workstations, laptops, smartphones and so on.

I am sitting at my desk on the first day of the summer school. I am told that all work this week will be done on this desktop computer running a programme called a virtual machine. The leader of the summer school tells the class to launch the virtual machine that is on our desktops. I have worked with virtual machines before – it is often the easiest and most convenient way to run software built for an environment that differs from that installed on the computer. The virtual machine allows me to run an operating system within an operating system. So, for these

workshops we would be running a *Linux* distribution on a *Windows* host machine. I am familiar with this particular *Linux* distro; it was specifically put together by the Open Source Geospatial Foundation (OSGeo). Within this self-contained software environment are a host of GIS tools – desktop GIS packages such as *QGIS* and *GRASS*, and server programs such as *GeoServer* – closed off from the rest of the computer. We were working in a kind of geospatial sandbox.

The virtual machine loads, and I am presented with a familiar *Lubuntu* loading screen. This often takes a few moments to load, especially as the operating system is having to share memory with the *Windows* environment it sits upon. When the desktop interface finally loads, I can see application icons arranged in a grid on the desktop, and a menu bar at the top of the screen. The first thing that I check are the keyboard settings; sometimes it is not configured correctly – in this instance I make sure that it is not set up for Spanish input. I glance at the top right corner of the screen to see a Union Jack icon nested in the menu bar. This tells me the operating system is configured for British English input. Whilst I wait for my next instruction my eyes continue to dart across the screen. I remind myself of where particular applications are found. I click on the ‘Applications’ menu at the top right hand corner of the screen, and scroll down to the ‘Desktop GIS’, where I find some applications that I am familiar with. There is a lot to be said for being familiar with this sort of thing. I gain a sense of confidence. I feel I have an upper hand over those in the class that had never used this system. The anxiety I feel as an outsider, a non- ‘GISer’, entering this space dissipates somewhat. I think back to my activities in my office in Glasgow as I tried to familiarise myself with a number of GIS packages. I installed the *ARCGIS* suite of applications using the department license and the open source *Quantum GIS* package that I downloaded from the internet. I had conversations with colleagues and mentors, one of whom recommended I try the *OSGeo Live CD*, the very virtual machine that I am using here. Knowledge of how to install software and operating systems is certainly not a skill emblematic of GIS practice but it is certainly something that I possess that allowed me a significant inroad into understanding GIS and to open up dialogue with those who practice it.

Aggregation of Bodies

Michelle sits in front of a computer at a row of desks. A keyboard tray sticks out from the desk above her lap. She has a scrap of paper on her desk to make handwritten notes. Her computer screen is just another version of the others in the room – all contain, in varying arrangements, some with anomalous extras, a web browser with a rectangular slither of a map on the right and in the centre a command line terminal. As others rest their chin in their hands and chew on pen lids, Michelle too is prepared for further instruction. She sits back in her chair and waits. A cannon of activity echoes down the row of workstations as every now and then Michelle and

her peers type commands into the terminal window. A couple of clicks on the qwerty keyboard followed by a tap of the return key, and the terminal almost immediately returns ten lines of white text against a black background. The instructor explains the rationale for this current task and she continues to respond to queries from the command line terminal (usually requiring a 'y' or 'n' response). The tiny white cursor blinks, awaiting the next command (Figure 50). She leans forward in her chair eclipsing the bodies of those to her right, and all I can see is her body and the many arms and hands of her peers manipulating their computer workstations. They place their hands on the mice, clicking, scrolling and dragging across the desk. With one click the screen changes, a newly opened window fills the screen with stripes of blue and white lines. Each line holds the details for a file or directory. Michelle glances at the file icons on the screen and then brings the small terminal window to the front. One tap of the keyboard and the terminal continues to load lines of the same white text, and the window scrolls of its own accord. First the text appears in chunks of six to ten lines, then single lines with a single line break, and then faster and faster single lines of text with no break. It stops. Back to the flashing cursor. Michelle's hand returns to her mouse once more, she places her finger on the scrolling wheel, and scrolls to the top of the page. The instructor continues.

She leans forward again, picks up her pen, and notes down the information at the top of the page. One notch at a time, she scrolls back up the page, studying the actions the computer has executed, her mouse cursor following the line of the text as she reads. Again, the instructor gives out instructions, there is no way that she can keep up, so she resorts to pen and paper. She writes quickly, resting on a small section of desk not taken up by the computer.

As the instructor explains to the class how colour is represented and dealt with in remote sensing, LCD displays, printing, and video projection, the participants are just required to listen. No interaction with their computers is necessary at this point, but still the screens in front of me change, keyboards are typed on, mice are clicked, and this activity cascades across the room as LCD panels change to reflect the participants' activities. The users all move from one window to the next. Some bring up the web browser, some glance back at the file explorer, some go back over previous exercises – but only momentarily- always returning after a few seconds so that their screen resembles the projected image at the front of the room.

I stand behind the camera in the photography studio at NLW as the two technicians explain to me the procedure they follow when scanning one of the historical maps. John walks over to a set of metal shelves in the corner of the room to demonstrate how he retrieves the materials

Figure 50 - Michelle working with terminal



from storage. He leans forward to look at the lower shelf and then continues his explanation, walking to the opposite side of the room where the large concave wall stands. He briefly describes the process of hanging the maps on the large, purpose-built wall and then continues his tour of the room back towards me and the camera mount. As he gently touches the camera with the tips of his fingers, pointing out the memory card slot and the *GigaPan* mount that controls the camera, he finishes his re-enactment of his regular routine. Now, in a kind of relay, John hands off to his colleague, Dan, who continues the description. Dan remains at his desk just inside the doorway of the studio and I walk over to see what he does. Dan inserts the SD card into the side of the computer and a window pops up displaying a mosaic of photographs taken of the map on the wall. He tells me that he now must run the image stitching software which joins all of the individual images into one. With a few drags and clicks of his mouse the process is started and he reclines in his chair as he waits.

John perceives this moment of inactivity and retakes the baton, not with words but with more of his wandering around the room, frequently picking things up and playing with them in his hands. He takes down a strip of card from the hanging wall and bends it between his two hands, then shuffles over the shelves that hold the maps, he pulls one from its position and seems to weigh it in his arms, he then returns to the mounting wall and pulls a magnet from the wall and lets it snap back into place with a thud. Meanwhile, Dan sits relatively quietly, concerned with the working of the computer and the software. What I am observing here is much like Seamon's (1980) place ballet in that these technicians seem immersed in individual practices that come together to produce a sense of place. One is concerned with mobilising the physical materials, and the other preoccupied with his iMac, explaining to me in short statements, never loosening his gaze from the computer screen.

Spheres – of Attention

spheres are forms of shelter that humans generate to protect themselves from the openness of the world. (Ash, 2015b)

Read, minimise PDF, reveal presentation, move finder window, stop, move finder, click 'view' menu, pause, open folder, arrange *Windows* (move finder left, move PDF right). Pete reads a PDF document displayed in the web browser. He navigates through a web-based file system on *Google Drive*. Other students walk around the class passing in front of him, but he does not seem to notice. He selects a drop-down menu from the top of the screen as the instructor speaks in the background.

Pete is working within a virtual machine, an operating system within an operating system, a closed sandbox with all the learning materials and tools he needs to complete the tasks that will be set for him during the five-day summer school. In a sense, Pete is getting a hang of the operating system. These are some of the most common actions he performs in his normal everyday work with a computer. He is warming up, getting a feel for the system. At the front of the room the instructor evangelises on the benefits of using an online repository of materials. The class are told that the learning materials are always being edited and changed. The system is always being error corrected. This is what it means to work with open source materials.

Pete continues to roam through the file systems looking for files; he skips between the file explorer to a PDF tutorial document in the web browser. Scanning through the document, scrolling up and scrolling down, Pete is becoming familiar with the task that he is about to begin. A condensed URL is scrawled on the blackboard at the front of the teaching lab which Pete types into the address bar of his web browser. Data is downloaded, and zip files unzipped. He is ready to begin. After about three or four minutes the class receives its first instruction: "start *GeoServer*." Pete does not seem to be actively listening to the instructor and continues to scroll through the document tabbing between the file explorer in the operating system, the file system in the cloud based, shared, *Google Drive*, and the cloud-based exercise open document. As he moves through these *Windows* he is infrequently presented with notifications from the operating system and the web browser – the web browser asks his permission to download a file and with the click of his mouse, he accepts, and a small window pops up at the bottom left of his browser.

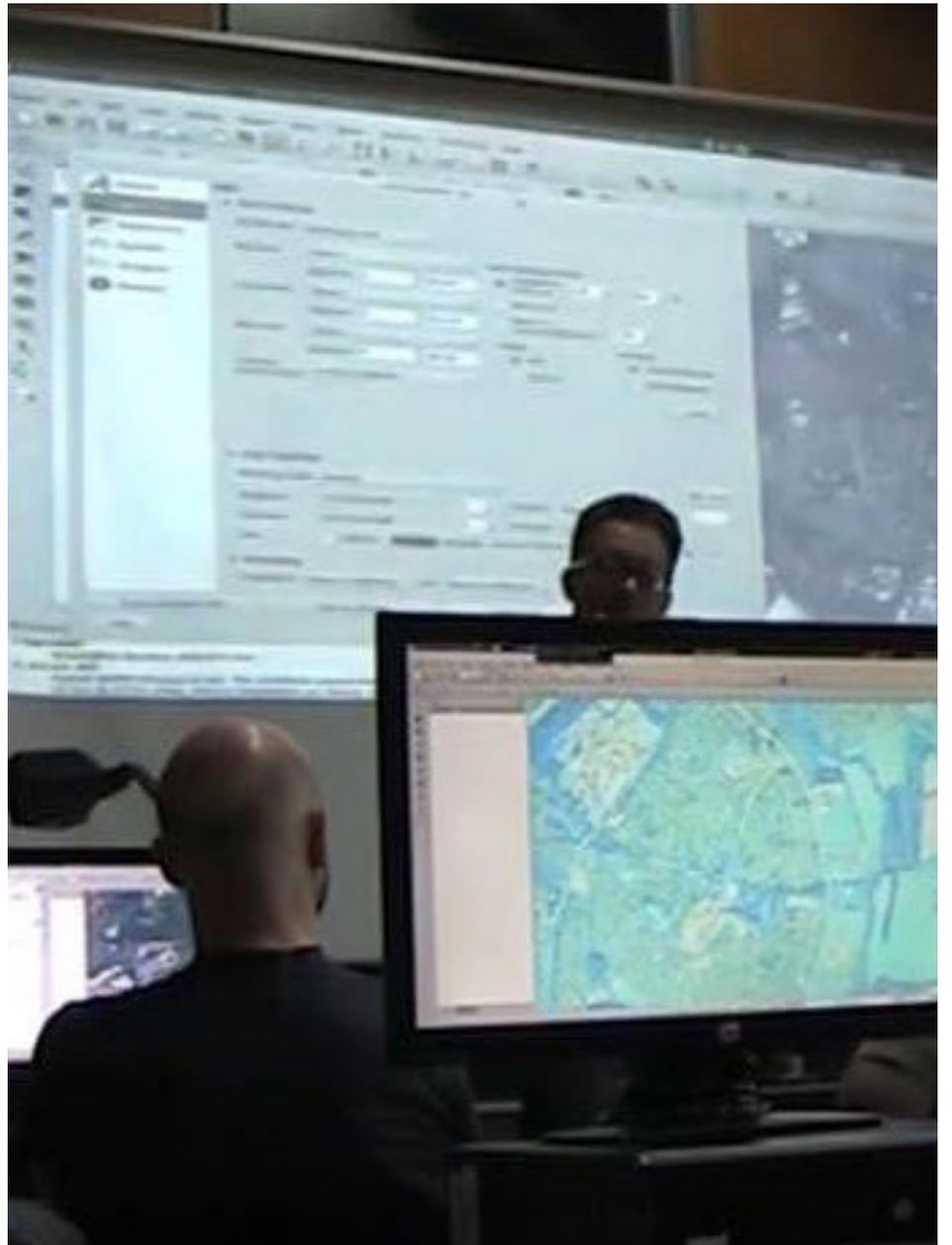
At this point the voice of the instructor seems peripheral. Pete does not need to give the instructor his direct attention. He continues to review the learning materials that he has in front of him until he senses that he needs to pay attention. Now, as his attention shifts to outside the bubble of activity that is confined to his workstation he begins a process of tidying his screen, tabbing through the open program *Windows* on his dock, closing them down, and searching for the materials relevant to the task. He is given an instruction that he follows directly: "Create a new folder." The instructor waits a minute or so then checks everyone's progress, "you have that folder?" Only at this point does Pete's sphere of attention touch on the presence of other participants.

Pete continues to perform a lot of actions that the instructor does not mention. Those actions the lesson requires are done relatively quickly, but in the time between instructions Pete returns to scanning through files and folders, PDF files and walk-through guides with images. He highlights text in the document and doodles with his cursor. During this time, others in the class complain that the instructor is going too fast. I observe Pete's activities from the back of the



Figure 51 - Students listening to the instructor (SIGTE, 2014)

Figure 52 - My view from the back of the room



class. Like him, and most of the class, all I can see is the backs of the heads backlit by the glow of an LCD panel. Sometimes I think that I might get clues of how to complete the task by looking at those screens of fellow students. However, the opposite is often the case – instead of being informative, other screens can be misleading and can often confuse and disrupt one's concentration on one's own screen.

As the day's lesson progresses, we are required to pay more attention to the instructor at the front of the class. Although our attention is directed towards the front of the teaching lab, where the instructor stands, each student's field of view is, to varying extents, littered with the glare of LCD panels, slightly occluded by the torsos of their classmates. The instructor stands in front of a projected image of a web browser window containing a map. The instructor discusses its various elements and nuances. The students' passive observation is denoted by a visible absence of cursor movements, scrolling *Windows*, and tabbing between applications, unlike that which usually envelopes the room. (Figure 51)

From my seat at the back of the class, I notice one participant's screen, towards the front of the computer lab, slightly masked by the participant's silhouette. In the same field of view, I can also see the instructor as he paces back and forth explaining some element of the software we are using. This screen, just moments ago, was busy with activity. I can see many *Windows*: a text editor containing lines of computer code, behind the computer code a couple of other *Windows*, a web browser that shows a map with a layer of polygons drawn over the top. The static nature of Jacob's graphical user interface denotes the stalling of activity as his attention has shifted towards the instructor. Now Jacob sits passively. He appears interested in what the instructor has to say. His keen interest is indicated by a lack of attention given to the computer screen and the surrounding peripheral devices (the mouse and keyboard). There are no discreet mouse movements, no tapping sounds coming from the keys. Only when the instructor's explanation seems to come to an end does Jacob again begin to play with the *Windows* on his computer - switching between tabs in his web browser. Then again, only moments after this shift back to the workstation, the instructor begins to talk, once more drawing Jacob away from the intimate sphere that encapsulates his computer workstation.

Pete sits in the second row of computer terminals. In the background we can hear people talking, there are many different conversations taking place. A low murmur. Pete sits with his arms folded. At this time the instructor is not addressing the class. Pete's attention is directed at his computer workstation. He is no longer listening for instruction, instead, he is just reading through the learning materials. After a while he begins to use his mouse - clicking and moving it around. The low hum of activity in the room – chatter from the other students, the creak of the classroom door as it opens, and the ruffle of the projection screen as it blows in the wind – does not distract him.

Pete sits half reclined, infrequently scratching his head. His right hand is on the mouse and left hand upturned on the arm of the swivel chair. Although Pete's attention appears resolute he does not touch the keyboard – an action that would signify active engagement with the task at hand. After approximately five minutes of small mouse movements, and then tapping of his nails on the desk, Pete starts to type. He has been preparing himself. His apprehension to begin the task appears to lessen. He appears ready to make a mark on the page. The previous minutes of seeming inactivity were in fact preparation. He now has the knowledge or has processed the information required to make a meaningful interaction with the software. As I observe Pete in this way, I question how I can make such claims about what he and other participants are actually doing. In some sense, I am mostly recognising behaviour that I have observed in my own work. I am also relying upon what I know about interacting with a computer already. For instance, I know that you cannot write code with the mouse, you cannot edit a document effectively with a mouse.

I sit at my computer workstation on the back row of the teaching lab. From here I can see my own screen and the one to my immediate right. Often my attention shifts to the front of the room where the instructor gives direction. During these moments, my field of view is filled with screens. I find this an odd situation. Throughout the day spheres of attention are in constant flux: from the intimate space of the single user and his/her workstation – a sphere that also frequently amalgamates that of the adjacent participant, to ask a question or check understanding - to that where the class direct their attention towards the instructor at the front of the room. But there is something incomplete in the later definition. In one particular rendering of this situation it is reasonable to homogenise the experiences of the students as they pay attention to the instructor at the front of the class – to suggest that they, to differing extents, are relatively passive recipients of information, as the instructor directs their attention. However,

I think it interesting that from the instructor's perspective, everyone is looking at him. He has the attention of the class. It is not present in his mind that most of us have many monitors glaring back at us. All he can see is the black plastic casing of the LCD panels. In this image (Figure 52) we can see four screens all displaying different things. Immediately in front of me is a panel displaying a *QGIS* window with satellite imagery, to the right we can see something slightly different. This participant's display has an extra window on top of the *QGIS* window. The user in front and to the left has his screen split in two with the same *QGIS* window on the right and a text editor on the left, the screen to the far right is mostly out of frame but shows a web browser. Above these monitors, and dominating the field of view, is the instructor's desktop projected on a large screen. The pedagogic method employed by the instructor in this instance seems to be somewhat undermined by what we can see here. For this exercise, the instructor invites us to follow along with him, executing commands as he does, and so, what is on his display should be what is on our display. However, as I have just described this is not the reality, every monitor is slightly different. As an individual student, I look to others computer screens to validate my own progress, and when everyone else's screen shows something slightly different, I feel adrift.

The workshop leader for the day makes his rounds of the teaching lab. He strolls up and down every row of desks, checking everyone's computer screen as they explore the tools introduced in today's lesson. The students are currently working on their own volition, trying to get the web-based GIS they have created to work for them. As the workshop leader passes the student directly to my right she senses his presence and twists her torso to speak to him. Michelle asks if there was a 3D web mapping tool in open layers (the SDK that we were working with). The answer, he tells her, standing behind her, her twisting in her seat, half looking at him, is no, "But there is another library", he notes. But this might be interesting for others, he says, gradually raising his voice, breaking the sphere of relative intimacy, so that it is projected throughout the room. He marches to the front of the lab as more students wake up from a moment of intimacy with their computer. At the front of the lab he directly asks for the attention of the class and gives a demonstration of a web map service that allows the user to split the screen where contour lines are shown on the one side and satellite imagery on the other. The instructor stood at the front bending over his computer. He would perform one action then stand upright again to explain it to the class. Then, for more sustained actions, for instance drawing a "polyline" across the map, he spoke as crouched and drew a line across the screen using his mouse and cursor at the same time as explaining his actions and results. Here is an instance where I track a vector

from one sphere of attention, from the relatively intimate (and somewhat awkward) conversation between instructor and student, to a sphere that gradually envelops the entire class. In these kinds of situations, the seemingly a-spatial quality of virtual materials is undermined. Despite the notion that virtualised materials are everywhere and immediately accessible, in this instance the instructor needs to move to the front of the lab in order to display this material for the whole class.

SECTION THREE - Concluding Remarks

In this chapter, I reflected upon time spent with GIS practitioners as they worked on various tasks, and my own exploits attempting to familiarise myself with GIS software. In reflecting upon my collection of fieldwork notes, discussions with practitioners, and video recordings, I have written a collection of short vignettes that capture something of the doing of GIS, paying attention to pedagogy. I have structured these anecdotes to give a sense of the different ways in which individuals bring themselves into the practice of GIS. I focused on the ways in which practitioners employ certain modes of thinking, feeling, and relating, that allow them to immerse themselves in to a productive practice. These vignettes are a reflection of my observations, and therefore mine becomes a more explicit voice than that adopted in the narrativisation of interviews in the previous chapter.

In this chapter I have traced five themes that I found to be useful in understanding how GIS users immerse themselves in practice. Whilst these themes are not ultimately sequential, it might be useful to trace the process of their deployment in order to understand how they might work together. I begin with ‘testing the limits of the technology,’ where users attempt to familiarise themselves with GIS software and technology, asking themselves ‘what can I do and what can I not do?’ The user may ask themselves ‘how much space does this system allow me? What are the ontological restrictions concerning representation of space? What kind of actions are allowed, or how much data can I import?’ I liken this to an artist getting the feel for their medium, for instance, how wet is the clay, how thin, how much weight can it support. The second theme is ‘anxiety’. This tended to be most obvious when users were required to perform tasks that they were not entirely familiar with, for instance, learning specific skills, like writing computer code, or if the software did behave as they expected. For the most part this feeling of anxiety was found to stem from concerns of an unknown future – would they be able to get the software to behave correctly? Did they possess the knowledge required? Would they be able to master the skills in order to progress? Sometimes this feeling of anxiety could be guarded against by focusing upon one’s existing knowledge. One observation of GIS practice common, in this

chapter and the previous, is that it is often reliant upon a multitude of different skills and knowledge. It is this 'reliance on disparate and existing knowledge' – where one individual may have some prior experience of writing computer code and another have knowledge and an understanding of remote sensing, or where one individual is familiar with approaches for dealing with valuable material collections and the other adept in photography and image manipulation – that often affords users of GIS the confidence to overcome anxiety. What is interesting here is that these anxious individuals, who test the limits of the technology – sometimes in a playful manner, sometimes in an overly structured and systematic process – assured by their pre-existing knowledge and skill, begin to aggregate. They work in concert, in relay, sometimes in a canon (one after another) of activity. Bodies aggregate doing of GIS in particular way, a way that is different, for example, to those of soldiers marching in a parade. Unlike those of soldiers, where bodies mobilise in an act of physical discipline at the command of others, the body doing GIS is mind and body together. This brings us to the final theme, where this body and mind working together give rise to particular spheres of attention. These aggregated bodies working to do GIS constantly shift their attention. They ask others questions, are distracted by the activities of others. They are locked into particular modes of thinking and become obsessed with minor details. Sometimes these spheres of attention envelop an entire classroom, sometimes a single row of desks, sometimes one individual and a computer, and even a single fingertip touching a camera port.

CHAPTER SIX: Performing GIS

SECTION ONE - Introduction

The two preceding chapters have focused on a period of field work where I employed established social science methods, comprising unstructured interviews and participant observation, to gather insights into the nature of GIS practice. These fieldwork studies were designed to gain a sense of the doing of GIS via testimony from those who work with GIS on a daily basis as part of their job, and my own observations and participation at three different field sites where people were learning how to do certain GIS tasks. These chapters brought out specific themes that, in the case of the work-based interviews, centred around how individuals explain and rationalise their everyday practices of working in a GIS consultancy via a negotiation of repetitive, embodied decision making, made amidst a plethora of mundane objects and computerised components. In the case of participant observation, I focused on how certain spheres of attention were formed around specific sense-making activities and emotional dispositions.

What my observations, and the tenor of my questioning of GIS practitioners also reveal, of course, is my preoccupation with a creative GIS practice. As noted in the literature review, we can track a pervasive interest across social science, and the arts and humanities, in the nature and significance of creative practice in bringing to the forefront not only new ways of knowledge-making, but also a more-than-human world of distributed agency and affect. Therefore, this chapter looks to reframe a period of creative experimentation in relation to literature from human geography on creative and artistic practice, experiment, play, curiosity, and performance.

Much recent geographic scholarship has focused on how creative practice is animating more-than-human research. Marston and De Leeuw (2013) note how the role of art practice in geography scholarship has shifted from a descriptive practice to a productive practice to, “do political work in the world” (2013, p. iv), in that, the work of art has become recognised as an empirical object in geography. Moreover, Hawkins (2011) explains how creative practice is useful in destabilising structural ontologies. Furthermore, Gallagher and Prior (2013) underline how through experimentation geographers themselves might become creative practitioners. They claim, “experimental geography is thus explicit in re-envisioning the geographer not merely as a (critical) bystander, but as an active and creative producer of space.” (2013, p. 279) There is an emergent interest in such practices within the GIS community, as well as a growing

cohort of artists working with GIS. Kitchin (2013) notes how mapping practices have moved away from seeing maps as static, definitive records of the world, towards a more ‘ontogenetic’ sense of map making, where mapping practices ‘unfold’. Indeed, Kitchin and Dodge’s (2013) attention to crowdsourcing in mapping practices focuses on, “mapping as a processual, creative, productive act, constructed through citational, embodied, and contextual experiences” (2013, p. 19). That is, there is a distinct push by the GIS community to understand mapping practices beyond the technologically mediate form of praxis described by Jerome Dobson (1983). Moreover, GIS scholars, such as Mei-Po Kwan (2007, 2008) have written about working with GIS as a creative medium. Both Kwan (2007) and Butler (2006) have written about the artist Christian Nold and his *Bio-Mapping* project in which participants wore Nold’s wearable bio-mapping device to record and narrate the environments of their everyday lives. Butler explains how these uses of new geospatial technologies, “can be used to introduce multiple voices and conflicting readings of the landscape (and those that move and live in it)” (2006, p. 906). Moreover, efforts have been made to think through the performative qualities of practicing GIS and how artists have engaged with neogeography, in projects such as the *Everyone’s Eastlake* described by Lin (2013). Furthermore, geographers have increasingly been participating and collaborating in creative practices as part of their research (Foster and Lorimer, 2007; Hawkins, 2015). For Hawkins (2015), participating in creative practice offers alternative ways to intervene in the social, political, legal, and so on. Additionally, Hawkins notes how drawing, as image making, allows geographers to unpack the practice of looking, paying attention, mimesis, and, “the impossibility of capturing everything” (2015, p. 254). More pertinently for this PhD, Martin Dodge’s most recent report on cartography in the journal *Progress in Human Geography*, is appreciative contributions from more creatively inclined geographers, and Matt Zook notes that, “creativity is important” (2017) in figuring geospatial technologies.

For Last (2012) experimentation in creative geographies is productive in destabilising a, “presumed binary of artistic-creative and academic-utilitarian research” by “de-romanticising and ‘demystifying’ artistic practice” (2012, p. 718). For Last there are two aspects to ‘experimental geographies’: the first sees geographers adopting artistic modes of representation; and the second pertains to the undertaking of risky research that embraces the possibility of failure. Others have sought to re-evaluate how we apprehend the sites of experimentation (Powell and Vasudevan, 2007; Kullman, 2013). Kullman looks to challenge our perception of, “laboratories as instrumental and ‘placeless’ settings,” (2013, p. 881) and reposition them as

places, “deliberately arranged to generate surprises” (Gross quoted in Kullman, 2013, p. 881), and uncover previously undiscovered knowledge and agencies.

Curiosity is often cast as a relatively naïve apprehension of the unknown. However, Geographers have looked to understand curiosity as productive, how it is evoked, focused, and becomes useful in the academy (Phillips, 2010, 2012, 2013). Debates have also been framed around where, how, and who can be curious (Phillips, 2013). Phillips notes how recent research has attempted to separate curiosity from notions of childishness by evoking the concept of a ‘focused curiosity’ as a more disciplined and academically credible form of curious interrogation. However, Phillips looks to “reject simplistic distinctions between curiosity-driven and practical research” (2010, p. 448), dispel the notion that curiosity must be risky and dangerous, and the notion that efforts to control and contain curiosity somehow undermines something vital (2013). In similar vein, Zook (2017) advocates curiosity as well as a ludic approach to research geospatial media. He notes, “Because the internet is weird, we were not afraid to be experimental and play with the data – It was about playing with the technology... and it’s about wrecking up the gears.”(Zook, 2017).

Play too is often cast as a childish pursuit. However, Harker explains that play is not always, “energetic, irrational, or opposed to ‘work’” (2005, p. 59). Woodyer (2012) casts play as transformative, “allow[ing] children to experiment with social roles and socio-cultural and political-economic practices” (2012, p. 317). Furthermore, Harker (2005) discusses the vital role of objects, how they participate in the dissemination and heightening of affect, and reshape the capacities of bodies to attune to affective atmospheres. Woodyer (2008) advocates for a performative approach to researching children’s geographies. She is concerned with what the research context does to the researcher’s body, and furthermore, how the researcher performs their identity within embodied performance. As such, in performance, “the body, the subject, is never fully determined; not bounded, but provisional, relational and enacted, in constant dialogue with objects, environments, spaces, times and ideas” (Woodyer, 2008, p. 353). Performance scholars, such as Schneider (2012) have noted the difficulty in representing performance as such, “performance cannot reside in its material traces, and therefore it ‘disappears’ (2012, p. 101). For Taylor (2003) aspects of practice resist the textual knowledge of the archive; thus she evokes the concepts of the ‘repertoire’ as the lived, embodied traces of performance do not disappear but reside in the bodies and memories of those who encounter, create manifest and the performance.

Certainly, as this chapter in particular will illustrate, I brought to the PhD my own creative practice, founded on an energetic sculptural practice primed by a curiosity in regard to formalism and conceptualism developed during an undergraduate degree in fine art practice, and latterly a more design-focused master's degree at Central Saint Martin's College of Art and Design. The practice that I developed during my undergraduate degree was complemented by modules in exhibition theory and practice, doodling with technology, the image and the archive, experimental film and video, and art and philosophy (specifically, *The Origin of the Work of Art*). However, my master's programme was to some extent a deviation from this. Encouraged and influenced by the practice of my new designer peers, the focus shifted from form and audience to function and users. That is, my practice, that was primarily concerned with a somewhat tactile working of ideas and materials to elicit affect, adjusted to involve an understanding of the importance of things like establishing a common visual language, and a rigorous attention to empirics and observation.

Whereas my creative practice had previously involved creating large scale mixed media sculptures, assemblages and installations, my masters course, titled *Creative Practice for Narrative Environments*, specifically focused on interdisciplinary collaboration, and the creation of immersive and narrative environments. That is, as designers, we learnt how to work together to create spaces that tell stories. Moreover, this intensive two-year master's programme taught me a great deal about designers' approaches to research and practice. And here, I hope to show how not only how this practice shaped the course of the PhD, but also how my practice has in turn been transformed as a result of my PhD research and fieldwork. For example, the creative works I outline below intimates the influence of methods and attitudes employed by artists and designers, such as, mood boards, sketching, prototyping, and modelling.

Rather than working to create an image or assemblage of objects to create a sculptural form that aims to evoke a particular effect, I have always enjoyed the process of making art. To be sure, I have found it gratifying when components of a sculpture came together in surprising and aesthetically pleasing way ways but have also found it difficult to realise the end point of the practice, where the process stops, and the artwork is 'solidified'. I am happier to tear down and salvage materials so that I can immerse myself once again in the practice, the process of art making. I believe this commitment to process over product has been largely influenced by the works of designers Charles and Ray Eames. In my years of studying artists and designers practice, the Eames' apparent attention to process resonated with me enormously. I have spent a great deal of time watching the videos they made to document, and largely inform, their

research processes. It seems that for the Eames, the application of the medium of video to document their research processes was as much about playing with narrative and semiotics as it was about systematically documenting activities. That is to say, the Eames always seemed sensitive to the way in which the capacities of the medium say something about the qualities of the subject material.

In this chapter I pay attention to literatures relating to creativity (Foster and Lorimer, 2007; Hawkins, 2010a, 2015; Marston and De Leeuw, 2013), experiment (Powell and Vasudevan, 2007; Last, 2012; Kullman, 2013), curiosity (Phillips, 2010, 2012, 2013), play (Harker, 2005, 2010, Woodyer, 2008, 2012), and performance (Nash, 2000; Taylor, 2003; Woodyer, 2008; Schneider, 2012), and consider them in relation to a period of two weeks when I explicitly set out to use the materials of GIS – including hard and software, peripherals, office infrastructure, muscles, skin and thought - to create a series of works. As such, my activities were led by attention to the following:

- Creative Experimentation – Here, following Hawkins (2015), I paid attention to creativity, not just as a mode of representation, but as an interventionary practice. This thematic relates to how my own artistic training interfaces with the materials of GIS. As such, the data collected for the previous two chapters served as a creative reservoir for the creation of these art works, in that this period of creative experimentation allowed me the opportunity to revisit themes and materials from previous chapters. For example, I was able to draw upon what I had noticed about the time and effort spent managing and processing large amounts of data, and video footage from my observational study of GIS learning served as material for experimentation and exploration of alternative readings. Furthermore, this thematic also relates to Last's work (2012) on experimental geographies. I think through how I embrace creative modes of representation, playing with creative registers such as doodling, sketching, still life, re-enactment, storyboarding and so on. Moreover, I am also concerned with how one might conduct risky research in which productive outcomes were not guaranteed.
- Being Playful – For Woodyer, playing is, “a vehicle for becoming conscious... [t]hrough its playing with limits, experimentation with rules, roles and meanings, and mimetic behaviour, playing contains transformative potential”(2012, p. 322) Relatedly, by playing with the materials of GIS I was able to develop understandings of them that would so easy to access in more traditional forms of geographic enquiry. Resonating with

Woodyear's constituent activities of play, I 'test limits' of the materials of study, create 'rules' and games, and re-enact as a form of 'mimesis' all in the hope of creating something that transforms my perception of the subject.

- Curiosity – This thematic broadly relates to the work of Richard Phillips (2010, 2012, 2013) on curiosity, and its relevance in an academic context. Here I cast my creative practices as productive, paying attention to the everyday and the mundane, as a credible form of knowledge creation, and creating space that facilitates curiosity. As such, I rearranged my office space into a kind of makeshift art studio cum archive of GIS materials. This involved repositioning the furniture in my office, collating my fieldwork data, and bringing in various other pieces of equipment to facilitate the creation of artworks. This period of creative practice was intentionally short so as to encourage a charrette-like approach to the production of ideas and works. That is, my plan was to create a different piece of work at least once a day and to foster an environment where I could work intensively and rapidly. Instead of working towards one art project, the intention was to create many sketches, doodles, and experiments.
- Performance – Here I follow Woodyear, who notes that, “the body, the subject, is never fully determined; not bounded, but provisional, relational and enacted, in constant dialogue with objects, environments, spaces, times and ideas” (2008, p. 353). As such I chose not to frame the products of my period of creative practice as finished artworks, but as documentary records of performative creative practices that are attendant the practices involved in *doing* GIS. Framing them as documents rather than artworks speaks to how performances resist representation. Furthermore, I feel I was performing a kind of hybrid identity, to-ing and fro-ing between GIS practitioner and artist, testing the water, until I found a comfortable spot between the two.

The following is a list of the works that I made during this period²:

1. Figure 53 - Snapshot of my Workspace – This is a simple photograph taken to illustrate the reality of the messiness of my creative practice.

²The videos referenced here can be found at <https://vimeo.com/album/4314321>

2. Figure 56 - Focus Stacked Still Life – This is a high-resolution photograph that I created by merging multiple photographs of a still life of arranged objects, materials, and components in? my studio workspace.
3. Figure 57 - Screen Shot Sequence Posters – These are two posters that I created that simply present a sequence of screen shots taken whilst working through a QGIS YouTube tutorial.
4. Figure 54 - Zoom and Pan Home – This is a video that simultaneously shows seven web mapping sites being used to locate the University of Glasgow.
5. Figure 60 - Printer/Mouse Interfacing – This video uses a split screen composition to muse upon the relationship between embodied movement and the computer interface.
6. Figure 58 - Downloading the World – This is a video that documents the process of downloading an archive of GIS data for the whole world from the OpenStreetMap website.
7. Figure 61 - Rendering the UK – This is a video that documents the time and effort required by a Raspberry Pi computer to render all UK data held by the OpenStreetMap website to a display.

This is by no means an exhaustive list of material produced during this period. There were in fact many other bits and pieces of documentation, doodles, sketches, and video clips that did not make it into any semblance of a completed piece of work. However, this selection of work does go some way to represent the array of concerns and ideas that surfaced over the course of the two weeks. As they appear in the above list, they are in a roughly chronological order – although some of the pieces were created using footage taken earlier in the process and put together later on. I consider all of these works as documents of practice. That is, these videos and images reproduce only a limited slice of the affect that these activities produce. For instance, the embodied interaction with the machine technology is at best only implied in these documents. Indeed, in some of these pieces the production of the video or image is more constructed. That is, I have employed certain layering, collage or narrative techniques to heighten the affective qualities of the piece.

One way of narrating these works, aside from chronology, is to loosely frame these according to the type of activities and ideas I was thinking about when I made them. For example,

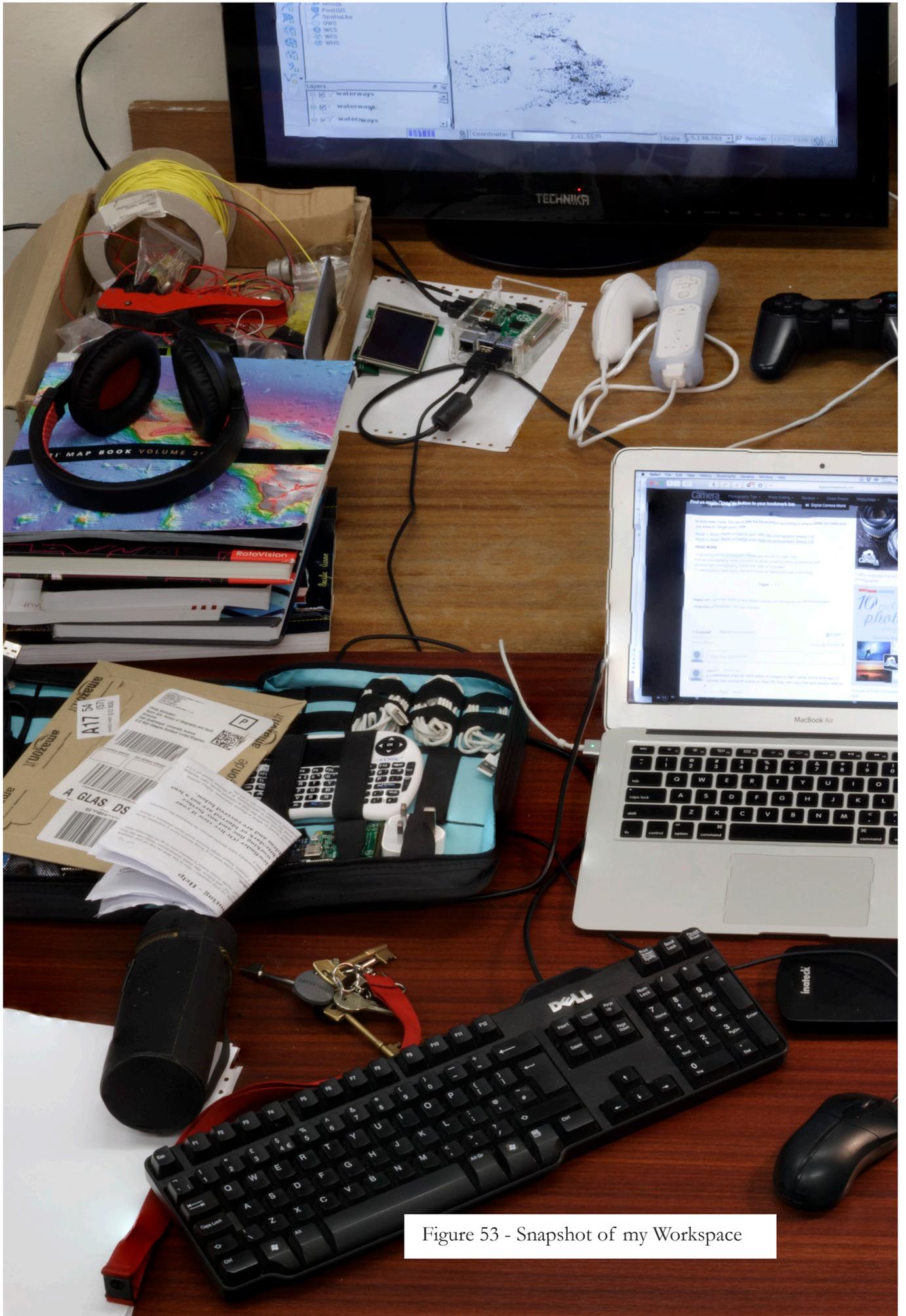


Figure 53 - Snapshot of my Workspace

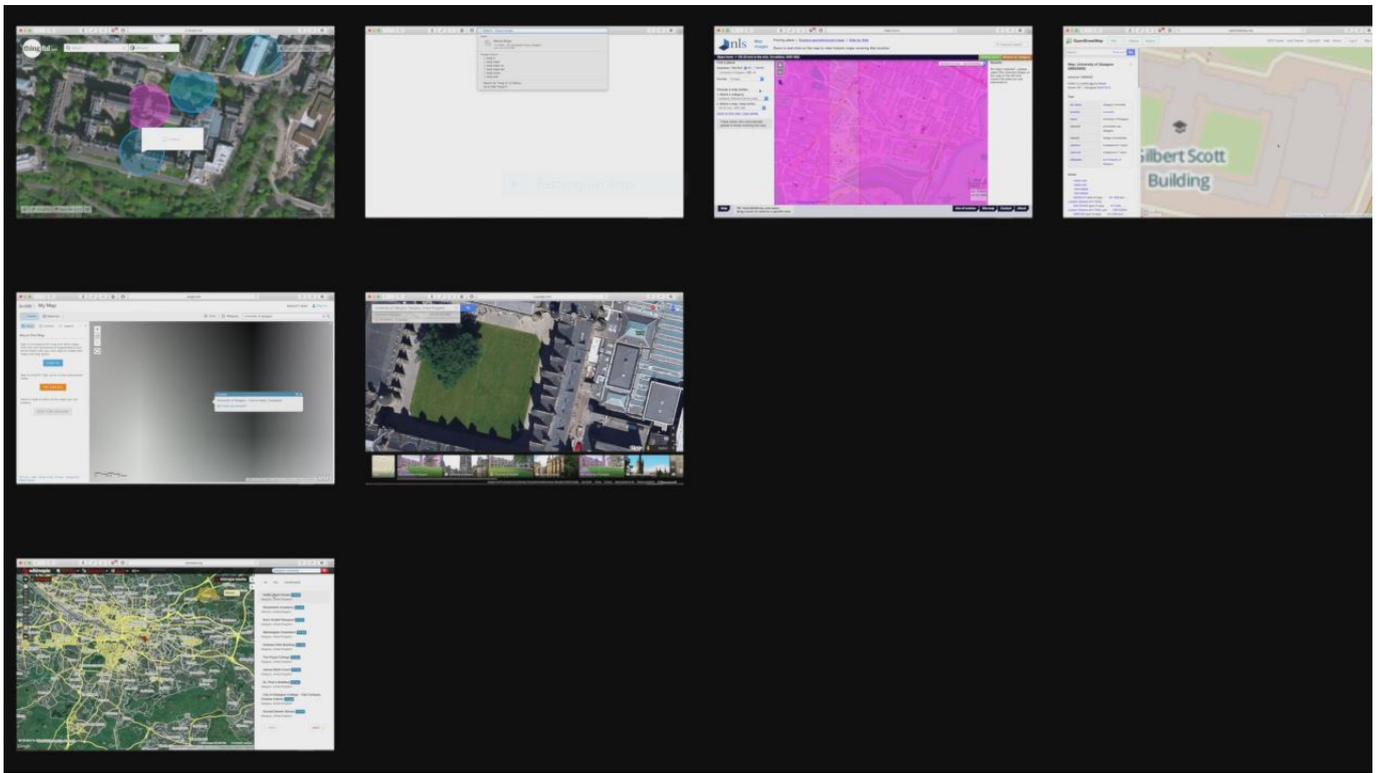


Figure 54 - Zoom and Pan Home

- Collage – Works one to four – Some of the works use collage to re-contextualise or juxtapose images to imply alternative readings. Furthermore, this use of collage is exemplary of the visual way in which I think through ideas. The way in which I use collage is more akin to the way in which a designer creates a mood board. That is, rather than composing a specific arrangement of images to communicate a particular idea or message, images are compiled, layered, and arranged in order to generate meanings, or formulate ideas.
- Zoom and resolution – Works two, four, and five – With these works, one of the ideas I was playing with was the way in which zooming, and panning seems integral to the visual language of GIS. In a sense, zooming and panning across images of the landscape with ‘slippy maps’ becomes synonymous with these types of technology. I wanted to explore how zooming and panning become such automatic and embodied actions – where the body makes things happen on the screen – but also to think about the ways in which the GIS GUI represents information at different levels of zoom.
- Visual Language – Works two, three, and six – During my fieldwork I found that the practice of GIS is facilitated by a very distinctive visual language. That is, GIS interfaces employ a particular way of ordering graphic or visual information to communicate information to the user. One way in which information is ordered is by a grid. Grids are used in various way, not least in the form of the graticule (to order geo-located objects on the map viewer), but also in the form of tabulated attributes (where these objects are defined in a table), and more broadly in the graphical user interface, where *Windows*, side panels, and drop-down menus, all conform to a convention of visualising information according to an ordered arrangement of straight lines and spaces. There is a parallel here with designers’ fascination with ordered arrangements of objects, something that is effectively distilled in the images submitted and published on the *Tumblr* blog, ‘Things Organized Neatly’ (Radcliffe, 2016)(Figure 55).

The person arranging the items is inherently exercising his or her aesthetic preferences. Even if the objects are arranged scientifically, by size for instance, a pattern reveals itself. So neatly organizing a subject will give visual interest, and even function to the viewer. Precision is beauty.(Radcliffe quoted by Kenedi 2011)

With these works I sought to understand the nature of the visual language employed by GIS. In addition to exploring the grid in relation to visual language, other works paid attention to the aesthetic qualities of the command line interface and the ubiquity and significance of screen shot-type images in GIS practice.

It might seem as though the works detailed here tie up as neat little packages of inspiration, or imagination, or experimentation. And yet, what I found most interesting about the entire process of doing this work was the amount of time that I spent frustrated, not knowing what I was doing. It was the time in between the activities described here that reveals a great deal about my way of working. I spent about 70 hours in the temporary studio space for this project and each of these creative experiments, doodles, sketches only took about half of that time to complete. Most of that time I just sat there, organising things, tidying up, pacing the office, staring at the objects on my desk.

In this sense, I would liken my approach here to that of the flaneur. I regard my slow and meandering contemplation of GIS by way of creative practice as a type of flaneurie or “form of perception”(Buck-Morss, 1989, p. 345), where certain anxieties, such as a distrust of the aesthetic qualities of digital or machine technology, manifest themselves as a critical eye adopting a policy of “look, but don't touch”(pg. 345). Relatedly, as Susan Buck-Morss (1986) observes, the flaneur's ability to “transform reality into an object that can be consumed passively, pleurably, and directly,” resisting the temptation to turn this into, “a tool that will make it possible to wake up from the dream”(pg. 144). That is, in practice I immerse myself in the imagery, technologies, and processes of GIS so as to understand, and make sense, though not necessarily to realise some kind of hidden meaning or transcendental clarity, rather to represent in a more palatable fashion.

Relatedly I would like to posit that the efforts detailed in the chapter serve as documentation of my becoming an embodied archive of GIS. Leading on from Buck-Mors' claims about the ability for the flaneur to turn mass culture into something more palatable and Guevara's claims about the repertoire, meaning embodied archive, perhaps the body of the flaneur is a more appropriate site for record. As Guevara (2005) notes, “the embodied knowledge of the repertoire resists the written knowledge of the archive” (p.240). In performance studies performance is often referred to as that which does not remain. This lies outside of, or is the remainder of, the archive or what might be more usefully termed the analogue archive. It is performance's specific trouble with representation that means that, “according to the logic of

the archive, ... performance cannot reside in its material traces, and therefore it 'disappears' (Schneider 2012:101). It is argued that it is only through the embodiment of such singular knowledge that such knowledge can be preserved in, 'the repertoire'. And, it is this experience that I wanted to foreground in my 'final' piece, which focuses on the material and embodied (working off anxiety etc.) traces of this PhD project, and themes from previous two chapters to create some kind of curated exhibition.

SECTION TWO – Works

Focus Stacked Still Life

From quite early on in this PhD project a period of sustained creative practice seemed to be a clear objective – and in a large part entirely appropriate considering my own academic background. Visual literacy is perhaps my most highly developed skill. Whilst I struggled to come to terms with the conventions and methods of human geography, and more broadly social science, research – literature reviews, establishing a conceptual framework for the project, and designing a fieldwork study – I was consoled by some of the creative methods that had sustained my creative practice. Creative methods, such as collage, doodling with technology, keeping a sketchbook-like note book, and so on, allowed me a realm of relative comfort in which I could make sense of my activities with methods with which I was familiar. One such method was to keep a folder on my computer into which I would occasionally drop images found online. I would bookmark online articles, news stories and webpages I found interesting. For the most part I did not immediately understand the direct significance of these materials. The purpose of this makeshift repository of ideas was to allow patterns to emerge as the materials amassed. This is a process of collecting found images that strike a chord, create oblique linkages, and form abstract relationships with a particular subject – in this case, my apprehension of GIS practice. As this repository of materials increased in volume I gained a better idea of how these materials might be analogous to one another.

This photograph (Figure 56) is a kind of sketch, or doodle, created in order for me to get a sense of the materials I had accumulated. The objects presented in this composition were accumulated as I was preparing to transform my office into a temporary art studio. Adopting the same sensitivity when collecting materials for the aforementioned repository of materials, in the weeks leading up to this period of creative practice I rummaged through my storage cupboard at home looking for art supplies, electrical components, books, and antiquated computer equipment. I

kept my eyes open around the Geography department for similar materials that I could add to this collection of materials and objects. I collated my research data (which included the aforementioned repository of materials), printed it out, and put photographs and desktop screenshots on the wall. I filled my office with all sorts of materials and shifted the furniture so that all of these materials were centred on two desks.

I set up the space as a physical archive of all the materials I have found analogous with my perception of what GIS is. Just as I tried to get a sense of these materials – that I felt had some relationship to GIS – by positioning them in an archive of found materials, I attempted to make sense of these materials by re-staging them in this makeshift studio space. This is another example of a method that I have often used in my creative practice to better understand the qualities and hidden meanings of subject material. By re-assembling, re-arranging, and re-contextualising the material I hope to gain a deeper understanding of how the materials might fit together. Moreover, this process of re-staging, creating repositories of found materials, and so on is part of a larger creative strategy of playing with materials, constantly reshaping the terrain on which the materials exists, and shifting and adjusting the angle of perspective.

In a sense, this was my first attempt to index the materials I was to use in this project. I placed all of the materials on the two desks that I had pulled together in the centre of the room. At the back of the desk I placed two display screens. One was a widescreen TV, the other a basic Dell LCD screen that belonged to my office workstation. Behind the Dell monitor was the Dell desktop computer. In front of the widescreen LCD TV was a Raspberry Pi. Each computer had a mouse and keyboard attached so that they could be used. Laid out on the desks between me and the monitors at the back were a number of materials that I felt would be useful in these two weeks of creative practice. There was a PlayStation 3 gamepad, a Nintendo Wii controller, my laptop and portable external hard drive containing a great amount of fieldwork data from the previous year. On the surface of the desk I laid out coloured card and paper which I felt allowed me to create a number of sections on the table.

Whilst laying out these materials I was beginning to think about taxonomies – that is which objects should go next to each other, I created loose relationships attaining to the utility of the objects. On one piece of red A4 card I placed only materials and tools for the manipulation of electronics: a breadboard for prototyping, some clear LEDs in a clear plastic bag, some electrical tape and a battery holder, adjacent to that sheet of paper was a greyish blue sheet with wire cutters, a large spool of yellow single core wire, some more LEDs (yellow this time) an

incandescent light bulb, and another bag of multi-coloured LEDs. Bottom right of the workspace were a pile of books on subjects such as big data, emotional mapping, and an introductory guide to GIS. These books were piled upon a white sheet of A4 paper.

There was an element of constructing this still life in which there was no specific schema as to where to place objects. Objects that shared a particular piece of paper (framing them) did have some kind of taxonomic relationship, but the positioning of these individual tiles of paper had no purposeful spatial relationship to one another. When I was making decisions on the overall composition I was more concerned with a formal aesthetics – that is, where things went so as to draw the eye into the image – rather than any specific meaning inferred from the utility of an object, or collection of objects. When considering the overall composition of this assemblage of materials I tended to think of it as a collage where the purpose of each layer is to re-present the adjacent or partially covered layer. The aim of this kind of image production is not always to compare and contrast, but often to complement, or re-present in unexpected ways. We can also look at this image in terms of the stories it tells. What kinds of narratives can be extracted from this collage of metaphors and signs? We have objects that speak of computerisation, technology, some objects speak about the relationship between computer and human beings as the interface.

Some of these technological objects speak to expertise. For instance, the expertise needed to operate a Raspberry Pi, and antiquated technology such as the dot-matrix printer. Some of this technology denotes a more consumer-focused, everyday user cohort - such as the tablet or *MacBook*. Also, electrical components and tools, and a carrying case containing USB cables, USB flash drives, and power supplies speak to more tech savvy or technical approach. There are also items that relate more to the biology of the human user - such as the migraine medication, the drinking bottle and empty coffee cup suggests something about the stimulation, medication, and hydration needs of the human body. All of these objects tell us something or allow us to make assumptions about what kinds of activities might take place using these materials.

I chose to manipulate and construct this photographic image using a digital process called focus stacking. I took photographs of the assemblage using my *Canon 70D DSLR* camera with a *Canon 50 mm 1.8 lens*. The photographs were taken with the aperture closed right down so as to create a large depth of field. A large focal range also has the effect of flattening the image, as most of the frame – background to foreground – is in focus. A small aperture, however, means that less light is allowed into the camera and therefore I had to set the camera to take photographs with

a relatively long exposure and set the camera on a tripod. I placed the tripod with the camera on top of a table in front of the desk so that I could fit the whole assemblage and desk in the frame. I angled the LCD view screen, so I could see what would be captured. In order to capture all of the objects in sharp focus and high detail, I took a series of images with the camera and tripod in the same position. For each photograph I was able to select a different object in the field of view to focus on. I was left with approximately 20 photographs of the same composition with subtly different focal points. I transferred the SD card from the camera to my laptop and opened up the *Adobe Photoshop* application. Using the focus-stacking tool, I merged all of the individual photographs into one. This had the effect of flattening the image, but it also created an image where all elements, or objects, have the same level of focus; there was no hierarchy in the focal range. This focus stacking method also has the effect of evening out the concentration of light in the image. This means that a human eye looking at this assemblage of objects would have noticed that it was lighter in the top corner where the lamp was shining. Instead, the final image is a hyper real composition where light levels appear consistent (despite the fact the lamp is visibly switched on) and sharp focus encompasses the entire image. We are left with the flat, hyperreal, still life collage of materials and objects, similar to the flattened images on a computer screen, and GIS maps and renditions of space.

Screegrab Sequence Posters

At the beginning of this period of creative practice, I also put up two A0 posters (Figure 57) that contained screegrabs from a *QGIS* walkthrough that I had followed in order to get a feel for how the software worked. I took screenshots of my desktop at key moments in the relatively arbitrary task of plotting natural gas wells in the North Sea and their proximity to London. These posters resembled comic strips, or sequential art, where each screen grab was a cell in a storyboard that illustrated my progress through the tutorial. Following this tutorial guide, and in other places throughout my fieldwork with GIS practitioners, these screegrab images were ubiquitous. This kind of screegrab illustrations were often used in combination with numbered procedures and also annotated with coloured arrows and circles that instructed the user where to look or to click. However, in my appropriation of this visual form I decided not to include any kind of annotation. Instead, I wanted to allow these images to speak for themselves by isolating them from their ordinary context. The idea was to hold this fundamental emblem of GIS learning apart so that I might say something about the visual literacy of GIS practice.

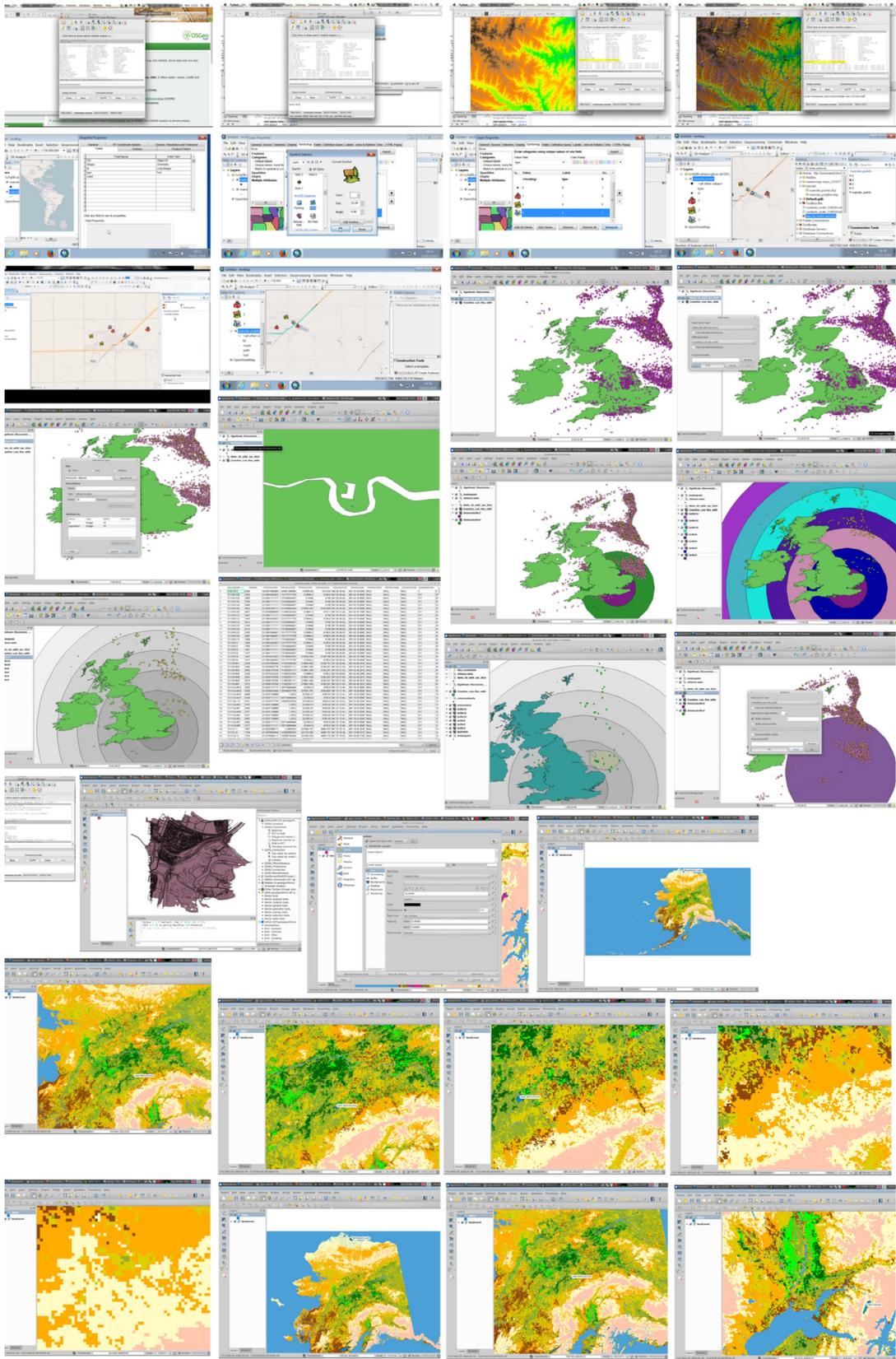
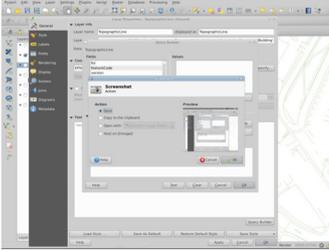
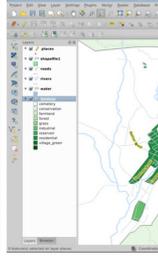
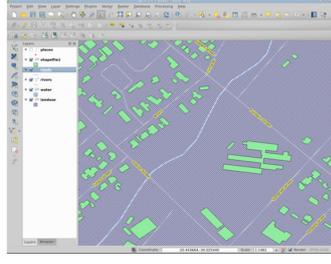
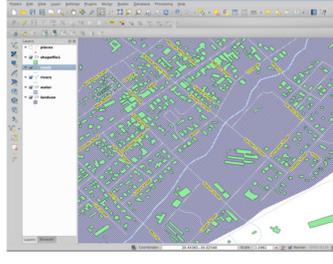
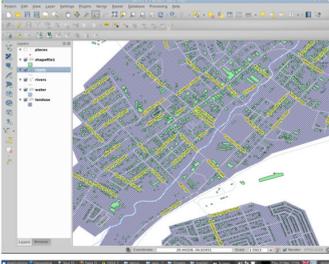
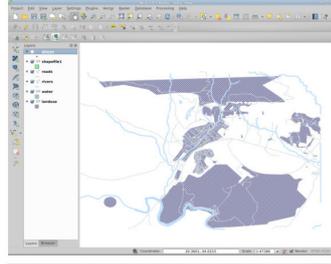
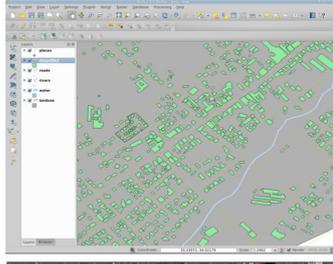
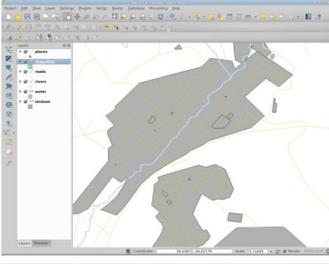
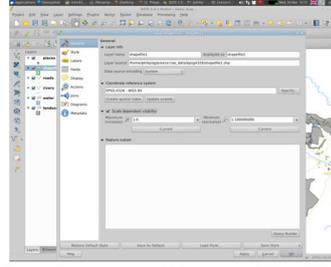
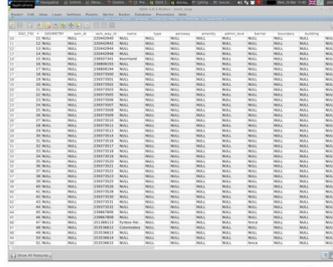
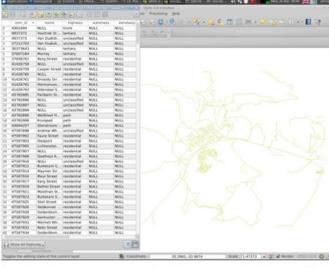
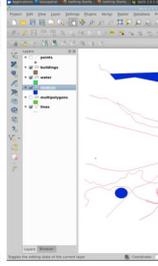
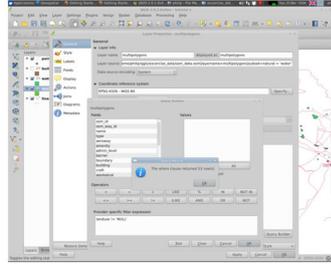
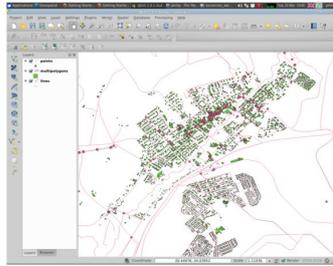
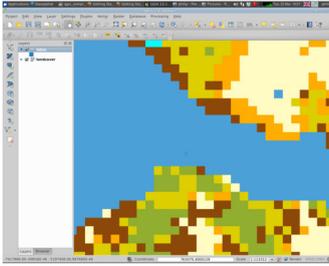


Figure 57 - Screenshot Sequence Posters



When I assembled these sequences of images in this way, and hung them above my workspace, it was not to solve a particular problem. Their reason for being in the space was not to represent any fixed meaning for this convention of screengrab images. As with most of the materials collected in this temporary studio space, these posters were provocations. They are sketches, meant to inform other practices that take place around them. The purpose for creating these posters was to inform other works created in the space (my office or studio). It was a way of visually representing some of the ideas I had about GIS practice, to distil some of the imagery I have found superficially interesting but have not yet worked out their broader significance in the practice of GIS. The sketches serve to represent assumptions I had made about GIS practice, as visual stimuli for me to muse upon, and to take inspiration. They were also for me to ignore and then return to as they hung above my workspace, to be part of the studio archive of ideas. They were doodles, studies, or sketches made to store certain concerns and observations. They were hanging questions, a peripheral reminder suspended so that they might inform further activities. As I focused on other creative experiments throughout this period I would often glance at the posters on the way and be reminded of these concerns. For example

- What kind of stories do these images tell when the annotations are stripped away?
- What makes them the first point of call, the ‘go to’ visual aid for GIS practitioners?
- Why did I choose to arrange this sequence of images in a linear form?
- What do these images tell me about the types of visual literacies employed in GIS practice?

I believe that art studios need these artworks, half-finished sketches, objects whose significance is not yet understood or realised – at least consciously. The art studio needs an element of messiness, to be full of materials and objects that even in their inception are ready to be thrown away.

Downloading the world

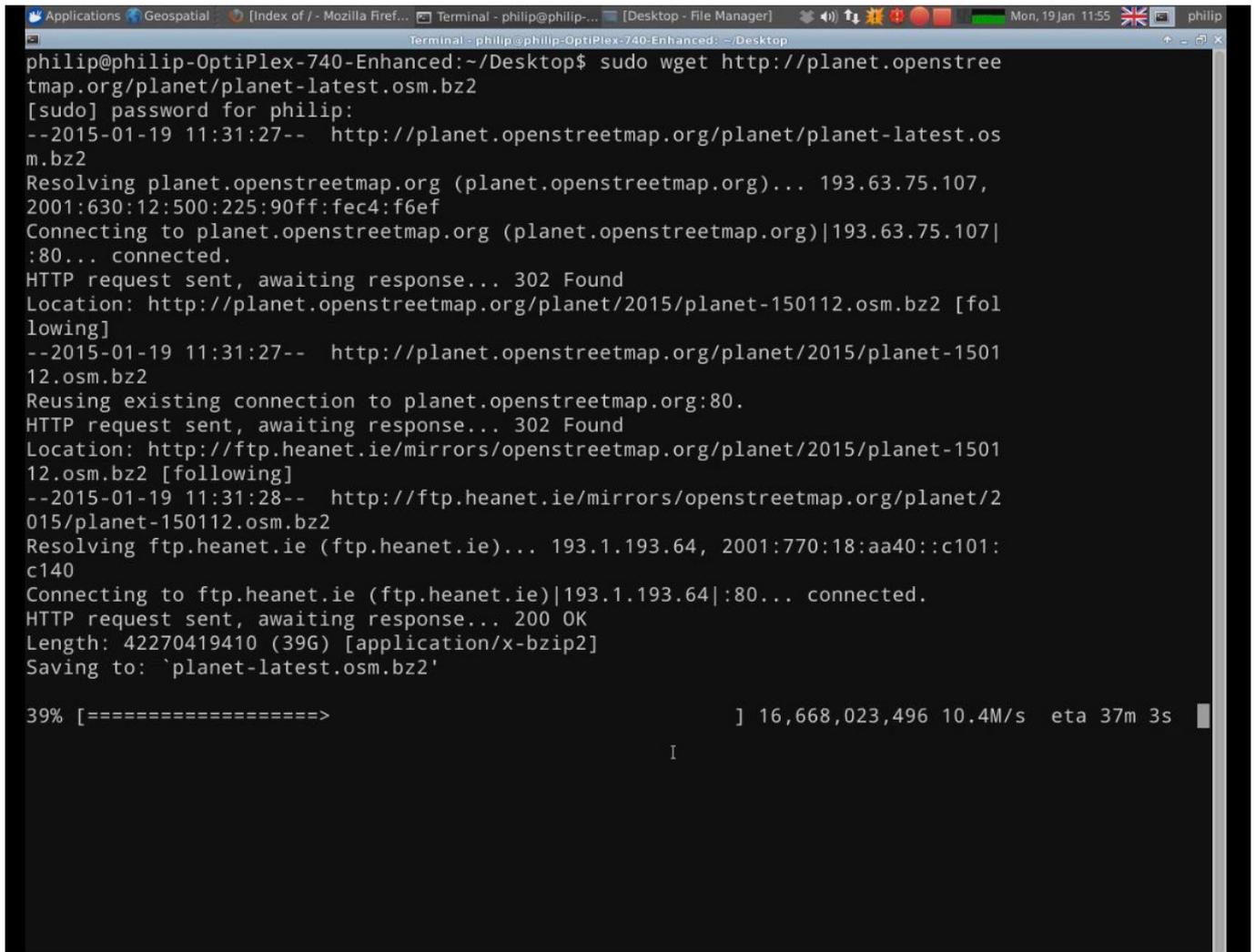
This was a piece informed by my experiences of working with GIS software. In the early days of introducing myself to the technology I spent many hours preparing myself for a period of working with GIS software. The first time I did this I had to find the software online. I googled *QGIS*, found a website, and downloaded the application. I installed *QGIS* on my PC and launched the application. I would sit at my desk, in my office, in front of the application interface

ready to 'have a go,' ready to 'see what it could do'. My only problem, I had no data. Where was I to acquire data? With no experience in geomatics, mapmaking, or GIS in general, I didn't know where to start. I didn't even have a question to ask. My way into GIS was via *YouTube* tutorials. However, what I found was that in order to get the software to do anything you needed to be equipped with some kind of raw data. This set the tone for much of my experiences of researching GIS practice. In video walk-throughs the first instruction, and often one that was interspersed throughout the process of working on a GIS project, was downloading data from various sources – often online. During my fieldwork, I observed GIS practitioners putting a lot of time and effort into the acquisition of data from all sorts of media. Often, they would spend a great deal of time waiting for files to transfer or download from one system to another.

The transfer or download of data is often initiated or set going by the user and then pushed to the periphery, as the process completes of its own accord. On some occasions, it would interrupt the practitioner's home-life, requiring them to remotely login to the office computer from home at midnight to check on the progress of a file transfer, or particular process within a GIS programme, such as *ArcMap*. Sometimes the process, or transfer, might take only a matter of seconds. In situations where the next task in the workflow relies upon this data to be processed the user does not have time to work on something else while the transfer completes. It is these relatively tiny periods of time that I found most interesting. These tiny blocks of time, often only a matter of seconds, leave the user with nothing to do but stare at the screen, sometimes with a progress bar, or scrolling terminal window. When I started to make this video sketch I was thinking about these very short periods of time. I was imagining how I could open them up. I was wondering how I could explore these fleeting but frequent periods of frustration, and boredom experienced by the user. I wondered what would happen if I stripped the process of downloading data of its context within the workflow. What happened was that the process appeared to become exaggerated. Every element of the process was elevated in my perception. A process, that normally seems to disappear into the doing, that normally appears peripheral, becomes drawn-out.

This video sketch (Figure 58) focuses on this process of downloading a file from the internet. In this piece of work I wanted to explore themes such as the 'data heaviness' of GIS practice, and the consequences this has on the perception and management of time for the user. For this re-enactment, I made a screen recording of downloading a massive chunk of data (about 40 gigabytes) from the *OpenStreetMap* website. The video shows my screen and the cursor

Figure 58 - Downloading the World Screenshot



```
philip@philip-OptiPlex-740-Enhanced:~/Desktop$ sudo wget http://planet.openstreetmap.org/planet/planet-latest.osm.bz2
[sudo] password for philip:
--2015-01-19 11:31:27-- http://planet.openstreetmap.org/planet/planet-latest.osm.bz2
Resolving planet.openstreetmap.org (planet.openstreetmap.org)... 193.63.75.107, 2001:630:12:500:225:90ff:fec4:f6ef
Connecting to planet.openstreetmap.org (planet.openstreetmap.org)|193.63.75.107|:80... connected.
HTTP request sent, awaiting response... 302 Found
Location: http://planet.openstreetmap.org/planet/2015/planet-150112.osm.bz2 [following]
--2015-01-19 11:31:27-- http://planet.openstreetmap.org/planet/2015/planet-150112.osm.bz2
Reusing existing connection to planet.openstreetmap.org:80.
HTTP request sent, awaiting response... 302 Found
Location: http://ftp.heanet.ie/mirrors/openstreetmap.org/planet/2015/planet-150112.osm.bz2 [following]
--2015-01-19 11:31:28-- http://ftp.heanet.ie/mirrors/openstreetmap.org/planet/2015/planet-150112.osm.bz2
Resolving ftp.heanet.ie (ftp.heanet.ie)... 193.1.193.64, 2001:770:18:aa40::c101:c140
Connecting to ftp.heanet.ie (ftp.heanet.ie)|193.1.193.64|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 42270419410 (39G) [application/x-bzip2]
Saving to: `planet-latest.osm.bz2'

39% [=====] 16,668,023,496 10.4M/s eta 37m 3s
```

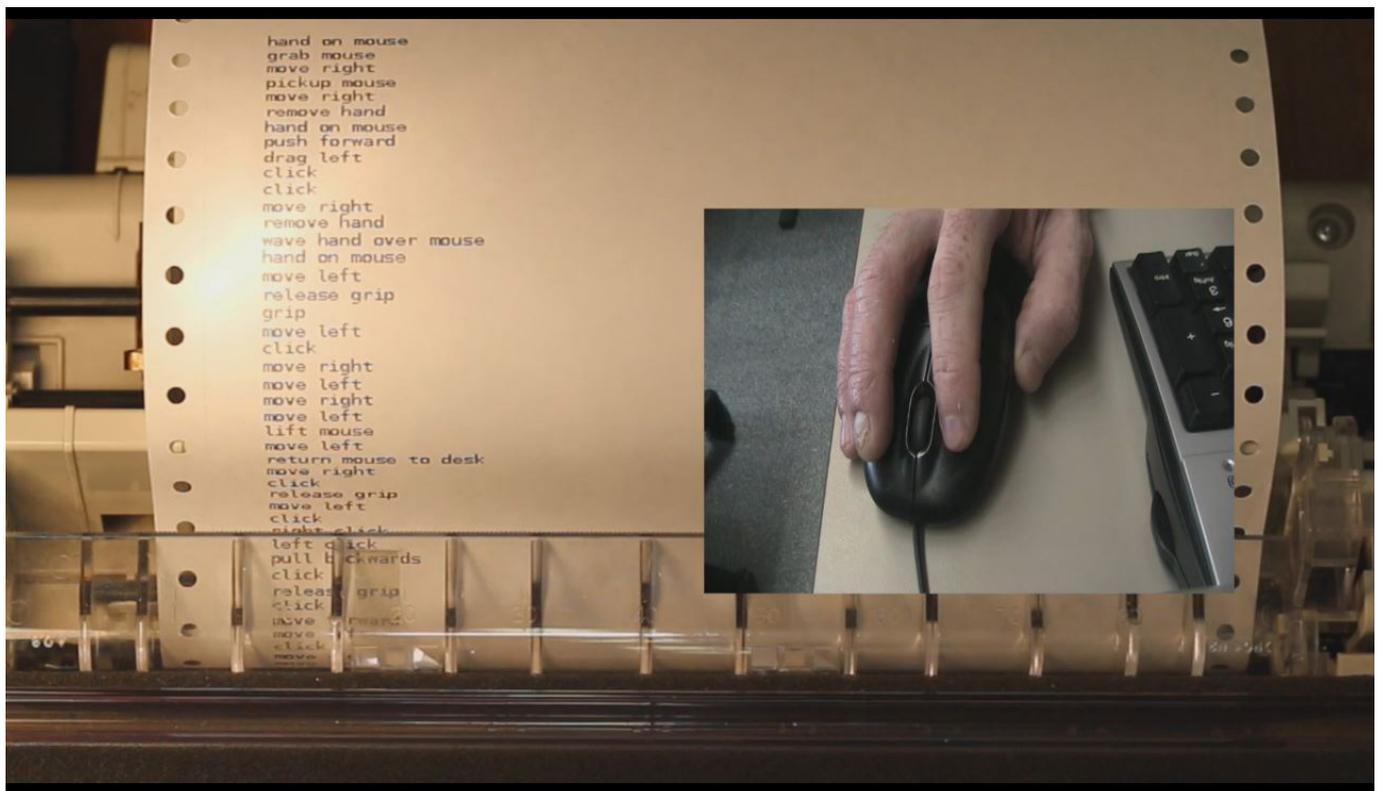


Figure 59 - Printer/Mouse Interfacing

movements – implying the use of the mouse and keyboard – as I go about finding data with a Google search. Because the process was rehearsed I knew exactly where to find the data. In this way, I play with the form of desktop recording. This is a re-enactment – but also an appropriation of the formal qualities and visual literacy employed by GIS tutorials. In the video, I copy the link from the web browser and then open a command line terminal window. In white text on a black background I type a command, containing the link copied from the web browser, into the terminal window, and this command instructs the computer to get the file from the specific location on the internet.

Ordinarily, a web browser would have been perfectly able to deal with this request. I could have simply clicked the link in the browser and the files would have been downloaded to the desktop computer hard drive, but for the purpose of the video I wanted to exploit the visual language of the command line. The aesthetics of working with the command line terminal can be quite alienating to some. Is not so user-friendly – white or green text on a black background – it mystifies the everyday user of attractive graphic user interfaces. The terminal interface is often incorrectly associated with other types of computerised text such as programming languages such as C++, Java, Basic, and Python. There is a sense that is difficult to operate, requiring a specific vocabulary and privileged access. Even I, who am somewhat familiar with the commands required to make things happen, often find it obtuse. Enter an incorrect command, a letter out of place, and it will often scold you with phrases along the lines of “incorrect command” or “unspecified path.” Nevertheless, in my experience of observing GIS practice and working with GIS software myself, I encountered this enigmatic computer interface regularly. This makes this piece something of a re-imagining, a reassembly, a reconstruction rather than a shot-by-shot re-enactment. Is it not the case, that in the practice of historical re-enactments, for instance, that there is something in the subtle accidental and sometimes unavoidable anachronisms that contributes to the charm of these practices? With this in mind, it would be better to describe this piece of work as borrowing from the formal language of re-enactment. It is, rather, a re-delivery of certain concerns, a certain sequence of events, re-contextualised, that elevates and highlights specific nuances of the original. In a sense, this is an allegory.

My intention was to invoke in the viewer sense of frustration and boredom. Very little visibly ‘happens’ in the video. A link is obtained from a web search, the link is then written into a command in the terminal, and the command is executed. This process at best – to anyone familiar with the terminal – is banal, or even superfluous, and to some – inexperienced with this

kind of interface – incomprehensible. Then, after the command is executed, the viewer sees a series of concise, hard-edged statements, produced by the computer, scroll down the screen. At the bottom of the page a progress bar appears, which begins counting up to 100%, and down to 0 minutes and zero seconds. The viewer is then left (as the user seems to have ceased activity) with the remaining 20 minutes of the video with which to contemplate time lost waiting for things to run.

Printer/Mouse Interfacing

This video is perhaps the most refined of the sketches that I put together during this period of creative experimentation. It is by far the most composed of the pieces that make up this collection. By this I mean that when I began making this video I had good idea of how it would look, the concerns that it would address, and how I would go about making it. Primarily, my intention with this video was to say something about the user interface as a set of surfaces, objects, graphics, wires, and so on that facilitate the actions of humans, or movements of their bodies, to bring about a change in the state of the computer and its software. I imagine the interface as a bridge between two incompatible languages – or spheres of understanding: that of the computer, at its most fundamental level a binary language of ones and zeros, and that of the human, an assemblage of an infinite number of different aural, and physical movements of the body. The computer offers the interface as a technology of translation, taking in the language of the human – for example, in the form of commands, that resemble written English, typed on the keyboard, and analogue movement of the mouse across a two-dimensional plane – and converting it into something more easily understood by the computer. As computer technology progresses, these interfaces seem to become better at interpreting human actions, moving from a state where the use of the devices that facilitate this translation – such as mechanical devices such as keyboards and mice, and software like the command line interface – have to be learnt, to new more intuitive technologies like capacitive touchscreens (like those used on tablet computers) and voice control.

When I was carrying out my fieldwork study, I spent a lot of time collecting data – in the form of video – that isolated some of these embodied actions involved in interfacing with a computer. This practice of isolating and framing specific actions and behaviours that make up the sphere of the interface, such as recording only the movements of a hand on a computer mouse or making screen recordings to capture the movements of a cursor in which the movements of the mouse and hand that control it can only be implied, allow me to pick apart the system of the

interface. For instance, using the camera viewfinder as a framing device to isolate elements of the interface, to focus on a particular scale, such as that of the mouse and hand, allows me to think about the ways, that the shape, texture, utility, weight, and pliability of the computer mouse affect the practice of working with the computer. Observing and thinking of objects at this relatively micro scale pushes everything outside of this sphere, peripheral devices, to abstraction. That is, I cannot see the effect that the mouse movements have on the computer and therefore I have space to imagine what is happening. For instance, I imagined the wire as a conduit, taking information out of the frame to be processed, or translated into something that makes sense to the computer. I could imagine how this information is translated, so that it makes sense to the computer and software.

With this in mind, sitting on my swivel chair, half day dreaming, looking at the array of objects on the desk in front of me, my eyes fell upon the dot-matrix printer. It seemed as though the frayed ends of ideas and imaginings started to mat together. This object is reminiscent of a time when computer commands were input using punch-tape, before the smooth edges of modern graphic user interfaces, when results were ejected in a format that required specific expertise to decode and make sense of. This was a time before the computer mouse, before a video display unit, a time when a great deal of training was required to use the rudimentary interface. By today's standards, the way in which computer users instructed the computer was much further from everyday methods of human communication; in a sense, closer to machine language, requiring more training and familiarity with the technology. My idea was to create a video using split screen to illustrate these two elements of the interface. That is, one frame would focus on the relatively analogue and embodied actions of a hand and computer mouse, and the other frame would act as a window into the parallel activities of more hard-edged language used by the computer to represent and make sense of those movements.

To make this video sketch (Figure 59) I appropriated some video footage from my fieldwork. When I recorded this video, the camera was mounted on a small tripod overlooking the student's workspace so that only the participant's hand, mouse, and a small portion of the desk were visible in the frame. The following two paragraphs, taken from my field notebook, describe the process of putting this video together:

I sit at the desk with my laptop in front of me, hands poised, hovering above the keyboard, fingers fanned out across the keys. One hand grazes the trackpad with a pinch to bring up a list of applications. Three keys are pressed F, I, and N, FCP rises to the top of the stack of

applications and I tap the return key – launch FCP. I press the alt and tab keys consecutively to retrieve the text edit window from the back of the stack of applications open on my screen, and then press command and N, for a new document. Alt-tab again cycles back through the open applications to FCP, and a tap on the spacebar starts the play head which moves across the video clip at one-quarter speed until a clear movement of the mouse and hand to the left can be distinguished on the video clip viewer. This takes about four seconds of play. I tap the spacebar with my right-hand thumb, to pause the video, followed by a flick of my left-hand finger and thumb on the Alt and Tab keys to bring up the text editing application. I type, “move Mouse left,” and repeat the Alt Tab key combination so effortlessly it seems as though I have a telepathic connection with my laptop. I press the spacebar again to resume playing, this time it takes a little longer for me to recognise a movement. In the space of ten seconds, the hand on the screen clicks the mouse button and drags it downwards towards the user. With my gaze fixed, brow furrowed, I am immersed in this task. Yet again, I shuffle through the stack of *Windows* on the screen back to the text editor, this time entering two lines of statements, “click” and “move mouse down.”

After about 20 minutes of watching the video clip, making notes on a specific movement, losing my place, returning the play head to the beginning, watching the video again, haphazardly defining one movement from another, I am left with a text document of 100 lines. I then connect my laptop to the dot matrix printer using a USB cable. I place the printer at the edge of desk so that I can position the camera and tripod so that the printout is immediately visible in the LCD viewfinder as it passes the print head. I then send the document to the printer after ensuring that I have the correct printer driver installed and online. This is a test. I watch through the camera viewfinder as newly printed text emerges, the spool rotates, the teeth at each end of the spool guide the continuous ream of thin white paper past the ribbon and print head which release a course scream as it punches hundreds of dots ink onto the paper. I make some small adjustments to the angle, zoom, and position of the camera; I rip the test print along the perforation in the paper and set the camera to record. Returning to my laptop, I send the file to print once more. Again, the spool turns, the paper proceeds past the print head. Once the print is complete, I return to the camera, press the button to end the recording, switch off the camera, and remove the SD card from its slot. I place the SD card in a similar slot on the side of my laptop and import the new video file. I start a new FCP project and drop this new clip into the timeline so that it fills the frame. The original video, from my fieldwork, is then placed on the timeline on top of this video file. At this point, the video of the mouse and hand is the only

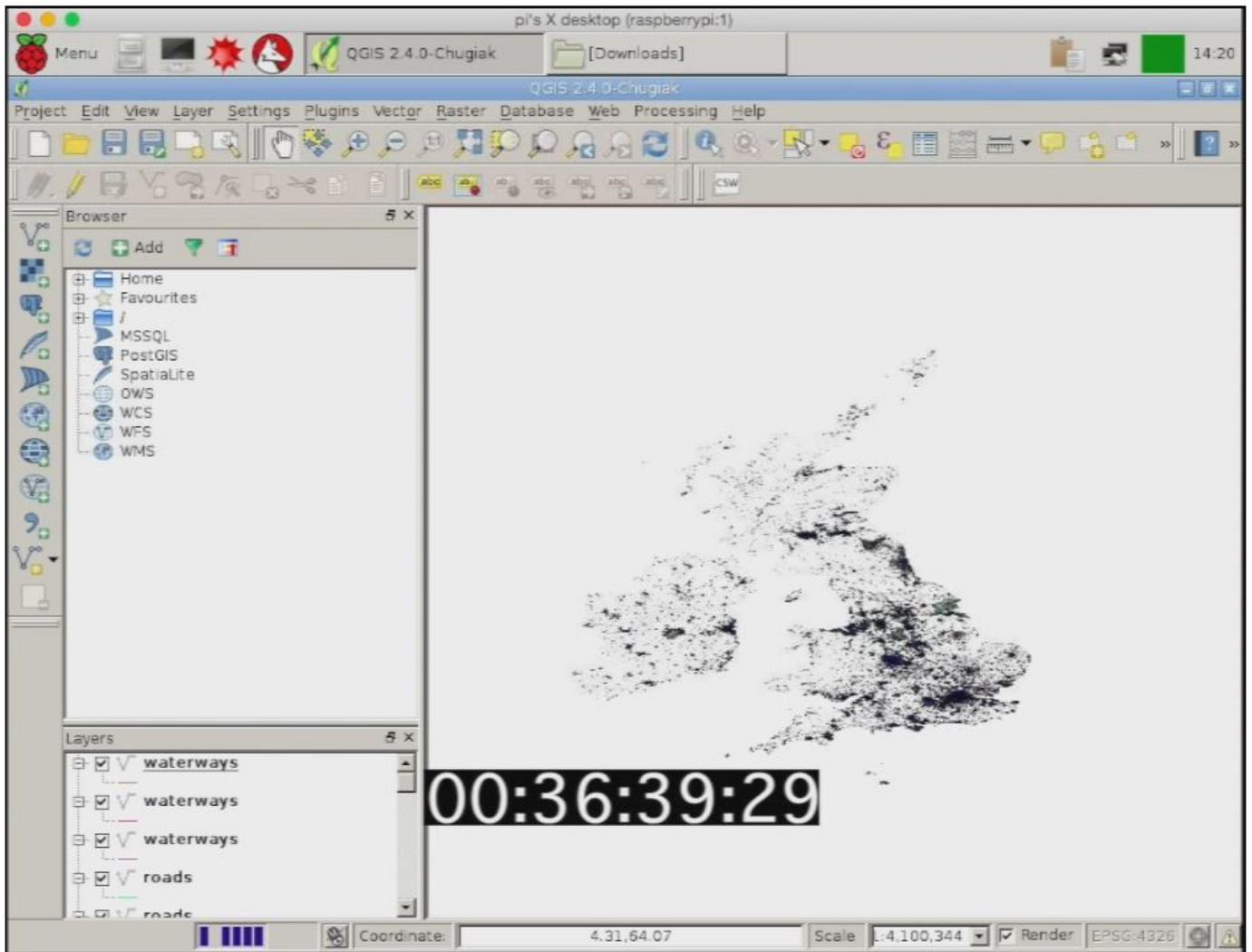


Figure 61 - Rendering the UK Screenshot

thing visible in the FCP viewer window. I now need to adjust the size of this clip so that it appears as a picture within a picture (PIP). I use the cursor to select the video frame bounding box, I select the bottom left corner and the cursor changes to an icon that looks like a diagonal line (bottom left to top right) with an arrow at each end. I hold my finger on the trackpad to click and holding the alt and shift keys on the keyboard, move up and to the right to reduce the video frame to about 40% of its original size. This reveals the printer video clip underneath. This bounding box is selected again, but this time in centre, and I drag the mouse so that the clip is positioned to right of the frame revealing the footage of the printer. I can now compress and export the finished project to a .MOV file.

Rendering the UK

This video echoes themes I was trying to explore with the video downloading the world. The resulting video sketch from this experiment emphasises notions of data heaviness, time spent waiting for processes involving computer hardware and processes to complete, whether that be certain blocks of time, or interspersed throughout the day. However, the circumstances that lead to the creation of this video were quite fraught. I had spent a number of days playing around with a Raspberry Pi computer. I wanted to integrate some elements of the practice of circuit³ bending into this creative response to GIS practice. This is partly because someone had just bought me a Raspberry Pi for Christmas, and partly due to an enduring fascination with electronics. My enthusiasm with gadgetry, computers, and technology has always been something that I had endeavoured to integrate into my creative practice. From the outset, I wasn't quite sure how I would use the Raspberry Pi. I had some idea that I might be able to link it to some electrical components – LEDs or small motors – to create some kind of kinetic sculptural assemblage. However, what I realised during this period of creative experimentation was that it was not until I had spent a great deal of time with Raspberry Pi, testing out what it can do, what its material qualities are, what it cannot do, what its limitations are, that I got a sense of how it could be used. In fact, the way in which an object plays a part in the production of a piece of artwork it is often very surprising. In practice, I used it to take advantage of its

³ Circuit bending is the practice of changing and manipulating or hacking the electrical components of electronic devices (such as children's toys) so that they behave differently than intended by the manufacturer.

versatility and robustness, and its relatively low computer processing ability to highlight, and make visible, the process of rendering graphics for GIS.

I spent the first couple of days in my studio playing around with the Raspberry Pi. I read materials in the form of PDF manuals and browsed through some homebrew projects on online Raspberry Pi communities. Looking at these pages, I saw retro gaming consoles, home media centres, remote control cars, home security systems, and so on. I followed instructions on how to install the basic *LINUX* operating system. I also spent some time trying to get a small touchscreen display to work with the Raspberry Pi – partly because I wanted to make some work with a touchscreen, but mostly because I enjoy the task of trying to get things to work. Trying to get the screen to work occupied a great deal of time and at the end of three days of installing, reinstalling, following guides posted to forums, trying to translate the screen manufacturer's website and installation instructions from Mandarin Chinese, attempting to recompile the kernel (a process I followed completely blindly-without any idea of what I was doing), I gave up.

At this point I felt my time spent playing with and learning about the Raspberry Pi had been fruitless. The reality was that these two or three days of failing did not feel like a learning curve. I constantly felt guilty that I was allowing myself to play with my new gadget at the expense of creating some artworks for this project. I would ask myself, what has the Raspberry got to do with GIS? I felt torn between an ambition to involve the aesthetic qualities of the Raspberry Pi – invoking a sense of the technological, do it yourself, a very visceral sense of physical computer hardware (with its exposed circuitry and tangle of wires) – and a sense of cluelessness as to how I was going to do this. Originally, I was thinking of the Raspberry Pi as a cog in a machine. I could get it to do something to create a particular effect. For instance, make an LCD screen work. Then I could make some work with the touchscreen. It did not occur to me that in the very difficult and ultimately futile attempt to get it to work in that way I would learn something different about the Raspberry Pi. Until this point I was anxious and stressed that I had lost time. It was only when I shelved my attempts to get the Raspberry Pi to work in a particular way that I realised just how much I had learnt in this process. It was only in hindsight, when I had accepted I had failed in my objective, that I could consolidate the experience of experimenting away from the feeling of failure.

What I learnt here is that the most important thing was to spend time with Raspberry Pi. It was useful to have an objective, just as it was important for me to have some data when I was trying

out *QGIS*. In spending three days waiting for numerous different installation files and patches to download and waiting for those files to then install on a significantly limited computer, it occurred to me that this time that I had spent waiting, in some way, brought to the fore this limitation in hardware. That is, the shortcomings in terms of reduced computing power and resources, impacted upon the time required to perform normally easy, straightforward, every day, tasks, but what I found most interesting was how these material shortcomings became translated, manifest, as feelings of frustration, boredom, agitation, and elevated – as result of an elongation of time taken- a sense of how much work is done by the computer. Furthermore, because, for the most part, I was using a command line interface – which details every individual file transferred and downloaded as an individual line of text printed on the screen – to carry out most of these processes and actions I became distinctly aware of the amount of work that was being done.

Ordinarily, the computer hides the work done, the labour, by exceeding in processing potential that needed to complete the task. Work is often done in seconds, allowing the user to multitask – the user is able to open up other *Windows* and work on other tasks. The Raspberry Pi, on the other hand, is somewhat limited in its resources. With its single core processor and measly? 512 GB of RAM, data heavy processes take a long time, they require all of its attention, and they overheat, further slowing down the process. Equipped with this revised understanding of the Raspberry Pi, I decided to try something new. I began to research the possibility of installing *QGIS* on the Raspberry Pi and came across a user forum where users had commented on their efforts. One comment that stuck in my mind, and in a large part inspired me to create this piece of work, noted that although it is possible, it would be very slow. It would struggle with large datasets and multiple layers.

This point made me curious about how this would impact on the look and feel of working with software under such constraints. I opened the web browser on my laptop, navigated to Google and searched “install *QGIS* on Raspberry Pi” there were a few promising results, but the top hit led me to a forum where one user had asked the same question. In response, I read that it is possible, and the respondent has written a brief explanation of how to do it. I follow these instructions. First, I had to download a fresh copy of *LINUX Raspbian*, copy it to an SD card, and insert the card in my Raspberry Pi. I connected the keyboard, mouse and an LCD TV to the Raspberry Pi and waited for it to boot. Once inputted I followed the on-screen installation instructions. The interface asked me for my name, to create a password, and how I would like to connect the Internet. I typed in my responses following the installation wizard to the point

when the GUI would be installed. I watched the screen as it told me the machine was downloading installation files, then installing these files, all illustrated by a sliding progress bar. I turned my attention to other things as I waited for this to complete. When the screen went black for a second before displaying the Raspberry Pi logo I knew that the installation had finished. I waited about 20 seconds for the operating system to load and then opened up the terminal.

The next step was to update the system. I was quite familiar with this process, but I kept my laptop open in front of me as I worked with the keyboard attached to the Raspberry Pi between me and the laptop keyboard. First, I entered the command that instructed the Raspberry Pi to download the most up-to-date list of packages. This took a couple of minutes, and whilst I waited for the process to complete I scanned the following steps in the process of installing *QGIS* on the Raspberry Pi. The next command updated the system – a measure that insured against compatibility issues for the rest of the process. Next, I had to edit a text file that contains the list of online repositories. I added a new entry so that I could update the operating system with the next command. Once these files were updated, I returned to the command line from the text application embedded within the terminal, I enter the command that would instruct the Raspberry Pi to upgrade the Raspbian *LINUX* operating system from the Wheezy version to the newer, and at this point experimental, Jessie. I did not know why it was necessary to upgrade the operating system to install *QGIS*.

This process of upgrading the operating system via the terminal took about half an hour to complete. During this time, I browsed the internet, looked at *Tumblr*, and thought about what I was going to do with *QGIS* once it was installed. Intermittently, I would gaze across the desk at the Raspberry Pi monitor to check the progress of the installation. At times, a progress bar would appear, marking the progress of files being downloaded from the internet with a succession of hyphens, slowly moving from left to right. When the progress bar had reached the right-hand side of the screen new lines of text would appear at the bottom. The speed at which these new lines appeared would vary, and each time I glanced across the desk they seemed to be a different frequency and pattern to the seemingly endless stream information scrolling up the screen. Sometimes new lines would appear every second, sometimes two at once, sometimes three and four. At times, I could look at the screen and find myself unable to guess the frequency of new lines. Every once in a while the process would pause when it required my input, usually asking me to press the Y or N button on the keyboard. After approximately half an hour of surfing the internet, glancing at the Raspberry Pi screen, and intermittently hitting

the Y key, the scrolling stopped, and I was left with the blinking cursor. I breathed a sigh of relief that it had worked and returned to the tab on my web browser containing the installation guide. One more command, “sudo apt-get install *QGIS*”, and more of the same scrolling text for about 20 minutes. At this point, with the operating system upgraded, and *QGIS* installed, it was time to launch the application. I restarted the Raspberry Pi by typing a short command into the terminal. When the computer restarted, and the operating system loaded, I immediately saw a new icon on the taskbar. Another sigh of relief. I clicked the icon to launch *QGIS*.

I had the data ready on a USB flash drive. I had downloaded all data held by *OpenStreetMap* for roads, buildings, cities, waterways, railways, natural features, and land-use in the UK and Ireland. Leaning across the desk to the Raspberry Pi, I inserted the USB stick into an available port, and used the mouse to locate the files on the drive. With a click and a drag of the mouse, I selected all of the files on the drive, and with another click and drag, I dropped them all into the *QGIS* window. At this point I triggered the screen recording app to begin. Over the space of two hours and 15 minutes *QGIS* went through every single layer (each layer holding a specific type of data, for instance, there was one layer for roads, and another layer for cities) in turn to visualise the data on the screen. It is important to note that ordinarily – on an average desktop computer- this would have taken a matter of seconds to render the entire dataset. Instead, the process is stretched out over 2 hours and 15 minutes. The process of translating and rendering the data files from the USB stick to the visual display was stretched out so that the user can observe the appearance of the point data as individual cities pop into visual existence as small red circles, and tiny symbols cluster across the landmass of the UK (Figure 61).

Summing up and moving forward

As a creative practitioner with a particular perspective, a way of approaching *doing* but also as someone who has come to embody the practices of GIS, this chapter documented my activities as I tried to tease out, or make visible, the ways in which I had come to know GIS. The works that resulted from that intensive period of creative experimentation serve as material manifestations of the interfacing of my creative practice and my understanding of GIS. The works created thus far were intentionally fractured, half-formed; they lacked a broader, overarching narrative, or curated form. It was important not to tie myself down to such a broad theme or form so as not to stifle the creative process. As a culmination of my practice I feel a curated installation to be important; this would take many of the activities involved in the doing

this research project as its constitutive components. But also and bearing in mind the emphasis I have given to the affective and the material, the aesthetics and the constraints of the technologies involved, I would like to 'open up' the dissemination of the thesis beyond the page and provide some sense of the what of GIS via other mediums.

CHAPTER SEVEN: A MANIFESTO FOR CREATIVE GIS

In this concluding chapter I want to highlight the main findings of this PhD project, and, bearing in mind the initial remit of the PhD, which was to produce a creative response to GIS, exit the written thesis with a proposal for an art installation that will take place following submission.

Concluding Thoughts on the Thesis

At the core of this PhD is the question of what is GIS? And, I have responded to this with a series of steps. To begin, I have discussed, with reference to various literatures (Chapter Two), how GIS emerged in part from the Quantitative Revolution as a confluence of spatial science and advances in machine computing. Here, GIS was figured as a particular kind of technologically endowed form of praxis. In turn, critical scholars have debated its suitability for capturing real world issues and concerns, given GISs reliance on the Boolean logic of machine computing, and other structural ontologies. Moreover, scholars, conscious to promote a more humanistic approach, were cautious of its potential to favour privileged perspectives, such as those of state and corporate power. I then looked to complicate the narrative thus far by outlining the multiple trajectories and moments of convergence and divergence between GIS and Cartography as they were described in reports in the journal *Progress in Human Geography* over the last 35 years. Furthermore, I undertook interviews with three key scholars of GIS in order to understand how they came to GIS, and their theoretical and disciplinary points of departure. Following this, I discussed literature relating to the ontology in GIS, particularly as it pertains to a reliance upon the epistemological assumptions of spatial science in the way it models and structures space. I also noted efforts to embrace more democratised epistemologies such as neogeography. Further to this I explained how scholars have looked to broaden their understanding of ontology in relation to GIS, figuring it in a more expansive constituted system or assemblage.

With a focus on post-humanist geographic concerns of affect, embodiment, performativity and doing, I have discussed how recent scholarly discussion has focused around the potential for new geospatial media, largely made possible by *Web 2.0*, to foster more inclusive and democratic forms of GIS practice, such as a type of citizen science called neogeography. Following this, I reviewed literature on creativity, curiosity, play, and experiment to offer arguments as to how a creative GIS might be composed. This literature pointed towards the potential for a more generative and interventionary set of research practices. Furthermore, I attended to literature

that help me understand how GIS can be more specifically addressed as a series of practices. As such I discussed how theories on sociality, collaboration, work, agency, affect, technological mediation, and embodiment might help me to unpack GIS as practice.

And finally, to understand how GIS might function as a kind of digital archival system for the storage and retrieval of geographic knowledge I have investigated the work of post structural thinkers such as Foucault and Derrida to understand two important perspectives of what 'the archive' is and what it does to the knowledge that it stores. However, I also note recent work by human geographers who have illustrated how some objects resist this conscription of the archive (DeSilvey, 2007; Cresswell, 2012). This leads me to contributions from performance studies where Guevara (2005) notes, some things – such as performance – cannot be held in textual form, rather it is stored in the bodies of those that take part.

What is absent from the literatures, I have suggested, are accounts of those involved in the *doing* of GIS. I felt it important to conduct field studies in order to investigate something of what means to be immersed in the practicing of GIS. That is, to get a sense of the everyday materiality of GIS as flesh and plastic, ideational and embodied. To this end I employed social science methods such as interviewing (Chapter Four) and participant observation supplemented with auto-ethnographic and ethnomethodological accounts (Chapter Five). In interviewing individuals who worked with GIS as part of their job I encountered a practice that was social and collaborative, consisting of digital working practices, mediated by technology, and assembled. I found that practitioners follow cues in the office environment to guide them to other practitioners with slightly different skillsets and talk and negotiate to establish understanding and distribute work. GIS practitioners do 'digital work', and as such. agency is distributed between humans and machines, and workers become familiar with repetition but are also intuitive; for example, they can negotiate problems with their automated workflows. Their practices are mediated so that they configure their bodies and construct mindful understandings of their work together with GIS technologies. Relatedly, GIS practice is assembled so that it emerges from the co-functioning of computer hardware, software, bodily capacities of human worker, and their individual knowledge and disciplinary expertise.

I also spent a considerable time observing others and participating in the learning of GIS. In this context, what was notable was how I and others seemed to employ certain modes of thinking, feeling, and being to bring ourselves into the doing of GIS. What was apparent was how certain emotional states, embodied registers, and affects contributed to, and coloured the

experience of learning GIS. As such, I chose to ground these observations in literature concerning, emotion, affect and embodiment. What I discovered as a result of this period of participant observation was how GIS involves being attentive to what my body and those of others was doing. I also paid attention to how I became attuned to the affective capacities of things such as command line interfaces and the conventions of GIS teaching environments. Furthermore, I noted how it was difficult to reconcile my emotional state and with the more intellectual demands of, for example, writing *JavaScript*

The practice-based element of this PhD project was, in large part, documented in Chapter Six. The objective was to investigate how my own creative practice might bring something new to the study of GIS. Here, I deployed my particular method of creative practice to work through the abundance of materials, insights, and feelings that I had amassed over the course of the project. I set myself the task of creating a number of art works over the period of two weeks. The works were to be quick and rapidly produced doodles and sketches using various media, with the hope that I might tease-out, distil, and probe the aesthetic qualities of GIS that had become known to me throughout the PhD. What resulted from this period of intensive making, were a series of small artworks. In Chapter Six I discuss the creation of a selection of these artworks in relation to literature on creative and artistic practice, experiment, play, curiosity, and performance. What I developed here was a way to intervene, become conscious of, and immerse myself in new imagining of GIS practice. Furthermore, by reflecting on literature on curiosity I was able to position my creative practice as something generative, and useful for academic research.

What this final empirical chapter brought to light was how this project is about the specific aesthetic touch points that resonated with me in learning to do, and think about, GIS. For me, this project became a matter of interfacing, between GIS as broad discipline and my creative and aesthetic sensibilities. As noted throughout this thesis, a significant endeavour for me in carrying out this project was working out how mine was a legitimate perspective from which to cast a rendering of what GIS is – to be a producer of knowledge in this field that I am not traditionally invested in. To be sure, a series of tensions unfolded as I reworked and repurposed my particular understanding of terms such as rendering, my attraction and articulacy to aesthetic forms such as narrative, and my propensity to immerse myself in activities such as doodling and playing with technology. All of these became strange, and then familiar again as I became part of GIS.

It is from this perspective that my particular reading of the remit of this PhD directed me to see GIS not only as a tool, as a means of producing geographic knowledge according the ontologies pasts and present, but as a set of practices that the user takes part in, and asserts his or her agency, but also must surrender themselves (at least in part) to the agency manifest through this historically, socially, and technologically produced mechanism that is GIS. Those that invest themselves in the practice of GIS learn to move their bodies in particular ways and adjust their mood to be productive. As I was learning I had to give myself over to certain things; for instance, I had to accept the logic of the software applications, to organise my data according to certain capacities of the media, but also to carry out processes as they were presented to me as a set of drop down menus. What I became interested in, then, is how individuals become immersed in this material, this technology; how they become invested in the environment, how they participate in the production of GIS. The practices involved in GIS are not just productive to a particular end, such as map making. The emotional dispositions, frustrations, anxieties, affective atmospheres of GIS practice produce a material and embodied residue that must be taken into consideration when we consider what GIS is. Evidently, the doing of GIS creates data (large amounts of data), data that humans can manipulate, think through, and put to productive ends with the technology of spatial analysis and remote sensing. But this doing also gives way to new ways of imagining the world. Just as GIS might be thought of as a kind of cybernetic extension of our ability to quantify terrain, it also trains our brains, and our gaze, to imagine and look at the world.

If we take the GIS practitioner as an embodied set of skills and practices -- as body that has become familiar and adapted to a certain way of doing, but has also brought with them their own literacies, and disparate and existing knowledge, that allows them to imagine what they are doing in a unique and creative way -- then I believe it is important that the broader understanding of what it means to do research with technologies like GIS needs to be augmented. We must ask ourselves, as researchers, as designers of research methodologies, how does this distinct practitioner, responsible for the operation of these technologies, feature as a discrete node in the production of knowledge? Indeed, critical GIS scholars have noted the significance of the emotional dispositions of the researcher in the doing of GIS (Kwan, 2007; Aitken and Kwan, 2010) and also the potential for GIS to be used in more participatory forms of knowledge production (Kwan, 2008). In regard to, this Kwan has noted how GIS can used in the co-production of knowledge to represent some of the emotional dispositions at play when it comes to the experiences of vulnerable participants. Indeed, Kwan (*ibid.*) has worked to

document sensitive research materials, to channel the emotions and narrativise testimony in spatial terms. Furthermore, Kwan also has also written about her own creative endeavours with GIS, applying artistic effects to GIS maps, as she claims, to, “explore the aesthetic possibilities of GIS” (Kwan, 2007).

At this point, I would like to return to the panel session at the AAG which I discuss in the first chapter of this thesis. In response to Louise Amoore’s rebuttal of the legitimacy of the ‘black box’ as a site at which (if we are allowed access) we might understand the nature of digital technologies. Her interlocutor in the audience offered an alternative position from which to understand digital technologies, that is as, “a complex system of emergent properties.” This alternative rendering of digital technologies, such as GIS, allows us to take into consideration their agency -- for instance, their ability to evoke certain affective atmospheres -- but also to figure their affects as being co-constituted in relation to other objects, materials, bodies, spaces etc. I believe one contribution to geographical knowledge that this thesis makes is, not only the empirical findings, but to broaden the understanding of what the GIS practitioner is doing when they become immersed in the *doing* of GIS. This practice is far beyond the kind of technologically involved form of praxis espoused by Jerome Dobson (1983).

Bearing this finding in mind and following in the footsteps of artists declaring their approach to an artistic medium, I would like to offer the following --- a ‘manifesto for creative GIS’ -- as a summary of the conceptual and disciplinary contributions of this thesis. Therefore a ‘creative GIS’ should:

1. Be mindful of the history of GIS, such as: its relationship to spatial science; its epistemological heritage and what that means in regard to ways of knowing and representing; its ascendancy with the proliferation of personal computers; commentaries relating to militarism and surveillance; a concerted effort to increase participation; the multiple, diverging and converging trajectories between GIS and cartography; and attentions to the more performative, affective and emotional. Such histories allow us to look forward and sketch out the rippling impacts of new technologies on practitioners, but also how the work of GIS practitioners impacts upon a myriad of others.

2. Incorporate the emotional and affective elements of the research process as part of the practice of GIS and be reflective of how the technologies involved play a part in the production of the apprehensions of the researcher and the research participants.
3. Embrace interdisciplinarity by encourage discourses relating to differing fields of expertise and how they might come together in research practice. A creative GIS should be open to multifarious forms of data capture, storage and representation, from maps and satellite imagery to interview excerpts, documentary video and photos, and the performative.
4. Be attendant to creative modes of representation and performative acts of intervention. For instance, to produce spatialised narratives of the research process as it unfolds, and deploying creative, playful, and experimental approaches as generative research practices.

As a means of implementing, and showcasing, the manifesto for a creative GIS, let me finish the written portion of this PhD by outlining the installation I have constructed and curated.

Curating a Narrative Environment for GIS

This installation took place in the GIS teaching lab in the School of Geographical and Earth Sciences at the University of Glasgow. The site (Figure 48) of the installation is of importance in that it is a GIS teaching lab; it is specifically configured according to the conventions of a certain way of teaching GIS. It already contains many of the materials used for GIS teaching, such as individual computer workstations, arranged in rows, centred around a central workstation used by the teacher. In this way, I could exploit these objects as part of the installation so that the computers and their screens, the gangways, ordinarily patrolled by the teachers looking over students' shoulders, become a site for the installation.

I wanted to use these surfaces, and objects as a site for a particular type of performance, one that subverted the audience's expectations of what normally happens. The purpose of this installation was to communicate my research findings to other audiences, for instance the research and teaching staff that work with GIS on a daily basis. The installation sought to encourage its audience to think about their work with GIS in a different light. One objective was to invite the audience to think about my activities working with and learning to do GIS – as these activities are documented as part of the installation – as analogous to their own. Moreover, I wanted to encourage them to think through their own embodied relationship to GIS and related technologies; that is, to understand the potential of thinking through the modes

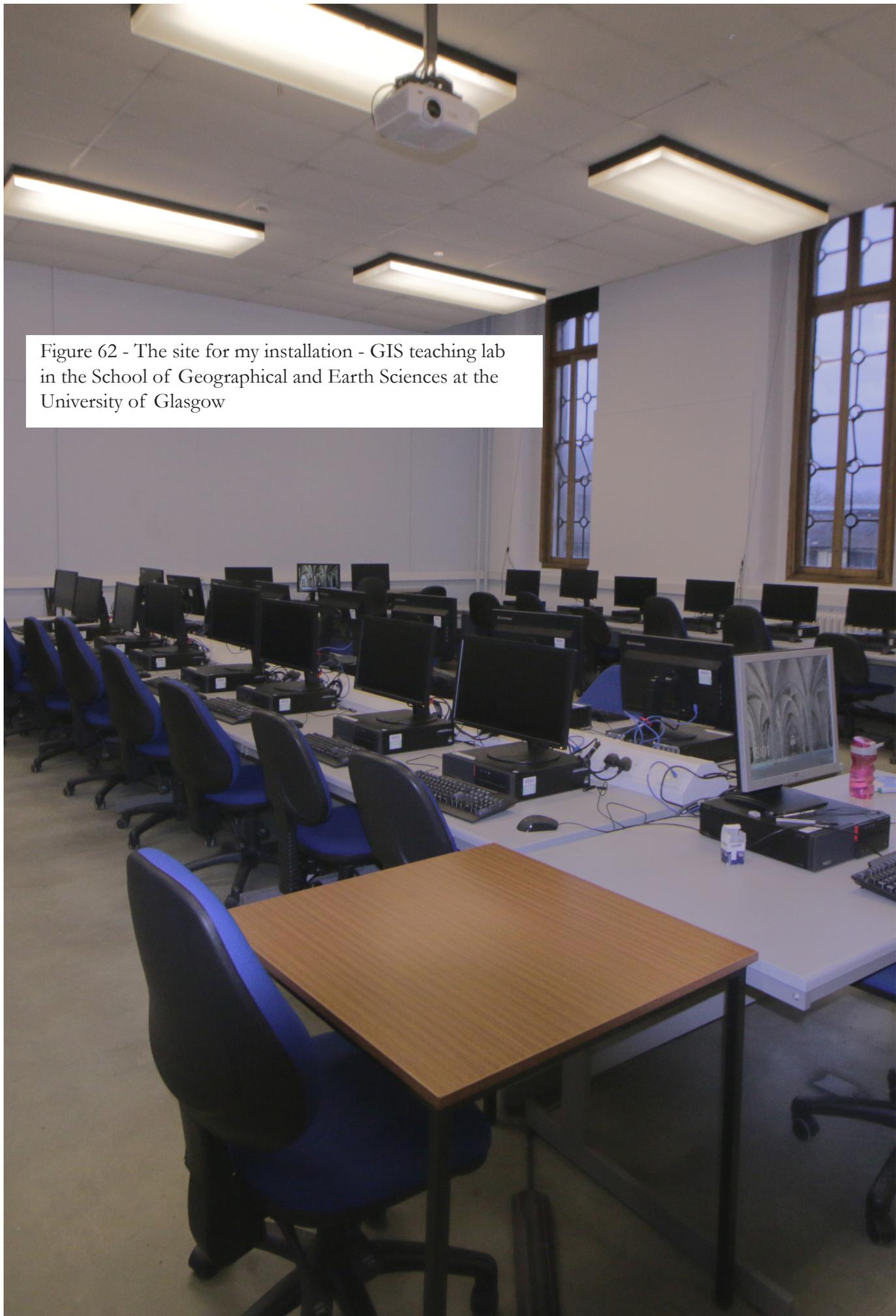


Figure 62 - The site for my installation - GIS teaching lab in the School of Geographical and Earth Sciences at the University of Glasgow

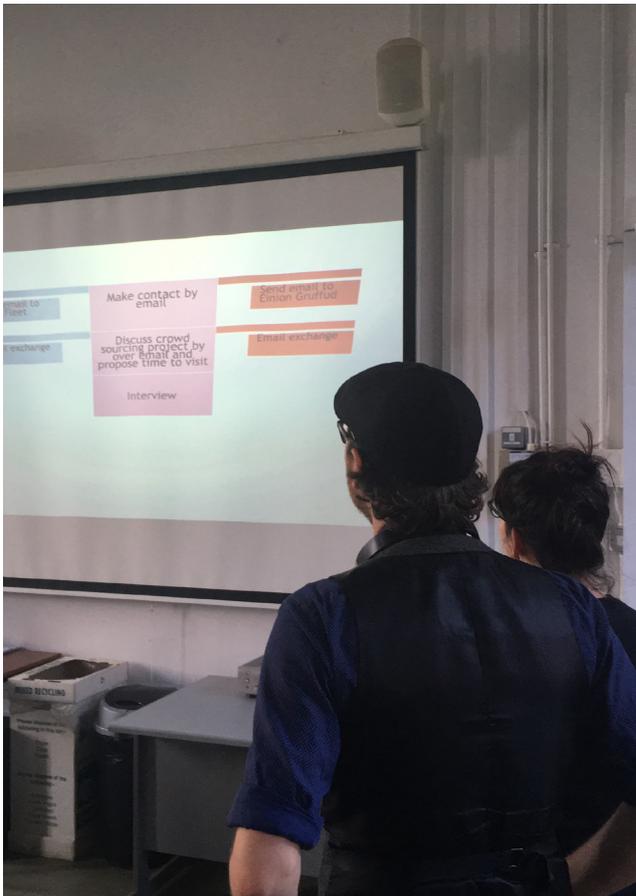


Figure 63 - Exhibition Documentation

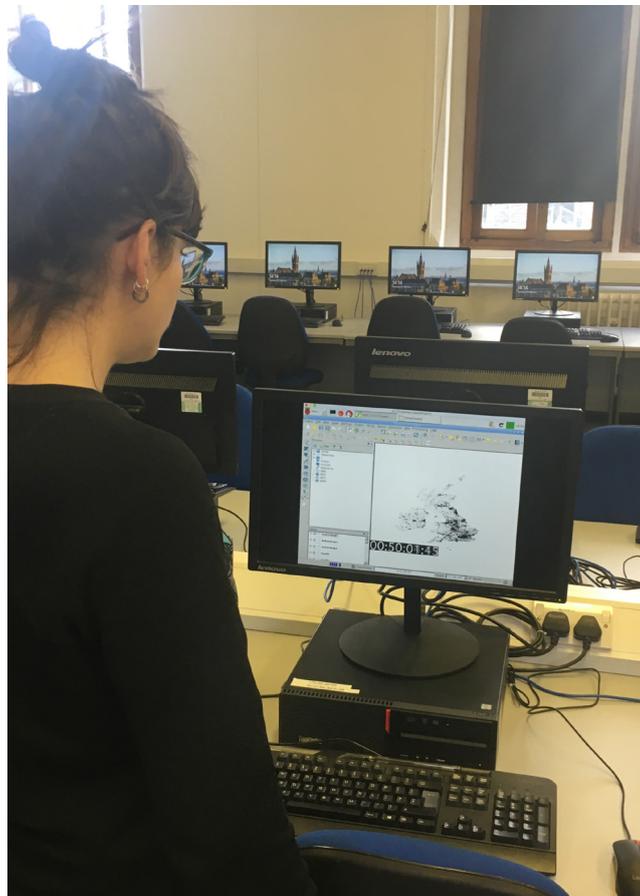


Figure 64- Exhibition Documentation

of thinking and doing that go into the process of doing GIS. I wanted to create an installation that, in some part, focused on what instructors at GES had formerly considered the 'unproductive' elements of GIS, rather than as potential for improving efficiency.

In terms of its substantive content, this installation drew upon my experiences of working with and learning to do GIS over the course of the last four years. It put to work the materials and experiences that I have collected. In this sense, it served as a kind of retrospective installation of the process of learning about GIS. It thus reflected on the teaching methods that I observed and participated in, the types of images and graphic language that I was exposed to, the repetitive processes involved – those that disappear in the doing – bringing these to the fore. This installation thus drew directly from the observed themes from Chapter Six – those of collage, zoom, and visual language – and unpacked them. For instance, I harnessed the visual literacies at work in the grid ontologies that are taken for granted in the doing of GIS as useful in some other way. For example, I created storyboards such that the grid is read as a narrative structure, and, in the arrangement of a still life image, the grid is used to guide the eye to particular areas of the photography. Furthermore, the role of narrative as a creative form to communicate my experiences throughout this project has been of great significance and therefore this installation paid attention to, and employed, narrative as a way to understand GIS. An example of this can be seen between the multifarious narratives the audience witnesses in walking through my curated installation to witness individual performances, and the larger arc of the project told through animated infographics at the front of the room. Furthermore, I elaborated upon the visual literacies at play in GIS, making reference to the work of other artists such as Fischli and Weiss who create dynamic videos exploring the materialities of objects, and the work of Richard Sides who stages performances in computer labs. Indeed, many of the materials that I collected over the course of this project fed into the creation of this installation. I included photographs, still and video screen shots, the videos and other artworks created during my period of creative experimentation, and the infographics that I created to document my research methodology.

This curated installation offered a moment of closure for the project, as a culmination, a coming together of many of the materials I have built up and collected during the project. The aim of this installation was to somehow bestow some of these experiences upon the audience. That is, to inscribe something of my experiences with GIS upon those that encounter the installation, to create space where my insights can be passed into the memories of the audience. This installation would serve to extend the scope of this project beyond the limitations of the storage and retrieval of the written thesis. As this written (in physical and digital form) thesis becomes

part of the analogue archive that is the University of Glasgow's thesis library, the installation will serve to preserve some of the more ephemeral and embodied material residue that will, instead, rest within the bodies and minds of those who encounter it. The textual form of this PhD will become part of the traditional analogue archive. It will become part of a system that gives it meaning and relevance according to and dependent upon logics that organise and manage in particular ways. Where the textual PhD is subject to systems of cataloguing according to subject, taxonomies, metadata, keywords, the installation instead will remain within the bodies of the audience, organised according to the embodied, disparate, and existing skills, proficiencies and articulations.

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