Critical posthumanism in geomatics education: A storytelling intervention

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Abstract

This study is located in engineering education at a South African university of technology, and is theorised using relational ontologies such as critical posthumanism, feminist new materialism and non-representational theory. It explores the potential of a digital storytelling intervention in an undergraduate geomatics diploma programme. Geomatics qualifications in South Africa are critiqued for their embedded humanism and subtle anthropocentrism despite attempts at post-apartheid curricular reform. Additionally, these qualifications are focused on technical content, and heavily influenced by Western knowledges.

A cartographic and diffractive methodology, which harnesses the power of posthumanism to be a navigational and analytical tool, is developed and reported on. The methodological assemblage is largely based on the theorising of Rosi Braidotti and Karen Barad – Braidotti's conception of cartography is put into conversation with Barad's diffractive methodology. Additionally, the methodology is supplemented with critical cartography, non-representational theory and selected feminist literature (such as the work of Val Plumwood). The way I have put the methodology to work in this thesis is to intertwine a number of stories together, and use the stories as 'hooks' on which to hang my analysis.

A Foucauldian approach looks at power as both restrictive (*potestas*) and productive (*potentia*). My research is developed around these two power relations – Part Two of this thesis is entitled 'Potestas' and Part Three 'Potentia'.

The thesis firstly investigates how a specific type of humanist subject is perpetuated by the geomatics learning experience. Modern geomatics education is analysed to trace entanglements that serve to promote specific dualisms and entrench hegemony. The power relations within the geomatics academy and industry are analysed to identify dualisms that promote specific types of subjectivity.

Secondly, the storytelling intervention is reported on and analysed to investigate how points of compatibility between the 'hard' and 'soft' sciences can be identified and demonstrated, as called for by numerous theorists who emphasise the importance of transdisciplinarity. Storytelling was also used as a means to develop students' social, environmental and ethical awareness, as well as to foreground student subjugated knowledge through the lens of geomatics. The subjectivity of geomatics students, practitioners and academics is investigated.

Focusing on and guided by a posthumanist ethic, this study is attuned to silence of several 'others', mainly the racialised and naturalised others. It makes the case for fostering novel relations across disciplinary boundaries through creativity, and diffraction helps to uncover learnings for both posthumanism and geomatics. Ultimately, this study contributes to the development of new engineering and related pedagogies, situated in the Global South and premised on relational ethics.
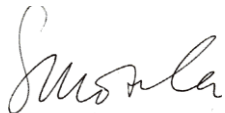
Declaration

I declare that *Critical posthumanism in geomatics education: A storytelling intervention* is my own work, that it has not been submitted for any degree or examination in any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Siddique Motala   May 2018

Signed:

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Dedicated to Mikhail and Zachary.

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Abbreviations

AI – Artificial intelligence
ANC – African National Congress
BoK – Body of knowledge
CDS – The Centre for Digital Storytelling
CLaRA – Communal Land Rights Act
CPUT – Cape Peninsula University of Technology
GIS – Geographic Information Systems
GISc – Geographic Information Science
GIS&T – Geographic Information Science and Technology
ITC - Faculty of Geo-Information Science and Earth Observation, University of Twente
NGI – National Geo-spatial Information
PLATO – The South African Council for Professional and Technical Surveyors
UCGIS - University Consortium for Geographic Information Science
UCT – University of Cape Town
UKZN – University of KwaZulu-Natal
UNESCO – United Nations Educational, Scientific and Cultural Organisation

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PART 1 – SETTING THE SCENE

In the first part of this thesis, the scene is set. In Chapter One, the geomatics education landscape in South Africa is surveyed so that is may be mapped. Problems relating to geomatics education are identified, and the research aims are outlined. In Chapters Two and Three, posthumanism is introduced and a posthumanist pedagogy is imagined. The use of storytelling combined with counter-mapping as a pedagogical device is investigated. A diffractive and cartographic methodology is developed to analyse a storytelling intervention in contemporary GIS education. The methodology results from reading several theorists (such as Braidotti, Barad, Harley, Thrift, Haraway and Plumwood) together.

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CHAPTER ONE – INTRODUCTION

1.1.   Preamble: Stories A & B

Meanwhile, in a Geographic Information Systems (GIS) class at the Cape Peninsula University of Technology (CPUT), I tell the students a story…

Story A: My Caltex story

I was working at a GIS company called the Knowledge Factory in Cape Town in 2000, and one of our clients was Caltex Oil, the large international oil company whose South African head office is here in Cape Town. Caltex was starting to use GIS as a tool for competitor mapping and site selection, and I was the person who looked after their account. I was eager to produce good work and I went the extra mile to make Caltex happy. When Tony (the Caltex employee who was in charge of the mapping) asked me for some data, I provided him the data, some maps, and some analysis. GIS analysis was still in its infancy in those days, and they soon realised the need for a permanent GIS employee. One day Tony asked me: "Do you know anyone who can do GIS who needs a job? We are looking for someone like you". I found out about the salary - it would be double what I was getting paid at the Knowledge Factory! Hmmm, let me think about it… I applied for the job.

(Laughter)

Soon afterwards, I was working for Caltex Oil South Africa, owned by the mighty Chevron Corporation. The job paid well – I was soon driving a beautiful red Audi A3 turbo and having a great time. At that time, Chevron was the fourth-largest oil company in the world, and I was in charge of the GIS for Caltex Southern Africa. I helped Caltex to decide on where to build service stations.

An oil company has a lot to lose. It spends huge amounts of capital to set up infrastructure all over the world. Strategically, Chevron has to decide on where to position itself – there is physical positioning, socio-economic positioning, and competitive positioning. A wrong positioning decision can cost mega-bucks! Here is a map showing the extent of Chevron's business. At the time, Chevron operated in 180 countries, with 53 000 employees, and it had over 25 000 retail outlets. It had over 11 billion BOE (barrel of oil equivalent) oil and gas reserves, 2.2 million bpd (barrels per day) of refining capacity, and this equated to $100 billion in revenue. A very powerful global company.

(Wows, hushed discussions, impressed gasps at the sheer magnitude of money in big corporate capital, undivided attention)

Let me give you a few examples of GIS practice from all over the Chevron world, and examples of where surveyors or GIS practitioners can find employment within the business.

After the presentation, I get the impression that students are happy – there is a buoyant mood during the discussion, with some students asking questions about Caltex, and others asking technical questions about software, specific examples or cost. I also discuss what it was like to work within a large corporate company, and the many opportunities it affords.

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Story B1: Why I left Caltex

After the first story, students approach me and ask about Caltex. After numerous repetitions of this story, it has become clear to me that many are motivated to join corporate companies, just as I was years before. My next story is less of a presentation, and more of a collaborative investigation. I present it in a questioning style, allowing students to interact with GIS software themselves, making them part of the performance. It always takes place in a computer laboratory, in which each student sits at a computer with GIS software.

I left Caltex for two main reasons – one political, and one environmental. Here is the environmental reason, which at the time, was the reason that was not the most important for me. Please use the GIS software on your computer to create a map of the world, showing the country outlines, and include the rivers. Let's look at South America. Where is the Amazon River? The river flows through the largest rain forest in the world, called the Amazon rain forest. It is like a huge lung, breathing in carbon dioxide and breathing out oxygen. How long is the Amazon River? Look at the rest of the Amazon River system. How big is the network of rivers that make up this system? It is huge. Find the country of Ecuador. Ecuador is one of seventeen megadiverse countries in the world. South Africa is one of these countries. Let's see where the others are. Is there some pattern to where they occur? Chevron has been involved in Ecuador, in upstream operations since the 1960s. In the 1990s, some Ecuadorians sued Chevron, alleging that its upstream operations polluted the rainforests and rivers in Ecuador, causing environmental damage and severely affecting the health of those who lived in the region. The affected population was mainly poor, indigenous people who lived in villages very close to the rivers or the oil wells. The common diseases were cancers, breast malignancies, childhood leukaemia, and pregnant women very often experienced miscarriages and spontaneous abortion. After leaving Chevron in 2005, I kept following this story. After much legal to-ing and fro-ing, in 2011 an Ecuadorian court ordered Chevron to pay about $9 billion in damages and clean-up costs. Chevron has been fighting the ruling, claiming it to be illegitimate. Chevron then sued back.

At this point, I show the class some imagery of the destruction in the rainforest, and internet resources that have been posted by both sides of the battle.

The fight still goes on, till today, with the villagers of Ecuador trying to get Chevron to pay, and Chevron's lawyers halting the process. In my opinion, they have polluted large parts of the rainforest, and they have gotten away with it.

Story B2: Why I left Caltex

A few days later, I tell the second half of the story.

South Africa needs to import crude oil. We import oil mainly from Iran, Nigeria, Saudi Arabia, and Angola. Caltex does not import crude oil from Iran, because of relations between the U.S.A. (Chevron is an American oil company) and Iran. Let's create a map showing the oil producing countries that South Africa gets oil from.

So how does an American oil company get involved with politics? When I was working for Caltex, I asked the same question after the events of September 11, 2001. I was sitting in my Caltex office in Cape Town when the planes hit the World Trade Centre and the Pentagon. The other employees around me knew that a huge event was unfolding, and there would be

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consequences. Under the presidency of George W. Bush, the U.S.A. invaded Afghanistan soon after. In 2003, they invaded Iraq, under the pretext that Saddam Hussein had weapons of mass destruction that posed a real threat to the world. These weapons were never found.

In 2004, George W. Bush was campaigning to be re-elected as president. Before the election, management of Chevron sent emails to selected American staff urging them to vote for the Republican Party, i.e., Bush. I went onto Chevron's website to check their contributions[1], and indeed, they were contributing large amounts to the Republican Party, compared to very small amounts to the other parties. The Republicans would obviously assist Chevron in their business. Here is a picture of Condoleezza Rice. Do you recognise her? Before 2001, she was a very important executive on the powerful board of directors of Chevron Corporation. So powerful, that they decided to name one of their oil tankers after her. In 2001, Condoleezza Rice became the Secretary of State, which is the U.S.A. equivalent of our Minister of Foreign Affairs. After George W. Bush's presidency, she joined Stanford University as a political science professor. Like her, I left the same company to join academia. I couldn't stick around and help a company that was doing these things - it didn't feel right from my ethical point of view.

A student shook his head in what could have been disappointment or disbelief.

Are you disappointed in me?

"Yes." He nodded and left it at that. Another student mirrored him, but her facial expression was far more animated – she wanted to know more.
"Why would you leave a job that obviously paid well?" she asked, her face grimacing and glaring at the same time, a mixture of anger and disappointment. "I mean, those people who worked with you must be high up now." (I silently recalled the colleagues who had died while working for Chevron – some of stress related diseases, and one committed suicide. But this is not what she meant). I told her that I had recently found out that my boss at the time had recently been promoted to the top echelons of the company. I went on to further recall my opinion of him – he was an honest, fair, hardworking individual who also well liked. He was a nice guy who deserved the job. In fact, during my corporate years, I worked with many people, and I hadn't met anyone who was evil. The vast majority of people were good people, earning an honest living. It was a working environment that I really enjoyed. In fact, I met my wife whilst working at Caltex.
"You see? Why?" she asked.

"I respect you" another student said quietly, against the rumble of disappointment.

You're right to ask me about this. Why would I leave a high-flying job to work at a university teaching you guys? What is wrong with me? I mean, look at you!

My dramatic comedic insult was met with laughter.

Can you help me to explain how a group of nice people can form a company that murders people?

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[1] See Chevron (2014) for an explanation of their rationale behind taking part in the political process.

This rhetorical question is one that has been haunting me for years. After this story, there is unease in the air. The mood is not as buoyant as it was after the first story – intensities have decreased. There are sometimes questions about my truthfulness, with students in disbelief about leaving an oil company to become a lecturer.

I usually tell my Caltex story over a period of three lectures, in the Geographic Information Systems 3 (GIS3) course. It is a performance, set in a computer lab, is non-linear, multiple, and an intense process. Being a performance, it is difficult to represent. Maps, images and videos are used during the story, and the story is co-created by the students. GIS software is showcased, using different display and spatial analysis techniques. I have been telling and re-telling it, returning and re-turning[2] it. The question has stayed with me, and continues to be interrogated by myself and students regularly. I never give a final answer to the question, and leave it open for students to take on.

My PhD journey has led me to the philosophy of critical posthumanism, which has helped to think about the Caltex story (and others) differently. Crucial to thinking about this problem is the idea of relationality, more specifically, how relations between participants[3] are primary in subjectivity formation. While corporate companies act as 'mediating institutions' (between individual employees and society) that teach their employees specific brands of business ethics, there is evidence of a growing number of corporate companies that have breached implicit social contracts (Mayer, 2001). Most recently, the much-publicised cases in the South African media of Bell Pottinger (the UK-based public relations company) and KPMG (the large auditing firm) are examples of such breaches. Telling my personal story is a micro-instance of activism within a curriculum that is unresponsive to the cries of nature and of subjugated people. It allows my students to stay with the trouble (Haraway, 2016) of contradictory viewpoints without jumping to conclusions or judgements.

Over the years, several stories have found their way into my curriculum, and I then developed an intervention in my Spatial Analysis course which required students to tell their own stories. This resulted in the production of digital stories. This thesis is part of a process to discover what useful insights for the geomatics total learning experience could emerge from the process of combining storytelling with critical pedagogy, mediated through a critical posthumanist stance towards geomatics education.

1.2.   Context

My university experience

Since leaving the employ of Caltex in 2005, I have been lecturing in geomatics programmes at both CPUT and the University of Cape Town (UCT). I am currently employed at CPUT, where geomatics students study towards undergraduate or postgraduate diplomas in Surveying or Geographic Information Science (GISc). UCT is a traditional university that offers undergraduate and postgraduate degrees in geomatics. A university of technology in South Africa is the successor of the technikon, and the diploma programmes are intended to be more focused on practical application of knowledge, whereas degree programmes are

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[2] Barad explains that re-turning is not "returning as in reflecting on or going back to a past that was, but re-turning as in turning it over and over again" (2014: 168) so as to create new patterns in space and time
[3] 'Participants' refers to both humans and non-humans.

more theoretical. Most geomatics qualifications in South Africa are housed within faculties of engineering.

My own geomatics studies were at the University of KwaZulu-Natal and the University of Cape Town, the only two universities in South Africa offering degree programmes in geomatics. At birth, I was categorised and labelled as an 'Indian South African' – it is a mark on my body and subjectivity that relegated me to the status of less-than human on a hierarchical scale of pejorative differences. In addition to this, my other label of 'Muslim' has seen me shifting on a variety of hierarchies, especially considering present-day global politics. Having been through my undergraduate studies during the early 1990s (during the last years of the apartheid era), and then lecturing to a post-apartheid geomatics student body, I am of the opinion that the change of the student experience between these two epochs is not substantial enough. This is because the various curricula, pre- and post-apartheid, have largely remained unchanged. The same can be said of the underlying ethical assumptions that guide the pedagogical and assessment methods. This was in spite of supposed curriculum reform in geomatics departments. This observation and others (to be further explicated, mainly in Chapter Six) were some factors that inspired me to conduct this research.

My questions related to ethics (as exemplified by my Caltex story) were also central to motivating this research. The problems that I identified in geomatics education (see Section 1.3) converged when viewed through the lens of posthumanism. In this regard, geomatics education in South Africa needed to be analysed critically to make explicit any promotion of the Eurocentric hegemonic worldview, as well as to expose any systemic inequalities within higher education that hamper quality holistic education. The hegemonic worldview is one that promotes the subject of humanism - the White, male, able-bodied human, speaking a standard language, heterosexual, and belonging to a recognised polity. In contrast to this universalised format of humanity, are the 'others' or the categories that do not make the norm. These are what Braidotti (2013a) calls the racialised, sexualised and naturalised others, and refer to people of colour, women and nature respectively. Once the promotion of the subject of humanism is identified and critiqued, a further problem presents itself: how to affirmatively convert the critique into affirmative action?

#Feesmustfall

As an analytical tool, posthumanism recognises the need to develop an analytical methodology that can cope with complexity and the contradictory nature of the world. Our current modes of description and analysis fail to fully engage with social and material happenings. As I write this, South African society is having to negotiate a very difficult set of interrelated problems: the calamitous effects of two terms of the Jacob Zuma presidency, the effects of a global economic recession, growing structural inequality, and the environmental crisis in the time of the Anthropocene. Events taking place in and around the higher education landscape also demand our attention. The '#Feesmustfall' student movement of 2015 - 2017 was an explosive re-turn of student activism to the South African socio-political arena. Triggered by disenchantment towards the very material presence of a statue of Cecil John Rhodes at UCT, the '#Rhodes must fall' campaign was the precursor to the larger #Feesmustfall protests. The UCT campaign highlighted the need to decolonise university curricula based on Western epistemologies which seemingly centred on ideas developed in the global North, and a colonial university culture that manifested in the skewed composition of the academic work force (Badat, 2015; Murris, 2016). This campaign soon saw student protests (some violent) in virtually all public universities in South Africa. CPUT was no

exception and I experienced the protests first hand. The CPUT student body comes from lower to middle income families: crushing debt, inadequate living conditions, insufficient funds and underpreparedness for university are realities that most students I teach have to face. The disenchantment towards the African National Congress (ANC) led government for not delivering on the promise of free education for all was inevitable.

The #Feesmustfall campaign was a valuable lived experience that made me interrogate affect, flows and intensities. The status quo of the tertiary education funding philosophy was disrupted by the actions of many human bodies on university campuses and other locations in South African cities. Students, academics, parents, politicians and many others members of civil society came out en masse in a show of solidarity against the unfair nature of higher education in South Africa. The moment was one of disjuncture, of sudden change, of intensities and affects that accelerated the passions in many people. *Potentia* (power that is enabling) was used to mobilise the group in an act of resistance towards the *potestas* (power that is restrictive) of the hegemonic order. The first wave of protests in 2015 were exemplified by a united, diverse group of students from virtually all of the higher education institutions in the Western Cape descending on the houses of parliament just before the Minister of Finance was to deliver his budget speech. A few weeks later, the movement took on a more complex and contradictory complexion. Students at CPUT were intimidated to join protest action. Some wanted to write exams, but were forced not to. Some had to leave Cape Town after being evicted from the residences, and were then confronted with the dilemma of whether to return to write their exams. Many were scared of returning to the residence. Many couldn't afford the transport cost back. A cacophony of dissenting voices was heard in the academy: staff criticising unruly students, students claiming the infiltration into their ranks of a 'third force', university management apologetically communicating with parents, police arresting 'troublemakers', and students expressing fear of their rooms being looted or burned if they wrote exams and were labelled traitors. Students and staff were stressed, angry, fearful, ambivalent, or unhappy. I joined a group of concerned staff who arranged food parcels for students who could not access food because the campus cafeteria was looted.

In late 2016, there was a resurgence of #Feesmustfall protests, but in this case, the repetition had differences. The territory of the university campus was contested. Misogyny surfaced, with female students living in the residence being threatened to be raped if they did not join the protests. Contestations evolved around white privilege, decolonisation and fees. In October 2016, I joined a large protest to the gates of parliament in Cape Town, calling variously for more government funding for tertiary education, for government to intervene in the crises playing out on campuses countrywide, for education to be made more affordable for poor students, or for Jacob Zuma to step down as president. The gate of parliament was the boundary between hegemony and protest. Violence started when a mock coffin for the then-minister of Higher Education was set alight and thrown at police. Riot police fired rubber bullets and stun grenades to disperse protestors. Chaotic scenes played out, and after scenes of cars being stoned, shots being fired, streets being barricaded and people being arrested, the protest ended.

The protests took on a violent note at CPUT. In 2016 buildings were torched, cars were burnt, and classes were disrupted by protestors spraying fire extinguishers into lecture venues. Similar events played out during 2015 and 2017. A staff member was assaulted whilst walking onto campus. The university campus was no longer deemed by many staff and students to be safe. The overwhelming majority of students in my class expressed the desire to write their final tests. Many of them were on the brink of graduating. So we approached

the management of National Geo-spatial Information (NGI, the national mapping agency) to ask if our tests could be written there. The request was granted. The date 9/11/2016 is etched into my memory as a particularly eventful, affective and important day. Donald Trump was elected U.S. president, and the shift to the right in the U.S. was confirmed. I arrived at NGI in the morning, and my students started writing my Map Projections test. Student leaders who were coordinating the protests got wind of our secret tests at NGI, and a large group of several hundred protestors arrived at the gates of NGI, warning us to stop exams. The security guards closed the gate, and police were called to assist. The gate was again an important boundary, but I found myself on the side of hegemony this time around. There were threats of further destruction of property, and harm to human life. One student who arrived late for the test had to walk through the crowd. Protestors threatened to beat him up. He arrived at the test venue, shaking with fear. The venue was in the basement, downstairs. I ran between the venue, up a flight of stairs, to the front door, checking what was going on with the protest, and back down to the test venue. I tried to put on a brave face, so as not to increase my students' stress levels. I tried to encourage students to do the best they could, and reassured them that if they failed, they would be given another chance to write. As students finished writing, plain-clothes policemen secreted them out of the venue, via the back exit, out of sight of the protestors. I waited till the end, and was also secreted out – I hid behind a wall, waiting for an opportune moment, and then ran to my car. I got in and sped off. The policeman in this case was my ally, which was strange to me. Throughout my childhood, police were seen as agents of apartheid, and therefore the enemy. The relations between the police and I changed in that moment.

Being entangled in such a dense sociomaterial context, and being a student of posthumanism, requires me to conduct an analysis that can do justice to these happenings, and try out pedagogies that attempt to transform critique into affirmation. The happenings mentioned above are of a dual nature - they take place in the world; and unfold in a way that dynamically creates and re-creates the world. Another important aspect of the vignette above is as a means to introduce my figuration of the *boundary*. The boundary is central to geomatics epistemology, and is crucial in the philosophy of critical posthumanism. In addition to this, the boundary is ubiquitous in the social and material realities of our embodied existences.

Let's draw a map

Being a surveyor, I draw maps. Being a student of posthumanism has resulted in me taking my cartographic process to another level. The preferred methodology of some posthumanist scholars (e.g. Braidotti) is called *cartography*, and requires me to utilise my situated, embodied and embedded reality to draw a map (in the philosophical sense) of the landscape around me. My navigation of the landscape has been guided by the posthuman (Braidotti, 2013a), which is both a navigational and analytical tool. The urgency for moves toward decolonisation and a more caring pedagogy is acknowledged, and my research is a step in that direction, situated within an engineering education context. In this thesis, I develop a methodology that combines the philosophical cartography of Braidotti with the diffractive methodology of Barad (to be explained in Chapter Four). I then deploy this method to draw a cartography of geomatics education in South Africa. This is done to identify certain problems within engineering education in general, and geomatics education in particular. The main problem that the cartography aims to uncover is the promotion of a specific kind of geomatics subjectivity, predicated on the influence of Eurocentric, Western humanism. I then convert this critique into affirmation by means of a storytelling intervention in my pedagogy. This is

achieved by an analysis that uses stories to illustrate a posthumanist ethical stance, as well as a meta-methodological analysis of my pedagogy.

The Department of Higher Education and Training has spelt out its main policy objectives in the White Paper for Post-School Education and Training, and of particular interest to this research are the objectives:

- a post-school system that can assist in building a fair, equitable, non-racial, non-sexist and democratic South Africa;
- a post-school education and training system that is responsive to ... broader societal and developmental objectives (Department of Higher Education and Training, 2013).

Within the undergraduate geomatics curricula under investigation, these objectives are largely ignored or not made explicit. Pedagogical practices are needed that are attuned to issues of social and environmental justice. Attempting to meet these objectives is made all the more difficult in a rapidly changing society such as South Africa. These objectives call for socially and environmentally aware practitioners with high ethical standards. This translates into a curriculum that is responsive to developmental needs.

The site of my research is at CPUT, but my experience of other geomatics departments and my work in industry all contribute to the knowledge that is developed. My formative experiences as a person of colour living in the apartheid state during the 1970s, 1980s and early 1990s also have had a profound effect on my evolving subjectivity. Posthumanism has shown me that time is not linear, and the past-present-future timeline is an experience of temporality that is shaped by dominant societal norms. So in this research, stories of colonial and apartheid pasts exist in tandem with stories from other times. They are used to trouble traditionally-held conceptions of time, space and matter.

Researchers have argued that traditional methods of understanding and describing identities of people living in highly diverse societies (like in South Africa) are problematic, and multidisciplinary methods are more appropriate to describe and research the multiple allegiances and societal complexities that exist (van de Vijver et al., 2015). With the influence of globalisation serving to further complexify our society, a situated analysis of the present is needed to understand the workings of the complex social and material assemblages of which I am a part of. At this time of political turbulence taking centre stage, there is an urgent need to focus attention on abuses of power on numerous fronts. The spectre of human extinction haunts us and plays havoc with our anthropocentric fears while rampant consumerism threatens to speed up our demise during this time of the Anthropocene; at the same time the turn to neo-fascism and a closing down of borders in the Global North has material consequences for people in the Global South. The role of institutions like education is becoming increasingly unclear in these unclear times. Boundaries are not what they used to be.

In order for an adequate analysis of the complex realities of the present/past/future, I have turned to the rich, ambitious and holistic philosophy of posthumanism. The brand of posthumanism that I am advocating is Braidotti's critical posthumanism, and I also draw heavily on Karen Barad's agential realism. Posthumanism is the historical moment that sees a convergence between anti-humanist philosophies on the one hand, and anti-anthropocentrism on the other. The characteristics of posthumanism will be further explicated in Chapters Two and Three, and its methodological implications will be explored in Chapter Four.

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Conducting posthumanist research requires a non-anthropocentric approach, and this has implications on contextualising the research. Contexts are not only social, thus it would be remiss of me to omit other contexts. Surveyors are land professionals, and geomatics is a discipline that is intimately connected to issues of the land. The South African colonised land has resulted in the imposition of the system of land ownership, one that did not strictly exist in pre-colonial times. Calls for decolonisation include the return of the land to its original human inhabitants, and current activism does not necessarily interrogate the Western model of land ownership. Furthermore, the land has been altered by the effects of humankind on a planetary scale. Global warming affects South Africa in very specific ways – in the Western Cape, we are currently experiencing the worst drought in recorded history, and the scarcity of water is being touted as 'the new normal'.

1.3.   Geomatics education and its problems

Geomatics is a relatively new term, created in the early 1980s, and includes the tools and techniques used in the disciplines of land surveying, photogrammetry, remote sensing, geographic information systems (GIS), geodesy, and cartography. The inclusion of these scientific disciplines under the umbrella of geomatics followed the increasing interdisciplinarity of their applications and theory development. Internationally, the spatial science community has been progressive in embracing changes in technology, working environments and global markets (Young, 2005), fuelled by a growing market. Much geomatics-related research and development has traditionally being driven by economic imperatives. This focus on innovation for the sake of monetary gain is a hallmark of modern research.

Feminist knowledge teaches us that where there is a focus on something, there is a concomitant exclusion of other things. A response-able pedagogy is one in which students and lecturers are rendered capable through the relational bonds that join them to each other and the world (Barad, 2007; Haraway, 2016). In this thesis, I am advocating such a pedagogy, one that is attentive, responsive (Bozalek, Bayat, et al., 2018) and ethical. Commenting on the ground-breaking transdisciplinary work that has been done between physics, biology and engineering to drive progress in nanotechnology, Karen Barad points out that "ethical, legal, and social considerations seem destined to be forever behind the curve of cascading technological advances" (Barad, 2007: 363). The same can be said for geomatics and related technical disciplines. As attested to by the growing list of weaponised technologies, there is no such thing as a benign invention. Every invented thing is pregnant with ethics.

Current geomatics education is an extension of the old surveying education which was developed during the apartheid era (and which in turn was influenced by colonial education). The curriculum is not just technicist, but also politically loaded in a way that entrenches certain discourses. Much of the surveying curriculum has been developed around cadastral surveying, which is the surveying and demarcation of land for the purposes of land ownership. During this development, power relations around the ownership of land were implicit. Since the advent of democracy (in 1994), any explicit reference to apartheid-era legislation (such as the Group Areas Act of 1950) was removed from cadastral surveying education, and textbooks such as *The Land Surveyor and the Law* (Simpson & Sweeney, 1973) became obsolete. Despite these minor changes, there has been very little research conducted to interrogate the philosophical underpinnings to see if the current curriculum is

striving to offer a socially just education or simply upholding the old colonial knowledge status quo.

Engineering qualifications in South Africa are heavily influenced by international standards. This results in a large amount of the core content being dictated by these international standards, at the expense of local content. This results in the situation where engineers who graduated in South Africa are "more likely to meet the needs of users in the developed world than the needs of local communities" (Winberg et al., 2014). Recent research has focused on professionalism of GISc qualifications in South Africa, and identified gaps in South African qualifications by comparing them to the American-based University Consortium for Geographic Information Science (UCGIS) Body of Knowledge (BoK) standards (du Plessis, 2012). The BoK is a comprehensive framework which assesses Geographical Information Science and Technology (GIS&T) undergraduate curricula, and was developed for use primarily in the U.S.A. (Dibiase et al., 2006). It was developed as an economy-driven response to the rapidly expanding geospatial industry, and the economic benefits of such an endeavour are made explicit in the justification for its development. It thus promotes a certain normativity underscored by a worldview which is largely capitalist and American. Research into the development of a new South African GISc competency framework has been done (du Plessis & van Niekerk, 2014). However, the proposed framework is an extension of the UCGIS BoK and not intended to disrupt or question the underlying philosophical thrust.

Geomatics qualifications at South African universities[4], like other engineering qualifications, are focused on maintaining minimum standards and covering specific technical knowledge areas (Winberg, 2008). These standards are prescribed by the South African Geomatics Council (SAGC)[5], which is the statutory body responsible for regulating the geomatics profession. For registering as a geomatics practitioner, SAGC requires that the educational institution, at a minimum, cover the following content areas in their lectures: Mathematics, Statistics, Physics, Information Technology, Geospatial Information Science, Photogrammetry, Remote Sensing, Map Projections, Business and Project Management, Professional Practice and Ethics, and Research. The Professional Practice and Ethics requirement constitutes 4% of the total required knowledge. This skewness of content towards technical knowledge tends to minimise the importance of affective, social and creative graduate attributes that should be nurtured during their education. This conditioning affects the subjectivity of students and graduates. The inclusion of the ethics component in the curriculum was intended to produce more well-rounded and industry-ready graduates, however, is it effective? A focus on emotion and affect in education is also important in subject formation, and is useful in finding "better ways of inhabiting the world with others" (Zembylas, 2009). CPUT's strategic plan aims to produce graduates with specific attributes (CPUT, 2011), and the CPUT attributes that are largely overlooked in the SAGC requirements are: social responsiveness and environmental consciousness. A result of this is a lacuna in the holistic education of geomatics students.

In unequal societies such as South Africa, the knowledges of the upper and middle classes are considered to be valuable (Yosso, 2005), and the marginalisation of the previously disadvantaged individuals continues. This marginalisation and othering within the higher education system is propagated by factors such as language underpreparedness (Postma & Postma, 2011) and inequalities associated with race, gender and generation (Bozalek, 2011).

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[4] I am referring here to both traditional universities and universities of technology
[5] Prior to 2017, this body was called the Council for Professional and Technical Surveyors (PLATO). The acronym derives from the Afrikaans name of the Council.

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Universities in South Africa have struggled to actively redress the injustices of the past. The gap between policy and practice has been noted, and the promotion of values such as equity, tolerance, openness and accountability has been difficult to practically attain (Badsha, 2012). In a technical discipline like geomatics, these goals seem especially untenable due to the prioritisation of technical knowledge. This research builds on an awareness that students possess valuable knowledges which can benefit the revitalisation of the geomatics curriculum. Through an experimental intervention guided by critical posthumanism, such benefits are investigated.

In addition to the silence on social issues raised above, geomatics education is paradoxically lacking when it comes to raising awareness of issues around the natural environment and sustainability. In practice, a major global challenge is the inability of land administrators to meet sustainability objectives (Williamson et al., 2010). Geomatics practitioners, who have a vested interest in land law and issues relating to sustainable development, should be ethical, knowledgeable of land issues, and caring towards the environment. Geomatics education should prepare them to attain these graduate attributes, but this is not always the case, with much of the geomatics education discourse being focused on technical issues (Burkholder, 2005, du Plessis & Van Niekerk, 2013, Young, 2005). GISc tertiary education in South Africa does not adequately cater for an awareness of sustainable development. In particular, the dimensions of sustainable development that are most neglected are economic growth, social inclusion and culture (Coetzee et al., 2013).

Research on the development of curriculum content and transformative pedagogical techniques that are aimed at decolonisation and ethical conscientisation in South African geomatics education has not been conducted. This research investigates the development of one such intervention, which is, in part, aimed at growing students' environmental and social awareness. It is not an attempt at a wholesale change of the geomatics curriculum, rather, it is a provocation. It is a micro-instance of activism within a structured curriculum that I have taken responsibility for, and is intended to provoke more questions than provide answers.

In this thesis, I am advocating for a specific type of transdisciplinarity that has been lacking not just in geomatics, but in many other scientific and technical disciplines. Indeed, geomatics has been at the forefront of trans- and interdisciplinary research, so I am not arguing for transdisciplinarity in itself. Rather, I am promoting the type of transdisciplinarity that transcends the border between ethics and technology, between art and science. It seeks to find interconnections between the discursive communities of the 'hard' and 'soft' sciences. This type of research is encouraged by many feminist theorists who insist that in order for an adequate analysis to take place, multiple viewpoints from previously separated disciplines is necessary (Barad, 2007; Braidotti, 2013b). This thesis follows a relational ontology that acknowledges a multiplicity of agents (both organic and inorganic) all linked together via multiple relations. Examples of these agents could be students, lecturers, land, geomatics technology or universities. Within this scheme, relations are ontological primitives, and contain within them power differentials. These relations deserve much closer investigation.

A note on the use of race-based terminology

This thesis is written within the context of post-apartheid South Africa. I acknowledge that current South African society has been left with a difficult legacy, as a result of dispossession, racially-skewed discriminatory laws and distribution of resources during the apartheid and colonial periods. Race-based terminology was extensively used to entrench the

apartheid status quo, and is still recognised in the democratic South Africa because of government efforts to redress past racially discriminatory laws or practices. I therefore utilise the unfortunate terms 'Black', 'White', 'Coloured' and 'Indian' to refer to the racial groups that were officially recognised in the apartheid era, and continue to live on in the 'new' South Africa. These terms are useful in the analysis of stories, which brings to light differences that matter in the lived experiences of students. The apartheid-era labels continue to haunt the present.

1.4.   Research aims and questions

This study is situated in geomatics education, and the site of the research is a South African university of technology. Critical posthumanism rejects false universalisms and strives to produce locally relevant knowledge and learning communities. Hence the specific focus on the geomatics learning experience within the context of a South African university, as experienced by me[6]. Its aims are to explore theory, to develop and apply methodology, and to investigate an ethical intervention as an exemplar of critical posthumanist educational practice.

The following two main research questions have been developed, each with related sub-questions:

1. How is a specific type of humanist subjectivity (which is premised on the centrality of the rational, autonomous, European, heterosexual, able-bodied Man) encouraged and perpetuated by the geomatics learning experience?
    a. How can the interpellative logic of geomatics be explored? In this respect:
        i.   What is prized in the epistemological foundations of geomatics; and
        ii. How does surveying and mapping order the world, not just describe it?
    b. How can the geomatics learning experience be explored cartographically to show how geomatics education emerged out of a contingent intersection of practices shaped by power relations?

2. How can a micro-instance of pedagogical activism in the form of a digital storytelling intervention be used as an affirmative critical posthumanist educational device in geomatics education?
    a. How can stories be analysed and used diffractively to critique dualisms and transcend them;
    b. How can the student voice be foregrounded through a socially just pedagogy using digital storytelling;
    c. How can posthumanist ethics be used to guide the intervention, thereby encouraging a posthumanist subjectivity and furthering the aims of decolonisation?

The aims and questions are able to be explored due to the dual nature of critical posthumanism as being both an analytical and navigational tool. There is thus a 'zig-zagging' between critique and affirmation, between theory and practice that is experimental and creative. Question (1) is primarily aimed at critiquing the geomatics learning experience, to

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[6] In the posthumanist relational ontology, identity is not prior to relations between people and things, so 'my' experience is not external to the world around me – it is an experience that is embedded in and co-produced by the assemblages that I am part of.

show how the education of geomatics practitioners is premised on and perpetuates a rational, autonomous humanist subject. I will show that this subjectification is achieved by focusing on specific aspects of geomatics education, at the expense of others. This research is thus attuned to silence: the silence on ethics in the geomatics curriculum, the silence of subjugated knowledge[7] in South African society, and the silence of the environment in the time of the Anthropocene. Question (2) aims at the affirmative transformation of the critique through showing how a micro-instance of pedagogical activism in the well-established geomatics curriculum can introduce a qualitative shift in the student experience. Through storytelling and counter-mapping, attention is drawn to issues that were previously kept silent.

This research is also intended to investigate how points of compatibility between the 'hard' and 'soft' sciences can be identified and demonstrated (Braidotti, 2013b). It will make a contribution to the development of the growing body of literature on posthumanism and new materialism: "As an important but poorly defined force in contemporary academia, new materialism stands in need of conceptualization"(van der Tuin & Dolphijn, 2012). I am guided by a posthumanist brand of ethics, as advocated for by Braidotti's nomadic subjectivity (2006), Barad's agential realism (2007), Haraway's speculative ethics (2016) and Tronto's ethic of care (2013).

1.5. Structure of the thesis

This thesis consists of three main parts: Setting the scene, *Potestas*, and *Potentia*.

Part One: Setting the scene

Part One introduces the research. Chapter One situates the study, myself, the research aims and research questions. Chapter Two presents the posthumanist theoretical framework by means of a literature review of the relevant literature. Chapter Three continues with the theoretical underpinnings, but relates it to an ethical pedagogical practice. It also presents a literature review of storytelling, which is the type of pedagogical intervention that is being researched. Chapter Four develops a posthumanist methodology that is primarily a blending of Braidotti's cartographic methodology with Barad's diffractive methodology.

Part Two: *Potestas*

Part 2 is based on what Braidotti refers to as *potestas*, which is a type of power that can be seen as restrictive, hindering and controlling. This is seen in the power that is exercised by the state; it was introduced in the political and philosophical writings of Spinoza and later expanded on by Deleuze (Deleuze, 1988). This section is focused on how geomatics promotes a specific brand of subjectivity, namely the hegemonic subject of humanism.

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[7] Subjugated knowledge is knowledge that is hidden and seen as inferior to knowledge that is given prominence in the curriculum. In this thesis, I refer to students' subjugated knowledges, which are knowledges that are derived from the lived experiences of students who are classified as 'other' (e.g. Black, female, or foreign students). The notion of subjugated knowledges derives from Foucault, who described subjugated knowledges as: "a whole set of knowledges that have been disqualified as inadequate to their task or insufficiently elaborated: naïve knowledges, located low down on the hierarchy, beneath the required level of cognition or scientificity" (1980: 21).

Part Two begins to put the research methodology to work. Chapters Five and Six contains, respectively, an analysis of geomatics in general, and geomatics education in South Africa. This analysis is done with the aim of investigating how a humanist subjectivity is encouraged by the geomatics learning experience.

Part Three: Potentia

In contrast to *potestas*, power can also be viewed as productive and enabling, where subjects are empowered to pursue their own ethical imperatives – *potentia*. *Potentia* is covered in Chapters Seven, Eight and Nine. In Chapter Seven, I examine the student storytelling intervention. In particular, I conduct a qualitative analysis of all student stories that were produced, and then I conduct a post-qualitative analysis on two selected stories that were produced by students. This is done with the aim of investigating how a micro-instance of pedagogical activism in the form of a digital storytelling intervention can be used as an affirmative critical posthumanist educational device.

Chapter Eight distils the findings of the analysis, and presents implications for the subjectification of geomatics students and practitioners. This is where I imagine an affirmative transformation of the subject of humanism, into a subject that is in the process of becoming, and guided by posthumanist ethics.

Chapter Nine closes off the thesis by drawing conclusions and recommendations for future work.
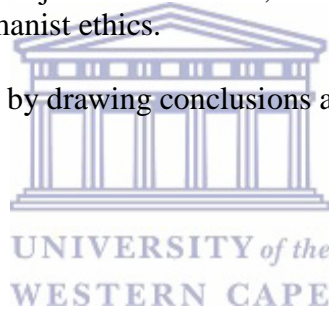
CHAPTER TWO – THEORETICAL FRAMEWORK

2.1. Introduction

In Chapter One, problems relating to the humanist and anthropocentric nature of the geomatics learning experience have been identified. The hegemonic subject of humanism (who is White, male, able-bodied, speaking a standard language, heterosexual, and belonging to a recognised polity) is a figure that has always occupied a central position in geomatics education. In advanced capitalism, one could say that this subject is the client that geomatics education both services and produces at the same time.

This chapter starts to outline the theoretical framework that I have used to guide this research. I draw on the work of numerous philosophers and theorists (most notably Rosi Braidotti and Karen Barad) to develop a methodology which combines elements of their philosophies, and which is appropriate to analyse and interpret the data that I have collected. I intend to provide an introduction to posthumanist theory that could be read across disciplines, and for disciplines perhaps unfamiliar to this theory, for example, for an engineering audience. In this regard, my emphasis on the need for both the 'hard' and 'soft' sciences to benefit is important.

It should be noted that although the dominant philosophical stance is that of critical posthumanism, as conceived by Braidotti, there are other aspects that I have included so as to provide a theoretical grounding for the specific pedagogical intervention. Besides drawing on geomatics theory, I reference non-representational theory, postcolonial theory and feminist new materialism (these are all closely related to posthumanism). I have combined these elements using a navigational and analytical methodology called 'diffraction' (derived from Haraway and Barad), together with a cartographic methodology (from Braidotti) to strengthen my argument. In addition to these theorists, the work of Val Plumwood and Joan Tronto are important in the development of my methodology. Plumwood is useful in the identification and critique of dualisms that emerge, and Tronto is useful in the development of a pedagogy attuned to social justice and care ethics. I will not go into much detail about specific geomatics concepts in this chapter as one of the aims of the diffractive analysis (to be explained in Chapter Four) is to carefully interrogate details of geomatics so as to glean important transdisciplinary learnings.

Posthumanism provides us with the tools required to analyse and navigate the complex world we are immanent to. Our current historical condition – the posthuman condition (Braidotti, 2013b) - is characterised by complex and contradictory features and requires new thinking to understand. The contemporary world has seen several boundary breakdowns between dualistically opposed pairs (such as nature/culture and human/technology) (Haraway, 1991) thus problematising the idea of absolute difference. Posthumanism eschews the nature/culture dualism, and is supported by a monistic ontology, which stresses the self-organising nature of living matter (Braidotti, 2013a). Critical posthumanism enables us to critically analyse the relationships that are immanent to the discipline of geomatics (such as the relationships between humans and non-humans). The process of othering is important to interrogate, as it is deeply ingrained in certain ways of thinking, most notably within the Western philosophical tradition, and helps to interpellate subjects into certain ways of being. Critical posthumanism views difference and the other in a more affirmative way. In this regard, my research is used to posit an affirmative reconceptualisation of geomatics students' subjectivity, and geomatics

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curricular knowledge, within a technology-rich educational environment. This is especially important in contemporary South African society, where the imperatives of decolonisation cannot be ignored.

In order to practice critical posthumanist research, a paradigm shift away from the traditional qualitative or quantitative research thinking is needed, together with a step into muddy interdisciplinary waters, and a healthy dose of imagination (Lenz Taguchi, 2012; Larson & Phillips, 2013; MacLure, 2013a; Petersen, 2014). That critical posthumanism is a relatively new philosophical territory makes it all the more challenging and exciting. The current corpus of research on posthumanism is diverse, and draws its inspiration from a variety of disciplines such as science and technology studies, physics, biology, psychoanalysis, environmental studies, critical theory, art, science fiction, philosophy and cultural studies.

The transdisciplinary nature of this research is encouraged by many theorists who insist that in order for an adequate analysis (or philosophical cartography as it is referred to by Braidotti) to take place, multiple viewpoints from previously separated disciplines is necessary (Barad, 2007; Braidotti, 2013b). One needs to start from a particular location, and describe in detail the workings of the sociomaterial processes in which one is immersed (Braidotti, 2006, 2013a). In this study I develop and use a cartographic methodology (which is based on the genealogy of Michel Foucault) which takes into account the historicity of geomatics education in South Africa. The various theories I am using are underpinned by a relational ontology. There is also an acknowledgement that all events are subject to power relations. The research is embedded in the South African higher education context, and is produced by me, the researcher-participant, who is also a co-creator and boundary-drawer/crosser. Coming from a surveying background, I am an observer, representer, mapper, boundary-creator, peg-basher, trigonometry practitioner (plane and spherical), co-ordinate transformer, satellite-watcher, error-minimiser and accuracy-maximiser. All these aspects have shaped and continue to shape my emergent subjectivity in a *becoming* with others. Many aspects are an advantage, and others a hindrance when confronted with the process of trying to understand the literature of posthumanism. The use of concepts like cartography, location and topology in the paradigm of geomatics over a period of time have sedimented their meaning within me, and trying to move to a more ambivalent notion of these concepts has proven difficult. However, once I moved away from the notion of exclusive representation to a more fluid, dynamic vision of these concepts, it has been immensely rewarding. Being able to understand the philosophy has helped to make connections between concepts, and has grown a deeper appreciation for things that were previously taken for granted. The language and concepts of posthumanism have grown an appreciation of complexity and the interrelatedness of the world. Engaging with posthumanism encourages one to live within modern society without giving in to the well-worn dualisms that have come to define the way that society has been self-represented.

2.2. Posthumanism

Posthumanism is the historical moment that sees a convergence between anti-humanist philosophies on the one hand, and anti-anthropocentrism on the other. The basic characteristics of posthumanism are: overcoming humanism and humanist anthropocentrism, taking into account human others (i.e. females and natives) and nonhuman others (i.e. animals, the environment and technology), and the affirmation of difference (Radomska, 2010; Braidotti, 2013b). Posthumanism can be seen as a new language with which to describe

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the world in all its complexity. It should be noted that language is more than just a descriptive tool though: it is not just informational or communicational, but it orders and controls us too (Deleuze & Guattari, 1987). Language has an interpellative power – it hails us into being subjects. This insight is taken further later on in this thesis by analysing the interpellative power of maps and cartography. Besides critiquing the *potestas* of language, a posthumanist orientation can harness the *potentia* of language to introduce new words, concepts, figurations or understandings.

2.2.1. Anti-humanism and anti-anthropocentrism

Philosophically, posthumanism emerged out of poststructuralism as a reaction to and a critique of humanism and anthropocentrism. Humanism and anthropocentrism are seen as related problems within posthumanism. Humanism is a belief that considers human beings as the central source of knowledge and values, and believes that humans are ontologically free through universally shared abilities such as reason (Wietzenfeld & Joy, 2014). Philosophical reason is associated with dialectical methods to resolve contradictions, and Braidotti suggests that, through reason, the task of philosophy has been elevated to "a privileged and culturally hegemonic tool of political analysis" (Braidotti, 2013a: 20). This feeds into the hierarchical thought that is eschewed by the thinking of posthumanism. However, posthumanism should not be viewed as a philosophy that is the polar opposite of humanism – this logic would be an example of setting up of a dualism which is critiqued by posthumanism. Braidotti explains that posthumanism "is the historical moment that marks the end of the opposition between Humanism and anti-humanism and traces a different discursive framework, looking more affirmatively towards new alternatives" (Braidotti, 2013a: 37). In the following section, I will explain further the issues that make posthumanism a philosophy that is both anti-humanist and anti-anthropocentric, and will get to the affirmative pursuit of new, creative alternatives later in this thesis.

Anti-humanism

A problem with humanism (Bell & Russell, 2000; Braidotti, 2013b) is that it has developed into a European civilisational model, promoting European hegemony, traditional Western philosophy and typified by Da Vinci's Vitruvian man (Figure 1). The Vitruvian man is the ideal of human perfection – white, able-bodied, handsome, male, youthful – and anything that is dissimilar is othered. It sets the standard for individuals and cultures, and its Eurocentric binary logic neatly places subjects into 'us' and 'them' boxes. Difference or otherness is equated to inferiority, and those branded as others are more often than not "the sexualized, racialized, and naturalized other, who are reduced to the less than human status of disposable bodies" (Braidotti, 2013a: 15). Plumwood (1993) shows how the Western notion of human/nature (and other relationships of oppression) is strongly dualist and relies on a relation of domination/subordination. Humanism creates a hierarchy of worth, on which women (sexualised others), people of colour (racialised others) and animals, together with non-living matter (naturalised others) are placed lower down than the dominant 'Man'. The racialised other is also extended to include non-Western and non-Christian others (Braidotti, 2009).
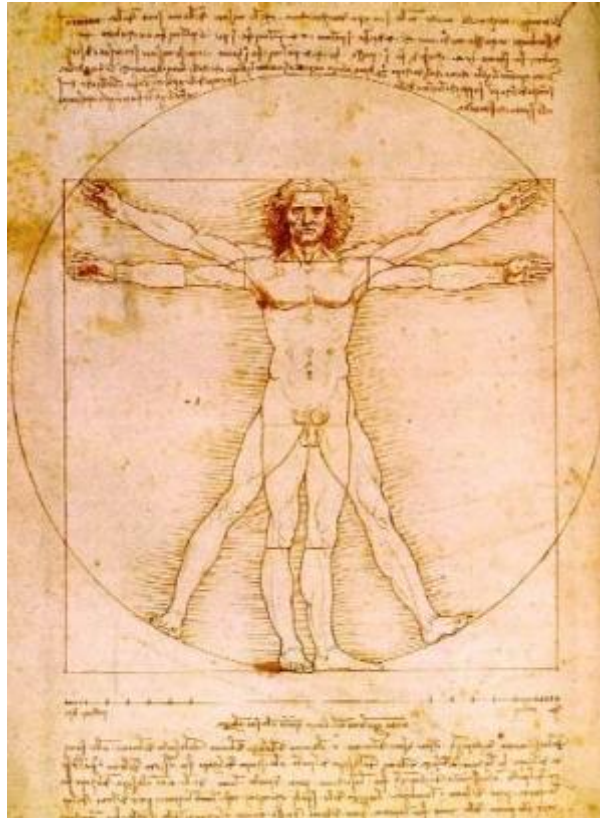
As mentioned, one of the problems with humanism is that it promotes a specific type of thinking by setting up dualisms. These dualisms may be overtly or covertly promoted by the coupling of the humanistic norm with self-representation. Self-representation of 'Man' results in a self-centred attitude, and implicitly contains the abilities of transcendental[8] reasoning and rational consciousness (Braidotti, 2013b), which are proudly Western humanist characteristics. The humanist subject 'Man' has defined himself, not only by what he has included in his description of himself, but also in what he excluded. This results in a violent relationship between Man and others, due in part to the hierarchical scale of decreasing worth that he set up, where Man is at the top, and the others follow. This critique is not only present within posthumanist thinking. Even within some Eastern philosophies such as Shin Buddhism, there is a view that anthropocentrism and humanism create a reality which has resulted in a host of pressing contemporary problems, such as "the destruction of the environment, exploitation, war, economic-centred society, and loss of spiritual values" (Dessi, 2006: 113). Although humanism intended to value the abilities of the individual, Buddhists feel that this has resulted in a justification for capitalism, competition and material prosperity, which manifests as egoism and a system that marginalises the weak. These arguments sound very much like the posthumanist critique of humanism, and anthropocentrism too, especially if the 'weak' are taken to include those that are weaker-than Man.

Humanism and its long-standing bond with Eurocentrism exposes a flaw within the humanities: "their structural anthropomorphism and perennial methodological nationalism" (Braidotti, 2013a: 152). Anthropomorphism (which is the attribution of human characteristics

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[8] Deleuze contrasted transcendent thought (which assumes an external, pre-existing reality, such as God) with immanence, which conceives of life as a process of creative power. Thus, thought does not represent the world - it is part of the world (Colebrook, 2002).

to anything other than human beings) results in incompatibility with science and technology, and nationalism challenges the humanities' ability to cope with cultural diversity. The current refugee crisis in Europe and South Africa is testament to the problems that are caused as a result of nationalism.

Critical anti-humanist epistemologies have evolved into interdisciplinary and transdisciplinary research areas, such as gender studies, cultural studies, media studies and human rights studies (Braidotti, 2013b). Added to the crisis of the humanities, the knowledge economy has engendered

> a symbiotic, mutually reinforcing, relationship between university researchers, especially in the STEM disciplines, and trans-national corporations that are heavily dependent on the knowledge produced in the relevant research centres (Alexander, 2014: 50).

As Bozalek (2017: 43) notes, the "corporatization of the academy has meant that market principles such as competitiveness, efficiency, excellence, consumerism, individualism and productivity now dominate all aspects of the university". The economic imperative has privileged the hard sciences and marginalised the humanities, setting up a dualism (hard science/soft science) that is detrimental to an understanding of the complexity of the world. This fosters an attitude that views people and things as exploitable resources. It further alienates disciplines and instead of difference being harnessed for celebrating diversity, difference "becomes a springboard for xenophobic stereotyping and latent social conflict" (Alexander, 2014: 53).

Posthumanism encourages interdisciplinarity and a rhizomatic[9] understanding of phenomena. It seeks out points of compatibility between alienated branches of knowledge through new and experimental methods which have a strong ethical basis.

Anti-anthropocentrism

Related to humanism, anthropocentrism has to do with the relationship that human beings have with nonhumans. Anthropocentrism privileges human interests and subordinates anything that is nonhuman. Anti-humanism focuses on critique of the centrality of the human (and the human Man in particular) as the measure of all things. Anti-anthropocentrism argues for ecological justice, against speciesism, and against humans being placed at the top of the species hierarchy.

Drawing on Spinozist ideas, Braidotti advocates a vitalist approach to living matter. She distinguishes between two life forces, namely *bios* which is political, discursive and reserved for humans, and *zoe* or non-human life. She points out that

> *Zoe* is the poor half of a couple that foregrounds *bios* as the intelligent half; the relationship between them constitutes one of those qualitative distinctions on which Western culture built its discursive empire. Traditionally, the self-reflexive control over

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[9] The rhizome was a figuration developed by Deleuze and Guattari, which helps us to move away from hierarchical thought and advocates a flattened, connected ontology. "A rhizome has no beginning or end; it is always in the middle, between things, interbeing, intermezzo. The tree is filiation, but the rhizome is alliance, uniquely alliance" (Deleuze & Guattari, 1987: 25).

life is reserved for the humans, whereas the mere unfolding of biological sequences is for the non-humans. (Braidotti, 2006: 37)

Living matter is self-organising (autopoietic) and the work of Felix Guattari extends autopoeisis beyond people and the biological to technology, material, the sociological and the ideological (Greenhalgh-Spencer, 2014). Against anthropocentrism, Braidotti advocates bio-centred egalitarianism (Braidotti, 2006, 2011a) or zoe-centred egalitarianism (Braidotti, 2013a) which requires a more equitable relationship with animals. Methodologically, this requires accounting for alternative subject positions by making transversal connections between relations. Ethically, this requires a recognition of the primacy of *relations*, as opposed to things. A posthumanist orientation is difficult, and requires a "double overturning of individualism, on the one hand – in favour of complex singularities – and of anthropocentrism, on the other – in favour of multiplicities of flows and assemblages" (Braidotti, 2011a: 353).

2.2.2. Theoretical influences

Besides anti-humanism and anti-anthropocentrism, posthumanism builds on the epistemological and political foundations of postcolonialism, anti-racism and material feminisms. Material feminism is closely linked to what has become known as new materialism, and prominent philosophers in the field (such as Rosi Braidotti, Manuel DeLanda and Karen Barad) have contributed much to the development of posthumanist theory through their new materialist insights (Barad, 2003; DeLanda, 2006; Braidotti, 2013a). The thinking and methodology pays close attention to the material engagements that occur in the phenomenon under investigation. It is also a relational philosophy, which views the world as entangled and sees relations pre-existing entities. Posthumanism and new materialism are non-dualist philosophies and they attempt to traverse dualisms by developing a new understanding of difference (van der Tuin & Dolphijn, 2012). Difference is seen as positive, and not in terms of a lack (Clarke & Parsons, 2013).

Posthumanism is a relational philosophy that is relatively new, constantly evolving, creative, open, ambitious and encourages innovative ways of investigation. It has had important contributions from philosophers and theorists situated across a wide spectrum of thought, such as the humanities, social sciences, natural sciences, media studies, critical theory, and science and technology studies. New materialism and critical posthumanism are in need of theoretical development (van der Tuin & Dolphijn, 2012), and this research aims at contributing to the growing body of work on critical posthumanism through an empirical application within engineering education in the Global South. In education, Taylor notes that posthumanism can be considered to be "a constellation of different theories, approaches, concepts and practices" (2016: 6).

Michel Foucault and Gilles Deleuze are central figures in Braidotti's critical posthumanism. Foucault's genealogy is important in developing a historical, cartographic methodology that concentrates on the workings of phenomena and the power relations contained therein. Braidotti emphasises that one of the most important tasks of the critical theorist is to account for the present. The French poststructuralists (such as Foucault, Deleuze and Irigaray) introduced a new way of thinking by interrogating the present so as to adequately account for change and the dynamism of the world (Braidotti, 2011b). Previously, the accepted way of conducting academic research was steeped in the past and was to be carried out in very

specific, established ways. With Foucault, cartographies of power relations were created (in works like *Madness and Civilization, The Order of Things* and *Discipline and Punish*), and the past was not something that was viewed as static and unchangeable. This dynamic conception of time is further strengthened by bringing in the theorisation of Karen Barad. Barad's conception of time troubles the beginning/end dualism (Barad, 2010) which, in a posthumanist ontology, is useful in seeking out the in-between spaces and movement.

Gilles Deleuze produced a massive corpus of philosophical work through his lifetime, and some of his works with the anti-psychiatrist Felix Guattari (especially *A Thousand Plateaus: Capitalism and Schizophrenia* and *Anti-Oedipus: Capitalism and Schizophrenia*) are seen as seminal texts in the development of an effective critique of our current capitalist society. With Deleuze, Braidotti was able to take the cartographic methodology a step further, and brought in the concept of desire. This assisted Braidotti in formulating an affirmative notion of ethics. Braidotti's work is focused on the ongoing emergence of subjectivity, and is guided by what she terms 'nomadic ethics'(Braidotti, 2006, 2011b). This is predicated on her figuration of the nomad, whose subjectivity is non-unitary, dynamic and always in a state of *becoming*. Deleuzian desire is a productive, social force that is "able to form connections and enhance the power of bodies in their connection" (Ross, 2010: 66). This type of desire is not premised on Lacanian 'lack', but is positive and based on a process of experimentation. Affective intensity based on relationality is centrally important in Braidotti's theory, and is premised on Deleuze's reading of the work of Spinoza (Deleuze, 1988).

The feminism of Braidotti, Donna Haraway, Judith Butler and Val Plumwood provide an anti-universalist and performative stance in the understanding of subjectivity as part of worlding. 'Worlding' refers to the co-constitution of the world and subjects (Kaiser, 2014) – in the posthumanist conception, the world, or nature, is not an inert backdrop in front of which humans go about their business. This anti-anthropocentric stance helps towards the related philosophical goal of troubling dualisms, such as human/nature and subject/object.

Braidotti inserts the voice of the previously marginalised and draws on postcolonial theorists such as Gayatri Spivak, Frantz Fanon and Edward Said. Posthumanism's flattened ontology questions or resists previous humanist hierarchies that have been developed over long periods of time – those that have been sedimented by repetition of normative injunctions.

New materialists and other sociomaterial practitioners take as their starting point the social and the material world being constitutively entangled, in this way challenging the anthropocentric perspective of how humans control and interact with things (e.g. tools and inanimate objects) (Barad, 2007; Braidotti, 2013a). These entanglements require us to adopt a new ontology, where "the material world is treated as continuous with and in fact embedded in the immaterial and the human" (Fenwick, 2010). This does not privilege humans or nonhumans, where both are considered to be inextricably linked – "there is no social that is not also material, and no material that is not also social" (Orlikowski, 2007). New materialist theory marks a distancing from a traditional social constructivist approach. Braidotti acknowledges that the social constructivist approach was important for social science, but the time has come to move beyond some of its long-held foundations. One of its main shortcomings is that it

> posits a categorical distinction between the given (nature) and the constructed (culture). The distinction allows for a sharper focus in social analysis and it provides robust foundations to study and critique the social mechanisms that support the construction of

key identities, institutions and practices. In progressive politics, social constructivist methods sustain the efforts to de-naturalize social differences and thus show their man-made and historically contingent structure (Braidotti, 2013a: 3).

Posthumanism replaces this with a non-dualistic understanding of nature/culture. New materialists do not see difference as pejorative; rather, it can be a source of affirmative development.

Matter is given importance as an active participant in the world's becoming, and it is through material enactments that phenomena (and knowledge about the world) get produced (Barad, 2003). Sociomaterial practices have been informed by many varying research areas, such as actor-network theory (ANT), complexity theory, cultural-historical activity theory (Fenwick, 2010), science and technology studies, physics (Barad, 2007, 2011), biology (Keller, 2002) and mathematics (Lury, Parisi & Terranova, 2012; De Freitas & Sinclair, 2014) and have contributed to research in information systems (Ulmer & Pallud, 2014), organisational research (Orlikowski, 2007), and non-representational theory (Massey, 2005; Thrift, 2008; Anderson & Harrison, 2010).

Being a relatively new and holistic theoretical framework, posthumanism has the potential to address complex contextual problems faced in higher education practice in South Africa. It has the potential to facilitate pedagogies that are socially just by opening up new territories through transdisciplinarity, relationality, affect theory, the use of emerging technologies and a focus on non-anthropocentric critical pedagogy. This potential is yet to be fully realised, and although posthumanist discourse is making an impact in the humanities and social sciences, it "has yet to make its presence felt in educational studies, despite some notable attempts to gain traction" (Snaza et al., 2014: 40). Locally and internationally, there has been a growth in interest in posthumanism and related philosophies. The applications of posthumanism in higher education is gaining traction (Hinton & Treusch, 2015; Snaza, 2015; Bozalek, Braidotti, et al., 2018), but in working with school children and teachers, there is a wider range of research (e.g. Hultman & Lenz Taguchi 2010; Juelskjaer 2013; Kuntz & Presnall 2012; Lenz Taguchi 2010; Lenz Taguchi 2012; Larson & Phillips 2013; Lenz Taguchi & Palmer 2014; Petersen 2014). In July 2015, the inaugural "Deleuze and Guattari and Africa" conference was held at the University of Cape Town, with keynote addresses by Rosi Braidotti, Ian Buchanan, Claire Colebrook and Paul Patton. The organisers noted that although Deleuze and Guattari studies are in their infancy in South Africa, they

> hold great promise for thinking through and engaging with the complexities of contemporary South Africa and Africa more broadly, with pressing concerns around identity, geopolitics, culture, art, time, memory, autonomy, oppression and justice desperately calling for a bold, radical new praxis (Gray van Heerden & Eloff, 2015).

2.2.3. Assemblages

Posthumanism represents a paradigm shift in the way we conceive of ourselves, our place in the world, and our subjectivity. The need to bridge the divide between the 'hard' and the 'soft' sciences has become more urgent in the time of the Anthropocene, in which human development threatens multiple species on a global scale. Deleuze was responsible for the theory of assemblage, which is useful for analysis at a variety of scales and inclusive of

elements across the natural and social sciences. It was further elaborated by Manuel DeLanda who points out that

> This theory was meant to apply to a wide variety of wholes constructed from heterogeneous parts. Entities ranging from atoms and molecules to biological organisms, species and ecosystems may be usefully treated as assemblages and therefore as entities that are products of historical processes. (DeLanda, 2006: 3)

Methodologically, it requires an analysis of *assemblages*, as opposed to discrete people or things (Lather, 2014). With this thinking,

> the body begins to be treated less as a bounded entity than as a network or assemblage, evolving with technology and the environment, where identity emerges as a consequence of the layered flows of information across multiple routes and channels, and of course subject to social pressures and power relations. This view of the body as an assemblage with non-human and machine, and embodied but distributed subjectivity, is at the core of posthumanist thought. (Nayar, 2014: 64)

This view of the world requires a relational understanding – material things and practices emerge as result of relationships. Furthermore, the relationships between discursive practices and the material world are important (Barad, 2007). For example, I will show how mapping, as a scientific practice, is both descriptive and creative at the same time, and is implicated in colonisation and knowledge/power practices.

According to DeLanda (2006: 5) assemblages are not 'seamless wholes' but "wholes whose properties emerge from the interactions between parts". Assemblage theory has an anti-reductionist conception of networked systems. Analysing the complexity in the world is encouraged, and acknowledging that assemblages can be internally contradictory is important. This is especially relevant in the diverse South African university, which contains a multiplicity of influences, imperatives, socio-political realities, material conditions and relations.

Deleuze and Guattari's (1987) diagnosis of the schizophrenic nature of capitalist society is an illuminating and influential tool in posthumanist thought. It analyses the "double pull in contemporary cultures" (Braidotti, 2006: 3), which is the conflict between the need for autonomy on the one hand, and the capturing of desires for the sake of commercial profit on the other. The paradoxical nature of our subjectivity in contemporary society must be accounted for, so as to create the possibility of transformative action. Braidotti's project has conceived the posthuman as a "dynamic amalgam of animal, machinic, technical, digital, organic, inorganic, viral, and capitalist dimensions" (Butler, 2014: 21). Assemblages (such as the South African geomatics education assemblage) can contain creative potential in their ability to change. In this regard, Deleuze's concept of *deterritorialisation* is important. It can be thought of as a movement that produces change in an assemblage – it frees up "the fixed relations that contain a body all the while exposing it to new organisations" (Parr, 2010: 69).

The concept of chemical molecules which are the building blocks of matter, is extended by Deleuze to explain aspects of subjectivity, politics, perception and affect. His ideas of *molar* and *molecular* are important in understanding assemblages. In biology or chemistry, molar refers to aggregates of matter. Molar entities are well defined, large, and can belong to the State or a governing apparatus. On the other hand,

their molecular counterparts are micro-entities, politics that transpire in areas where they are rarely perceived: in the perception of affectivity, where beings share ineffable sensations; in the twists and turns of conversation having nothing to do with the state of the world at large (Conley, 2010: 175).

Molecules can aggregate into molar aggregates and vice versa. Subjects or assemblages can be appreciated in terms of their elasticity, fluidity or sedimentation. Phenomena are thus not rigid but always in the process of *becoming*. With this thinking, there are no hard boundaries, as molecules can detach from molar aggregates and engage in complex interactions with other molecules. This chemistry-inspired view reminds one of, but is in contrast to, the Democritean atomist worldview, which holds that the world consists of atoms (the 'uncuttable' smallest possible things) and that the properties of things derive from the properties of their atoms (Barad, 2007; Kaiser, 2014). Much of the philosophy of the 'hard' sciences comes from Democritean atomist metaphysics, which is the basis of Newtonian mechanics and Cartesian[10] epistemology, and is challenged by posthumanism. In a posthumanist understanding of the world, relations (not things) are the ontological primitives.

2.2.4. Types of posthumanism

Braidotti maps out the three main strands of contemporary posthumanist thought (Braidotti, 2013a).

The first type comes from moral philosophy and develops a reactive form of the posthuman. Braidotti gives the example of Martha Nussbaum who defends the first type. Nussbaum is criticised for reintroducing the classical humanistic norms into this form of posthumanism. Although her admirable intention is to engage with bioethics and the challenge of treating nonhuman animals justly, she is criticised for being humanist on a theoretical and methodological level (Wolfe, 2010). This re-insertion of the subject of humanism (the dominant Man) is an eventuality that one must be alert for. We shall see that this is unintentional but is a contingency that re-appears with regularity in the geomatics learning experience. Nussbaum's cosmopolitanism, Braidotti argues, is built on a traditional American liberalism which reinscribes humanistic norms, such as "fixed identities, steady locations and ties that bind" (Braidotti, 2006). Cary Wolfe demonstrates that bioethics itself is "woefully inadequate – both ethically and philosophically – for confronting the complex questions of life, death, and our relations to other living beings that far exceed what bioethics currently constitutes as its unified field" (2010: 61). Posthumanism is the tool by which such relationality can be interrogated. Posthumanism, however, is not a monolithic philosophy, and Wolfe, like Braidotti, maps out "a kind of philosophical or theoretical spectrum that moves from humanist approaches to posthumanism (or anti-anthropocentrism) to *posthumanist* approaches to posthumanism" (Wolfe, 2010: 62, italics in original). This trajectory has been continued by new materialist theorists who focus, amongst other things, on the agency of matter and non-human others.

Analytic posthumanism

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[10] The Cartesian co-ordinate system is a fundamental building block of geomatics knowledge.

In Braidotti's typology, the 2nd type focuses on the science and technology aspects of posthumanism, which she calls 'analytic posthumanism'. Developments within the 'hard' sciences contribute mainly to this branch of posthumanism, and are related to what has been called 'transhumanism'. Transhumanists research and predict the link between advanced technology and human bodies. Common areas are medical enhancement, military technology and virtual reality. Science fiction has many examples of technologically enhanced human life, set either in utopian or dystopian societies. It is rife with visions of a future where mankind is transformed or annihilated by technology. By placing the human at the centre, the insidious re-insertion and intensification of humanism can be observed here (Wolfe, 2010).

Analytic posthumanism recognises an intimate relationship between people and technology, but it is criticised by Braidotti for attempting to be politically neutral, and not realising the implications for a revised vision of the subject. The focus is generally on how the technologies function. It also re-instates the individual at the centre, thereby extending the humanistic norm – in this way a "revised and updated form of humanist ethics gets superimposed on post-humanist technologies" (Braidotti, 2013a: 41). Literature on advances in geomatics technology is illustrative of analytic posthumanism – the relationship between the surveyor and his (almost always his, hardly ever her) instrumentation is definitive. Even from early surveying literature, the surveyor-theodolite-mapping assemblage assumes a central place:

> The Theodolite is the surveyor's principal instrument, and is the most important item of equipment in nearly all branches of survey. Many types and models are available, ranging from fairly simple contrivances to highly complex masterpieces of precision (Durban Corporation, 1987: 34).

Issues of efficiency and accuracy have dominated the discourse, with much energy being directed into research that is market-driven. In GIS literature too, the theoretical turn towards the social implications of GIS is relatively insignificant compared to the technical research and publication. The social focus has emerged largely because GIS has changed from an industry that developed software and hardware, to an applied field utilised in a wide variety of disciplines. If it involves spatial data, it can be analysed with GIS. This move, popularised by the tag 'GIS and society' (Dibiase et al., 2006) does recognise that GIS is not merely technical, but is located within institutions and discourses, resulting in societal effects, and hence has an ethical component. The development of GIS technology and knowledge is firmly entrenched in, and given impetus by advanced capitalism. It simply could not have developed without the support of corporate capital, yet it also has co-developed as a result of its location within society.

> The divide is not, in this sense, between GIS and social theory, but between a social theory and notion of science rooted in empiricism (in which theory is that which accounts for the outcome of model testing) and social theory in which theory is the precondition for any understanding and analysis in the first place (Pickles, 2005: 52).

Braidotti says that analytical posthumanism actually contributes to the segregation of knowledge into the two cultures, the humanities and the sciences. Learnings generated by both cultures have dramatically altered the way we understand the basic frame of reference for the human, and are very important in understanding posthumanism. The deepened segregation comes from the divergent lines of enquiry generated by the two camps. Recognising how advances in science and biotechnologies have affected the very structure of

living matter, the humanities ask about epistemological and political implications of a changing view of the human subject.

The Global Navigation Satellite System (GNSS) is a typical example of geomatics technology that is replete with transhumanist references, and it can be seen through the lens of analytic posthumanism. The United States-run Global Positioning System (GPS) is the most widely-used GNSS by surveyors. The World Wide Web, stock market transactions and power grids are all reliant on GPS or other GNSS networks for keeping accurate time, since the satellites have atomic clocks on board, the most accurate timekeeping devices humankind has invented. Millions of people all around the world carry personal GPS devices for most of their waking lives. It is an extension to subjects that helps them navigate their social reality. The GPS was originally developed by the United States military, and it is still the primary user. The technology allows for precise locating of troops, ships, aircraft and their targets. GPS satellites help smart missiles precisely hit enemy positions. Prior to May 2000, the GPS satellite signal was intentionally degraded by the U.S. military "for national security reasons" (U.S. Government, 2013). This practice was subsequently discontinued under the presidency of Bill Clinton, making it easier for surveyors and other civilians to utilise GPS for precise positioning. The de-encryption of the GPS signal was perhaps not as benevolent a move by the U.S. government as they make it out to be. There are large corporate companies that sell GPS hardware, software and services that benefited from the move. There are also other large corporates in rich countries (such as oil companies) which require accurate geographic positioning to carry out their work, often to the detriment of the environment of poorer countries (Dorling & Fairbairn, 1997). On the other hand, GPS has been deterritorialised from the U.S. army and used by many civilians for affirmative developmental work, such as nature conservation.

Land surveying, agriculture, planning, construction, mobile technology and car navigation have benefited from GPS technology. GIS and GPS technology have been used to map informal settlements, and there has recently been a shift towards community-led development in South Africa, where researchers and communities living in informal settlements form partnerships with the aim of upgrading their built environment (Pinfold, 2014). Participatory multi-criteria evaluation for risk assessment has been used in informal settlements in Cape Town, where information was collected by and from the community. Sophisticated spatial analysis has also been conducted on a host of social and environmental factors to assess the community's risk of flooding and other hazards (Musungu, Motala & Smit, 2012). Engagement between (often impoverished) communities, government and academics can help to benefit all concerned. It is a community building exercise, attuned to basic principles of social justice, respectful of human diversity, and affirming the positivity of difference. It will be seen later how these characteristics are important within critical posthumanism.

Critical Posthumanism

In the 3rd type, Braidotti proposes a combination of critical thinking with creativity. This paradox results in an affirmative development of the posthuman subject, the practice of which is called critical posthumanism. It aims to move beyond analytical posthumanism and unlock the productive potential of posthumanism. After all, too much critique could result in feelings of hopelessness, especially when humanism is the target of the critique. Critical posthumanism rejects the notion of humans being placed above other life forms – it involves the "radical decentring of the traditional sovereign, coherent and autonomous human in order

to demonstrate how the human is always already evolving with, constituted by and constitutive of multiple forms of life and machines" (Nayar, 2014: 2).

According to Braidotti, the task of a critical theorist is to firstly account for the present. Once this is achieved, the critique can then be transformed into affirmative creation. Accounting for the present is a cartographic move. Foucault's work is important in developing a historical, cartographic methodology that concentrates on the workings of phenomena and the power relations contained therein. Power can be seen as oppressive and controlling, and is called *potestas*. This is seen in the power that is exercised by the state[11]; it was introduced in the political and philosophical writings of Spinoza and later expanded on by Deleuze (Deleuze, 1988). In contrast to potestas, power can also be viewed positively, where people are empowered to pursue their own ethical imperatives – *potentia*. This is predicated on the ontological nature of people to be free to express themselves. These two conceptions of power can help to forward the notion of critique as creativity.

Methodologically, Braidotti outlines her rules that can be seen as building blocks for critical posthumanist theory. The golden rules[12] are:

> cartography accuracy, with the corollary of ethical accountability; trans-disciplinarity; the importance of combining critique with creative figurations; the principle of non-linearity; the powers of memory and the imagination and the strategy of de-familiarization (Braidotti, 2013a: 163).

For the purpose of referencing, the rules are numbered below:

Rule 1: Cartography accuracy with ethical accountability
Rule 2: Transdisciplinarity
Rule 3: Combining critique with figurations
Rule 4: Non-linearity
Rule 5: The power of memory and imagination
Rule 6: De-familiarisation

I use these rules in the development of, and the reporting on, the storytelling intervention that is central to this research. I also use them in the development of my research methodology.

Braidotti's method requires a good understanding of the current political context – much of her work takes the form of cartographies of present political situations, where she accounts for the changes and transformations taking place in terms of *potestas* and *potentia*. Linked to critique, there is always an ethics that helps to construct a social horizon of hope (Braidotti, 2006). In this research, I examine how a certain type of humanist subject is produced in part by the *potestas* contained in the geomatics curriculum. I also examine storytelling as a means of activation of *potentia* within students.

2.2.5. Agential realism

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[11] *Potestas* should not be seen as 'bad' or 'good' – this type of value judgement is an example of dualistic thinking which is eschewed in posthumanism.
[12] I use the term "golden rules" with a hint of irony, as critical posthumanism by its nature is anti-authoritarian.

In addition to Braidotti's critical posthumanism, I utilise Karen Barad's theory of *agential realism* in the development of my research methodology, and for ethical guidance of my pedagogical practice. The concept of *intra-action* is useful in analysing *phenomena*[13]. She challenges Western individualist metaphysics by critiquing representationalism, and draws on the insights of Niels Bohr, Judith Butler, Michel Foucault, Donna Haraway and others. Coming from a theoretical physics background, she also draws on quantum mechanics in the development of her theory. Agential realism is

> an epistemological-ontological-ethical framework that provides an understanding of the role of human and nonhuman, material and discursive, and natural and cultural factors in scientific and other social-material practices, thereby moving such considerations beyond the well-worn debates that pit constructivism against realism, agency against structure, and idealism against materialism (Barad, 2007: 26).

One can see that agential realism, like assemblage theory and Braidotti's critical posthumanism, promotes an understanding of entanglements of phenomena. These entanglements are not easily handled by traditional research methods (especially entanglements that require thinking across 'hard' and 'soft' sciences). In addition to this, agential realism posits a performative understanding of the world, opposed to the dominant representationalist worldview. The focus shifts from "questions of correspondence between descriptions and reality … to matters of practices / doings / actions" (Barad, 2003: 802). Instead of being inert, matter is seen as an active participant through intra-action. Barad clarifies the relationship between intra-action and the *agential cut*:

> Intra-actions include the larger material arrangement (i.e., set of material practices) that effects an *agential cut* between "subject" and "object" (in contrast to the more familiar Cartesian cut which takes this distinction for granted). (Barad, 2007: 139–140)

In my analysis of geomatics, the traditional Cartesian worldview that posits maps as representations is problematised. This problematisation is facilitated by a combination of critical posthumanism, agential realism, critical cartography and non-representational theory. Non-representational theory and critical cartography help us to understand that a map is not so much a description of the world, but rather an image of a world that is being made (Harley, 1989, 1990; Massey, 2005). Thus, power relations that underlie the dominant practice of cartography need to be analysed, so as to uncover the subjectivity that is promoted by geomatics education. Hence, my agential cut sees maps as more than mere objects. Indeed, their objectivity is questioned when one expands the analysis to include the social and material context within which cartography developed. Following Barad's reasoning, there are numerous apparatuses employed in this research, for example the geomatics cartographic process and the storytelling intervention are apparatuses that allow for different emergences. I focus on subjectivity that these apparatuses either promote or restrict, by way of *potentia* and *potestas* respectively.

For a rigorous analysis of power relations, Foucault's genealogical method is incorporated into my research methodology to make visible the link between knowledge, power and the material. This is especially pertinent in surveying education, where its effects are manifested in power exerted over the land. Foucault's work on prisons was important because it made

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[13] According to Barad, phenomena are "the ontological inseparability of agentially intra-acting components"(2007: 33). Entanglement and relationality are central in this ontology.

visible that which was unseen, yet in plain view – his historical analysis showed the power relations that were exercised by certain institutions. He points out that the "making visible of what was previously unseen can sometimes be the effect of using a magnifying instrument" (Foucault, 1980: 50). This instrument effects an agential cut, and Foucault was making the point that it is important to focus differently on the thing being studied. Further on, he alludes to the importance of the material in an effective analysis: "to make visible the unseen can also mean a change of level, addressing oneself to a layer of material which had hitherto had no pertinence for history and which had not been recognised as having any moral, aesthetic, political or historical value" (1980: 50–51).

Agential realism is an ambitious, holistic philosophy and it uses the metaphor of diffraction as an analytical tool. Agential realism critiques reflection, because reflection focuses on sameness, whereas posthumanism sees difference as important.

2.3. On difference, dualisms and representation

2.3.1. Difference

Difference, a fundamental concept in posthumanism, can be seen as a Deleuzian response to Western metaphysics' idea of difference. The Western, binary construct of difference is "difference-from-the-same" and "relies on a stable identity (or sameness) for external comparisons and relations" (Jackson & Mazzei, 2012: 87). In this way, difference is expressed negatively, different from something else – it assumes that there is a basic underlying sameness against which variations are observed (Stagoll, 2010). Hence, Western philosophy emphasises universal characteristics of groups, so that categories like 'man', 'woman', 'poor' and 'foreigner' may be created. These relations contain value judgements, and a "hierarchical scale of pejorative differences" (Braidotti, 2006: 44) is set up. The subject is defined by what it is excluded from, and by what is included in the self-representation of the human.

A posthumanist conceptualisation of difference disrupts binary thinking, and difference must not be thought of as positioned in opposition to sameness, nor is it synonymous with separateness (Barad, 2014). Deleuze defines the 'majority' and 'minority' not necessarily in terms of absolute numbers, but in terms of relationality to the larger group that they are part of. In any group, there is a standard or ideal type of member of the group. The majority is that group which most closely approximates the standard, while the minority is the 'other' (Patton, 2010). In South Africa, it is easy to see how Whites, through dominance and power, are in the majority. Because of European humanism, 'White-man' is said to be 'majoritarian' in the world, both in relation to other people and nature. Deleuze and Guattari elaborate on some of the differences:

> we must distinguish between: the majoritarian as a constant and homogeneous system; minorities as subsystems; and the minoritarian as a potential, creative and created, becoming. The problem is never to acquire the majority, even in order to install a new constant. There is no becoming-majoritarian; majority is never becoming. All becoming is minoritarian. Women, regardless of their numbers, are a minority (Deleuze & Guattari, 1987: 105–106).

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Hence a pedagogy which allows for voices from minority groups (or the structural 'others' of modernity in Braidotti's terminology) to be heard would be an exercise in becoming-minoritarian. Braidotti uses difference as an important affirmative device in her cartographies, which draw linkages between seemingly disparate elements. These elements are usually the structural others of modernity, namely the racialised, sexualised and naturalised others – people of colour, women, and nature respectively (see for example Braidotti, 2006).

Posthumanist difference is positive; it can be seen to relate phenomena along a continuum rather than separate things out by placing them in boxes. In Deleuze's relational ontology, positive difference "is like life itself: a continuum and a multiplicity in a constant state of becoming" (Lenz Taguchi, 2012: 269) where each body in an assemblage affects, and is affected by, other bodies. In South Africa, historical experience has conditioned society to represent people and neatly place them in racialised boxes. It is a difficult task to disidentify with this ingrained, sedimented expertise. In critical posthumanism, "difference joins rather than subtracts, recognizing all things (including bodies, material environments, the production of selves) as engaged in overlapping relations" (Kuntz & Presnall, 2012: 736).

Deterritorialisation is needed, where difference can be viewed as an opportunity to move along a line of flight and create a new, more affirmative understanding of the world. Working across difference is a fundamental trait of posthumanist educational research, where I don't objectify or essentialise my students, and see myself as rhizomatically linked to the 'other'. In this regard, the concept of the 'inappropriate/d other' is important. It was a term coined by Trinh Minh-Ha (1986) in her work on liminal subjecthood, and later used extensively by Donna Haraway and Karen Barad. It signifies both subjects that cannot be appropriated, and who are inappropriate. These are subjects of alterity that cross borders and disrupt understandings of difference based on taxonomies (Barad, 2014). In this research, I seek out the inappropriate/d others.

Lury, Parisi and Terranova (2012) identify and analyse a new topological organisation that cultural forms are now exhibiting. There is a multiplication of relations of difference, and culture is being reorganised according to its capacity for change, and "not as a structure based on essential properties, such as archetypes, values or norms, or regional location" (Lury, Parisi & Terranova, 2012: 5). Change and movement produce new kinds of relations, differences, inclusions, exclusions, ordering and continuity in a topological society – it can be seen as a space of continuous transformation within this rapidly globalising society, dominated by cognitive capitalism. The multiplication of differences helps to create the complex, non-linear, multi-layered and contradictory world that we are living in. Methodologically, this is difficult for research, and traditional methods of social analysis struggle to cope with complexity. Traditional qualitative methods are better at working on themes or codes (sameness) that have been identified, rather than difference (MacLure, 2013a; St. Pierre & Jackson, 2014). The language of posthumanism can help us to understand this complexity, and I will later expand on the algorithmic and interpellative power of dominant knowledge systems.

The posthumanist difference is opposed to representation (MacLure, 2013a), and does not contain an implicit humanist value judgement or hierarchy. Doel explains that "representation is bound to a specific form of repetition: the repetition of the same" (2010: 117). Non-representational theory refuses representation linked to a repetition of the same. Furthermore, a posthumanist ontology problematises the concept of identity, which is fixed and complicit

in power relations that promote hierarchisation. We shall later see, however, that the geomatics knowledge base operates in a way that relies on hierarchies. The practice of geomatics education helps to create subjects that conform to Western Eurocentric humanist norms. In a similar vein as Braidotti, my cartographies carefully analyse the relationship between dominant knowledge and the structural others, mainly people of colour and nature.

2.3.2. Anti-representation and time

Of importance to this research is a critique of the representational worldview central to geomatics. Representation is associated with humanism, which rests on the metaphysics of individualism. Representationalism assumes that there is an ontological distinction between a thing that is being represented, and its representation (Barad, 2007: 47). The historical representation of Whites and males serves to aid in their continued privilege. There is thus a strong element of *potestas* within representational thought, which is hierarchical, categorical and judgmental. It relies heavily on language or linguistic systems to construct and regulate things, whereas a relational understanding of the world requires a 'flattened' logic, "where discourse and matter are mutually implicated in the unfolding emergence of the world" (MacLure, 2013a: 659–660). Deleuze and Guattari claim that the purpose of language is neither informational nor communicational. Rather, its primary purpose is to command (Deleuze & Guattari, 1987: 76). I extend this argument to include maps, which ostensibly are forms of communication. Deleuze and Guattari show how language is about power relations. Brian Massumi explains that "every utterance, innocuous as it may seem, takes place in a social or institutional context that inflects it with an imperative, however indirectly" (Massumi, 1996: 33). One therefore needs to analyse language, not as a system of communication, but as pragmatics[14]. This suggests that we can make sense of the world through examining relationships.

Geomatics traditionally sees the land as an inert backdrop against which we go about our everyday lives - surveyors measure the world and cartographers represent it using the language of maps. On the other hand, a posthumanist ontology challenges the land-as-backdrop view, and recognises that specific procedures, methods of observation and practices produce the world. Non-representational geography, which emerged out of non-representational theory, looks at space and spatiality performatively.

Nigel Thrift, who developed non-representational theory, outlined its seven core principles. They are:

1. Non-representational theory is about movement and tries to capture the flow of everyday life;
2. It is anti-biographical and pre-individual;
3. It concerns itself with performance and practice;
4. It is built on relational materialism, where material objects are given equal conceptual and empirical weight as humans;
5. It is experimental;
6. It pays attention to affects and sensations;

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[14] Pragmatics is a field of study that looks at the ways in which context contributes to meaning.

7. It is driven by an ethic of novelty aimed at boosting aliveness and does not ascribe to traditional ethical systems built on humanistic principles (Thrift, 2008; Vannini, 2015).

An analysis of the practices of surveying and mapping with non-representational theory produces interesting diffractive insights. In this thesis, Thrift's seven principles are used to identify patterns of difference between elements of selected stories and traditional geomatics knowledge. I then analyse the effects of these differences on the subjectification of geomatics practitioners.

As an alternative to representationalism, Barad proposes a performative understanding of naturalcultural practices: "knowing does not come from standing at a distance and representing but rather from *a direct material engagement with the world*" (Barad 2007, p.49, italics in original). This resonates with non-representational theory, which does not prioritise the role of representation in subject formation. Non-representational theory critiques social constructivism, which was the dominant mode of human analysis throughout the 1980s and 1990s (Anderson & Harrison, 2010). Social constructivism attempts to textualise the world, and is, in a sense, the opposite of materialism. Non-representational theories emerged as a reaction to this textualisation of the world, and developed some key insights, for example, that signification is also related to extra-linguistic forces.

In my research, I acknowledge that I am part of the knowledge being created, and my theorising is an embodied, embedded and material practice. When it comes to theorising, I also acknowledge that "the world is more excessive than we can theorise" (Dewsbury et al., 2002: 437). Even qualitative researchers within the social sciences recognise the limitations of representation: "The crisis of representation is about the inability of qualitative researchers to present in their written reports the lived experiences of those they study" (Willis, 2007). I face this challenge in the production of this thesis too, which requires me to textualise my findings. My storytelling intervention is performative, and the way in which I have written this thesis aims to convey a sense of my pedagogical practice. My practice is process-driven, non-linear, and, being variable, is multiple and iterative. This research is guided by a posthumanist ethic which takes cognizance of a multitude of voices. This multitude is an assemblage of things, experiences, texts, affects, transversal connections across boundaries, and of theorists. Storytelling allows for multiple meanings, time zones and senses to be conveyed. It is thus non-representational. Staying in the storytelling mode is well-suited to navigate the complexities of the posthuman condition, and helps in the drawing of adequate cartographies of power.

The traditional, linear understanding of time itself is problematised by Barad (2007, 2010, 2014) and Braidotti (2013a). Barad notes that "[t]here is no smooth temporal (or spatial) topology connecting beginning and end" (Barad, 2010: 244). Through diffraction, she shows how "new temporalities" or "spacetimematterings" (2014: 168) can be made. Connections are made across space and time to show new diffraction patterns, enriching the analysis. In some stories, specific events in the past result in the actualisation of a particular future – today. It is useful to identify the gestures to the future in the past[15]. Then, one gestures to the future (virtual and actual) in the present. The past/present/future boundaries are not stable or well-defined.

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[15] Thanks to Karen Barad for drawing my attention to this.

Braidotti expands on the concepts of *Chronos* and *Aion* (Braidotti, 2006, 2011b, 2013a). *Chronos* is linear, recorded time – it is molar and is the timeline of the hegemonic political order. Traditional history is written in this way, and institutional practices are recorded in *Chronos*. *Aion*, on the other hand, is the dynamic, discontinuous, cyclical time of becoming. It is molecular and related to the feminine, whereas *Chronos* is related to being / the molar / the masculine (Braidotti, 2006: 151). *Chronos* is deeply implicated in the traditional geomatics knowledge base. Focusing on processes, transversal connections, the in-between spaces and becomings would be working with *Aion*. It is related to a subject's potential, and becoming-minoritarian. *Chronos* is related to majoritarian 'Royal' science, and *Aion*, 'minor' science. Braidotti explains:

> Official, Chronos-driven 'Royal science' is opposed to the process of 'becoming-minor of science', which is based on a different temporality. One is protocol-bound; the other is curiosity-driven and defines the scientific enterprise in terms of the creation of new concepts. Nomadic theory proposes a critique of the powers that dominant, linear memory-systems exercise over the Humanities and social sciences. Creativity and critique proceed together in the quest for affirmative alternatives which rest on a non-linear vision of memory as imagination, creation as becoming (Braidotti, 2013a: 165).

Geomatics is a Royal science, *Chronos*-driven, representational and holds time still. A posthumanist orientation to geomatics education would encourage movement, and evoke questions about what geomatics would look like if time was set free.

A move away from representation can also assist us to break down established anthropocentric boundaries. An anti-metaphorical approach can assist to work towards bioegalitarianism. Braidotti points out that animals have acted as boundary markers between species, with specific reference to the boundary between man and the 'natural' others. Animals are used to prop up humans' self-projection of moral superiority – we often describe others as being deceitful as a fox, dirty as a pig, stubborn as a donkey, or noble as an eagle. She suggests that we move beyond this representational relationship, "beyond the empire of the sign, toward a neoliteral relationship to animals, anomalies, and unorganic others" (Braidotti, 2011a: 84). In moving away from representation and metaphor, we engage with animals and the earth differently, recognising the vital connection that links us to the environment. In fact, the 'we' that used to represent humans only gets expanded to include the previously excluded others. This is a new vitalist, materialist mode of thinking that is central to a posthumanist ontology and important to my research because geomatics is a discipline that has traditionally had specific ways of relating to the land.

Contrary to the traditional geomatics conception, surveying and mapping can also be viewed as performances. Whose voice is privileged in the traditional geomatics conception of the world? This is my task in conducting a posthumanist analysis – to account for the geomatics education assemblages in South Africa, highlighting the differing actors (animate and inanimate), performances and power relations. My focus is to observe what has been iteratively produced by this specific assemblage to understand the *potestas* contained therein, and imagine ways to creatively activate *potentia* in students.

2.3.3. The dangerous logic of dualism

Key to my methodology, especially in Part 1 of this thesis, is the identification of dualisms in the geomatics learning experience. Feminist theorists have described how dualism plays a key role in Western philosophy. Difference has been used to create boundaries that define not just the self, but a devalued other (Haraway, 1992; Plumwood, 1993; Braidotti, 2013b; Barad, 2014). A dualism is a relational phenomenon which relies on a denied dependency between relata in a domination/subordination relationship. A dualism denotes a relationship of binary opposition which erases any continuum that may occur in between both ends of the binary, and implies a hierarchical relationship in which one side is depicted as superior and the other is depicted as inferior (Bozalek, 2014).

Dominant systems use otherness to institutionalise power, as well as to appropriate materials and cultural aspects of the subjugated other. This is a system that uses difference to advantage a specific group, as opposed to celebrating and encouraging diversity. Cartesian logic is central to subjugation - it is used by hegemonic forces and is "instrumental in structuring hierarchies and oppressions among human groups" (Deckha, 2012: 528). Val Plumwood takes these ideas further by theorising about how dualisms work, as well as how they can be dismantled. Dualisms require anti-dualist remedies, which is a difficult task because of the "logical maze" (Plumwood, 1993: 42) set up by Western, humanist philosophy. The logic of dualism normalises domination/subordination and denial of dependency, and the colonised are appropriated into the culture of the master. Furthermore, "the dualisms of male/female, mental/manual (mind/body), civilised/primitive, human/ nature correspond directly to and naturalise gender, class, race and nature oppressions respectively" (Plumwood, 1993: 43). Dualisms are closely linked with the logic of capitalism and colonisation – dualisms are seen in their sociomaterial expression as well as in their justification. We will see that surveying and mapping, too, are implicated as devices used in the propagation of dualist logic, and add credence to the justification of dualisms.

Characteristics of dualism

Plumwood identified 5 characteristics of dualisms that can be used to reinforce superiority or inferiority:

1. Backgrounding (denial) – this occurs when the master relies on and benefits from the services of the other, but denies this dependency.
2. Radical exclusion (hyperseparation) – differences are magnified and similarities are eliminated to create maximum separation between the privileged and the marginalised.
3. Incorporation (relational definition) – the lower member of a dualistic pair is defined in relation to the upper member, in terms of lack.
4. Instrumentalism (objectification) – the lower side of the dualism is objectified and its identity is constructed instrumentally, resulting in the master not viewing the lower side as kin.
5. Homogenisation (stereotyping) – the dominated class is made to appear homogeneous, and internal differences are disregarded.

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Plumwood has also suggested ways in which dualisms can be subverted or escaped – this is done by countering each of the characteristics which serve to uphold the dualism. She emphasises the importance of relationality and difference:

> Dismantling a dualism based on difference requires the reconstruction of relationship and identity in terms of a non-hierarchical concept of difference (Plumwood, 1993: 60).

Each characteristic can be countered in the following ways:
1. Backgrounding – the contribution of the underside must be recognised and dependencies acknowledged.
2. Radical exclusion – continuity is affirmed between the relata, showing areas of overlap.
3. Incorporation – a story for the underside is rediscovered, hence reclaiming positive sources of identity.
4. Instrumentalism – the needs, values and striving of the underside are recognised as being separate from those of the master.
5. Homogenisation – the complexity and diversity of the other nations that have been homogenised and marginalised are recognised.

Bozalek (2014) applied Plumwood's theorisation within two South African universities to address White students' 'privileged irresponsibility'[16]. She designed a learning experience where heterogeneous groups of students were given opportunities to engage with each other across difference, in order to counter various hegemonic constructions. In a similar way, I use Plumwood to analyse dualisms where they appear in the geomatics learning experience and in selected stories, and use counter-mapping together with storytelling to subvert hegemonic boundaries.

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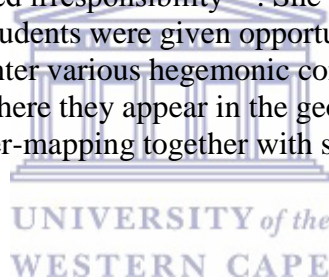
[16] A term coined by Joan Tronto, referring to the phenomenon of how a dominant group fail to acknowledge their exercise of power and maintenance of hegemony, thus taking for granted their position of privilege.

CHAPTER THREE - TOWARDS AN AFFIRMATIVE PEDAGOGY

> The challenge for critical theory is momentous: we need to visualize the subject as a transversal entity encompassing the human, our genetic neighbours the animals and the earth as a whole, and to do so within an understandable language. (Braidotti, 2013a: 82)

This chapter continues to outline the theory that is pertinent to my research. I focus on the theory that relates more directly to an affirmative, posthumanist reconceptualisation of geomatics educational practice. Underlying a posthumanist pedagogy is a vitalist, materialist conception of ethics. In this chapter, I draw mainly on Braidotti, Barad and Tronto to explore what an ethical pedagogy entails.

Geomatics education in South Africa, and the geomatics diplomas that I am focusing on in this study, tend to produce specific types of subjects. This research investigates the humanist and anthropocentric nature of the interpellation of these subjects. The process of the geomatics student's subject formation is historically rooted in the specificities of local conditions. The subject is also non-unitary and connected to the global via a complex web of material and discursive forces. This is the posthuman condition, which urges us " to think critically and creatively about who and what we are actually in the process of becoming" (Braidotti, 2013a: 12).

3.1. On ethics: nomadic, agential and caring

Underpinning posthumanist theory and guiding educational practice is an ethics that is transformative and aware of entanglement of humans, nonhumans and the earth. This ethics is attuned to a pedagogy of social justice, and is meant to resist the subjectification imposed on students and educational practitioners by the dominant neoliberal order (Postma, 2016). In my research, I have carefully considered Braidotti's and Barad's theorisation of ethics.

Braidotti's nomadic ethics is grounded in a monistic ontology and pays close attention to the process of subjectification. Beginning with the theorisation of Spinoza, nomadic ethics is taken further by Deleuze and Foucault. It rests on a non-unitary vision of the subject, in relations within multiple assemblages with a host of bodies, both animate and inanimate. Practicing critical theory requires situated (hence partial) arguments that identify problems, and then movement beyond critique. Braidotti calls for ethically accountable cartographies of the phenomena under investigation – these cartographies rigorously frame the problems within a complex network of power relations that be either empowering (*potentia*) or limiting (*potestas*). These conceptions of power should not be viewed simply as 'good' or 'bad'; rather, they are interwoven into the fabric of everyday life and are integral to subjectification. Potestas, although enforced by organs of state, for example, is important for minimising harm. Laws prohibiting the sale of alcohol to children, or laws prescribing the sexual age of consent are intended to protect children. However, this should not close down critical thought around institutions and others (including ourselves) that wield *potestas*. It is important to note that we are part of and complicit in the very power structures that we can critique. Hence, posthumanism contains in it a warning that we should be wary of the desire for power, as power in its oppressive form can dominate and exploit us.

There is a difference between morality and ethics. Taylor (2018) points out that within humanism, morality is concerned with personal character and principles of an individual or group, whereas ethics is the study of morality in social systems and concerns itself with how moral principles are put into action. Taylor further points out that this scheme of thought is insufficient because it locks one into the individual/universal dualism, and obfuscates other ethical issues, such as responsibility towards others. For Braidotti,

> Morality is the set of norms and normative conventions that are operational in a given social context; it deals with the negative or restricted sense of power as *potestas*. Ethics, on the other hand, is the inquiry about the role, position and relationship that subjects entertain to alterity (2006: 115).

I will show in Chapter Six that a dominant driving force behind South African geomatics education is a European and Christian morality. This morality emphasises rationality, individualism and the logic of rights. Despite the transition to a post-apartheid democracy, many aspects of the old morality are still firmly rooted in the hegemonic order, and encourages geomatics practitioners to be rational, that is, to transcend their emotions. Furthermore, the ethics promoted by the geomatics profession can be labelled as 'professional ethics' and is preoccupied with issues such as accuracy, legality and profit. The subjectification at play in the education of geomatics practitioners promotes an idealised subject – the subject of humanism, and it does not deal well with alterity. Critical posthumanism's radically transformative ethics is situated, and is also opposed to relativism. It questions transcendental moral values, and relies on an environmental, geo-centred monistic approach.

Barad's theory of *agential realism* centres ethics through what she calls the *agential cut.* Everything (social and material) is so intimately entangled that an act of observation makes a 'cut' between what is included and what is excluded. Her framework requires a new conception of the relationship between matter, discourse, subjectivity, agency, space and time. What the critical practitioner focuses on, and, by extension, also what is left out, must be carefully considered. The question of agency is central to Barad's agential realism. Her ethico-onto-epistemology is an entwining of ethics, knowing and being, and an awareness of each intra-action which constitutes the becoming of the world: "Objectivity and agency are bound up with issues of responsibility and accountability. Accountability must be thought of in terms of what matters and what is excluded from mattering" (Barad, 2007: 184).

Agency does not lie exclusively in people or things, but in actions or doings too. For Barad "matter and meaning cannot be severed" (van der Tuin & Dolphijn, 2012: 69), and the world expresses itself through matter which is dynamic. Thus, the land, a story and a boundary hedge all have agency. Thinking in this way, we realise that matter has agency in its materialisation. Barad points out that

> what we commonly take to be individual entities are not separate determinately bounded and propertied objects, but rather are (entangled "parts of") phenomena (material-discursive intra-actions) that extend across (what we commonly take to be separate places and moments in) space and time (where the notions of "material" and "discursive" and the relationship between them are unmoored from their (anti)humanist foundations and reworked) (Barad, 2011: 125).

The theory/practice dualism is challenged and the boundary between the dualistic pair is not as well defined as traditionally envisioned. Thiele sees theorising as being a thought-practice in which "concepts are not abstraction from the world, but an active force of this world" (2014: 203). Worlding envisions practices whilst enacting these practices at the same time. Non-representational theory and critical posthumanism intersect with critical cartography in this area. The emphasis on practice-as-worlding resonates with the critical cartographer J.B. Harley's insight that maps help to create the world. There is thus agency in the physical map itself, as well as in the practice of cartography. The identification of these types of resonances (in particular, resonances that help to trouble dualistic boundaries) is an aspect of a diffractive analysis.

Anti-anthropocentric ethics requires a species equality and an appreciation of the environment, eschewing transcendental human exceptionalism and the arrogance that has resulted from the dominant Eurocentric humanist orientation (Braidotti, 2013a). This is related to anti-hierarchical thinking in general, and an acknowledgement of the agency of the material. Zoe-centred egalitarianism, as promoted by Braidotti, is

> a materialist, secular, precise and unsentimental response to a transversal, trans-species structural connection of those whose bodies are 'disposable' in the logic of advanced capitalism (Braidotti, 2006: 99).

For students and practitioners of land surveying, the agency of the land is surprisingly absent in their discourse.

What is included (and what is therefore excluded) in the analysis is a boundary drawing practice (Barad, 2014). The human surveyor, the land, the surveying technology and the practice of surveying and mapping all constitute each other. The exclusion of deep thinking about the environment, ethics and social issues in surveying education plays a constitutive role in the way the profession is practiced today. I show that a historical lack of interrogation of social and environmental issues in the curriculum has contributed to an inertia of action, a deep-seated unwillingness and inability to conceive of action on these fronts. Furthermore, the environmental and ethical 'blind spots' are aided and encouraged by the promotion of a specific humanist subject through the practice of geomatics education.

Joan Tronto's 'ethic of care' is a useful framework to consider in the development of caring pedagogical practice. Tronto defines care as being a practice and process which is more than human-centred, and is also key to responsible citizenship:

> We suggest that caring be viewed as a species activity that includes everything that we do to maintain, continue and repair our 'world' so that we can live in it as well as possible. That world includes our bodies, our selves and our environment, all of which we seek to interweave in a complex, life-sustaining web. Caring thus consists of the sum total of practices by which we take care of ourselves, others and the natural world (Tronto, 1993: 103).

By approaching care from the direction of nomadic ethics, the ethic of care is compatible with a posthumanist brand of ethics (Braidotti, 2006). Tronto's conception of ethics fits in well with my theorisation, as she emphasises relationality, complexity, connecting across difference with others (human and nonhuman) and affirmative practice. I utilise Tronto's

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conception of care and read it together with posthumanist theory to consider how a caring pedagogical practice might be enacted.

Although I focus primarily on anti-humanism in this research, I believe that a diffractive reading of the ideas of Tronto, Braidotti, Barad and Plumwood can guide a practice that moves in an anti-anthropocentric direction. Furthermore, geomatics is a suitable site in which to pioneer a new geo-consciousness, as it is based on knowledge that is land-focused. This research gestures toward that future.

Tronto (2013: 34–35) built on her initial theorising and expanded on her initial four ethical qualities of a feminist democratic ethic of care. Her five qualities are:

Attentiveness – caring about,
Responsibility – caring for,
Competence – care giving,
Responsiveness – care receiving, and
Plurality, communication, trust and respect; solidarity – caring with.

The last of the 5 ethical qualities was an addition to her initial (1993) work, and will be referred to as *trust*. Tronto's definition sees care being predicated on relations, and stresses that it is a practice. In addition to this, it also sees care as a disposition, thus troubling the mind/body dualism (Bozalek, 2016). This dual conception of care (being a practice and a disposition) is resonant with the figuration of the posthuman (Braidotti, 2013a) – it is both a navigational and analytical tool.

In Chapter Seven, Tronto's ethic of care is read together with posthumanist theory and applied to my pedagogical practice. There are resonances between the elements of care (Tronto), speculative ethics (Haraway), agential realism (Barad) and nomadic ethics (Braidotti) that have assisted my pedagogy and analysis. These are all ontologies that conceive of entities coming into being through relations. It should be noted that these relations are not only personal, because care is also a strategic approach that is systemic (Bozalek & Leibowitz, 2012). Care should thus be applied across institutions, cultures and geographies; this conforms to posthumanism's emphasis on working across difference.

3.2. The power of affirmation and figurations

3.2.1. Spinozist affirmation

The theoretical foundations of Braidotti's posthumanism can be traced back to the work of the Dutch philosopher Baruch Spinoza (1632-1677), who in turn influenced many other modern philosophers. Deleuze's reading of Spinoza (Deleuze, 1988) is very important in framing Braidotti's affirmative ontology.

Spinoza was opposed to Descartes' mind/body dualism, and instead posited that everything that exists in nature consists of a single, fundamental substance. The mental and the physical are intimately linked, and in fact are different attributes of the same underlying substance. This is a philosophy of monism, which rejects dualisms such as nature/culture. The posthumanist brand of monism stresses that living matter is self-organising (or auto-poietic) and intelligent. It implies that matter is "not dialectically opposed to culture, nor to

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technological mediation, but continuous with them" (Braidotti, 2013a: 35). Nature/culture can thus be viewed as a continuum that is constantly evolving. Haraway takes this further, and points out the importance of becoming-with, not just becoming (Haraway, 2016). She stresses the importance of seeing living matter as being sympoietic, or collectively-producing through relations.

Taking a monistic, Spinozist stance would require a focus on the powers of affirmation. Much of Braidotti's conceptualisation of critical posthumanism requires a balancing out of critique with a measure of affirmative action. Affirmative affects result in the relations between bodies being strengthened, sped up and enhanced. These are what Spinoza referred to as 'joyful passions', and serve as the counterpoint to negative passions that result in bodies being slowed down. Braidotti links these insights to the philosophy of Foucault, which sees power as being both restrictive (*potestas*) and productive (*potentia*). Power can be held in individuals or distributed across assemblages, and, being relational, can be used to produce positive or negative passions. Deleuze explains:

> [E]ach idea or each mind in thought are constituted by the characteristic relations that subsume the parts of that body, the parts of that idea. When a body "encounters" another body, or an idea another idea, it happens that the two relations sometimes combine to form a more powerful whole, and sometimes one decomposes the other, destroying the cohesion of its parts. And this is what is prodigious in the body and the mind alike, these sets of living parts that enter into composition with and decompose one another according to complex laws (Deleuze, 1988: 19).

An important paradox presents itself in Braidotti's work: how does one engage in affirmative action (entailing the creation of hopeful, sustainable alternatives) whilst at the same time practicing critical theory (entailing resistance to the present situation)? (Braidotti, 2011a) In my teaching, I have attempted to be in this in-between space, engaging in critique, but always attempting to become something that moves beyond the object of my critique.

The emphasis on the negative and silence on the affirmative is echoed in the post-anthropocentric discourse that is commonplace nowadays. The excesses of the global economy threaten the sustainability of our planet. In geological time, the Holocene is making way for the Anthropocene epoch, characterised by changes brought about to the earth's climate, land, oceans and biosphere as a result of the actions of humankind. In this epoch, the influence of humans is evident in the extinction of many species of fauna and flora, rising levels of CO_2 in the atmosphere, rapid erosion and sedimentation due to 'terraforming' of urban areas, and a significant drop in the oceanic pH (Zalasiewicz et al., 2011). The spectre of human extinction looms large in popular media. "A negative sort of cosmopolitan interconnection is therefore established through a panhuman bond of vulnerability" (Braidotti, 2013b: 7). Critical posthumanism aims to move beyond the paralysing fear and hopelessness, and posits an affirmative reconceptualisation of the subject.

Many negative passions were created and sustained in the name of Western humanism, as seen in racism, the colonial experience and its injustices. Edward Said (1978) acknowledged the need for a new type of humanism that took into account subaltern subjectivity. Braidotti (2013a: 47) gives examples of "affirmative politics of transversal movements, such as anti-slavery, feminism, Médécins sans frontières and the like", which change negative passions into positive passions. A South African example of this can be observed in the work done by the disaster relief non-governmental organisation Gift of the Givers. The organisation

practices ontological pacifism, yet actively seeks to be present in the most war-torn regions of the world. Despite its Muslim roots, it provides assistance to those in need, irrespective of religious, racial, political or geographical situations. It is the largest disaster relief organisation in Africa, and to date has provided aid to 41 countries around the world (Gift of the Givers Foundation, 2015).

3.2.2. Figurations

In order to move beyond traditional constructions of subjectivity and knowledge-making practices, some theorists employ the use of creative figurations. To adequately account for posthumanist complexity, non-linearity and liminality, figurations are used as tools to understand who we are, as well as the types of subjects we are in the process of becoming. Figurations are thus analytical and navigational. They help to reconfigure traditional research methods by troubling humanist representations (Mauthner, 2016). Braidotti explains that an important part of her project is to

> explore the need and to provide illustrations for new figurations, for alternative representations and social locations for the kind of hybrid mix we are in the process of becoming. Figurations are not figurative ways of thinking, but rather more materialistic mappings of situated, or embedded and embodied positions (Braidotti, 2002: 2).

This approach ensures that subjects are related not only on negative or reactive grounds of shared vulnerability (e.g. when faced with the spectre of global climate change) but also affirmatively. The figurative representations that are of interest to me are: the nomad (Braidotti, 2011a,b), the cyborg (Haraway, 1991), diffraction (Barad, 2007) and the rhizome (Deleuze & Guattari, 1987). These liminal figurations are used to transgress boundaries, subvert conventional views of human subjectivity, and help to create a tangible image of complexity. Furthermore, they have assisted me to identify my own figuration: the boundary.

The nomad

The figuration of the nomad is aimed at subverting and providing an alternative to the hegemonic, phallocentric vision of the subject of humanism (Braidotti, 2011b). In contrast to a yearning for fixed identity, the nomad

> has relinquished all idea, desire, or nostalgia for fixity. It expresses the desire for an identity made of transitions, successive shifts, and coordinated changes without an essential unity (Braidotti, 2011b: 59).

The nomad is dynamic, non-unitary and located in a specific yet dynamic environment (the *milieu*). A posthumanist methodology considers subjectivity in terms of embedded subjects and milieu (Gray van Heerden, 2017). Focusing on the middle eschews transcendentalism, with its focus on a source or finality. Nomadism encourages critique and an opening up of middle spaces, a yearning to trouble dualistic conceptions of the world that have so effectively been put into place by humanist norms.

The nomad is especially pertinent to my storytelling approach, as some of my stories have nomadic characters (such as Krotoa and Ibn Battuta[17]) who serve as navigational tools that assist me in conveying a sense of complexity and promoting nomadic ethics.

Diffraction

Dealing with difference in a positive way can be achieved by using the figuration of *diffraction.* It was first used by Haraway (1992) as a metaphor to engage with issues related to identity, difference and liminality. Haraway originally critiqued reflection for the way it implied fixed identities and relied on representation for its image formation:

> Diffraction does not produce "the same" displaced, as reflection and refraction do. Diffraction is a mapping of interference, not of replication, reflection, or reproduction. A diffraction pattern does not map where differences appear, but rather maps where the effects of difference appear. … [Reflection] invites the illusion of essential, fixed position, while [diffraction] trains us to more subtle vision (Haraway, 1992: 300).

Haraway linked this epistemology to an ontological stance:

> As a metaphor it drops the metaphysics of identity and the metaphysics of representation and says optics is full of a whole other potent way of thinking about light, which is about history. It's not about identity as taxonomy, but it's about registering process on the recording screen. So I use it to talk about making a difference in the world as opposed to just being endlessly self-reflective (Haraway, 2000: 103–104).

Barad (2007) expanded on Donna Haraway's idea of using diffraction as a potentially useful epistemological device, and proposed a diffractive methodology that could be put to work across different disciplines. The analytical tool of diffraction has been sharpened by empirical application (Barad, 2011, 2014; Hoel & van der Tuin, 2013; Larson & Phillips, 2013; Sehgal, 2014; van der Tuin, 2014) and its ethics have been conceptualised and clarified (Thiele, 2014). Texts and readings have a productive dimension; they work, which means that texts and readings cannot be seen as separate or separable from what we tend to accept as that to which they refer. Karen Barad (2007) picked up on this entanglement between sign and referent. For her, diffractive reading is a strategy that involves "reading insights through one another in ways that help illuminate differences as they emerge: how different differences get made, what gets excluded, and how those exclusions matter" (p. 30).

I have utilised these insights to read ideas from geomatics theory, posthumanism and stories through each other to see what resonances or dissonances emerge. In this regard, observing where the effects of difference appear (one effect being subjectivity) is important.

Within the academy, being a reflective practitioner is applauded, and we are asked by university management to reflect on our teaching. Reflection, however, is caught up in the geometry of sameness, and diffraction is interested in differences: "whereas the metaphor of reflection reflects the themes of mirroring and sameness, diffraction is marked by patterns of difference" (Barad, 2007: 71). Traditionally, research within the different academic traditions

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[17] Ibn Battuta was the medieval Moroccan traveler who was a contemporary of Marco Polo and travelled further than Marco Polo. Yet Ibn Battuta is not as well known in contemporary culture. Could this be because Ibn Battuta was African and Muslim, whilst Marco Polo was European and Christian?

(such as the 'hard' and 'soft' sciences) has been done using methods and theory internal to the respective tradition. A diffractive methodology reads insights from different traditions through each other, and "moves us away from habitual normative readings and accounts grounded in discursive readings that often fail to account for material intra-actions" (Jackson & Mazzei, 2012: 114). This requires a critical rethinking of the boundaries of the academic traditions. Barad describes the relationship between the hard sciences and the social sciences: "What often appears as separate entities (and separate sets of concerns) with sharp edges does not actually entail a relation of absolute exteriority at all" (Barad, 2007: 93).

Undertaking an analysis requires more than just *being*, and Karen Barad calls it an ethico-onto-epistemology to mark the entangled and inseparable nature of ontology, epistemology and ethics:

> We are not merely differently situated in the world; "each of us" is part of the intra-active ongoing articulation of the world in its differential mattering. Diffraction is a material-discursive phenomenon that challenges the presumed inherent separability of subject and object, nature and culture, fact and value, human and nonhuman, organic and inorganic, epistemology and ontology, materiality and discursivity (Barad, 2007: 381).

Diffraction thus changes the traditional way we think about ethics and ontology – Thiele shows how these two concepts relate to each other more intimately, drawing on inspiration from Deleuze, who in turn was inspired by Spinoza (Thiele, 2014). Ethical thought is central to a diffractive interrogation of the world (Braidotti, 2006; Barad, 2007; Butler, 2014; Thiele, 2014) – it conveys a sense of being-in-the-world during practice (in this case educational practice) as well as analysis. It also emphasises the production of something new, towards the goal of making a difference in the world.

The cyborg

Donna Haraway, one of the founding material feminists, realised early on the need to develop a more sophisticated political understanding for progressive people of the time. She identified the need to move away from the

> deepened dualisms of mind and body, animal and machine, idealism and materialism in the social practices, symbolic formulations, and physical artefacts associated with 'high technology' and scientific culture (Haraway, 1991: 154).

Haraway is influential in the work of Braidotti, and her figuration of the cyborg is important in much of the theoretical development of analytical posthumanism, and later, critical posthumanism. The cyborg, a machine-organism hybrid is a construction that subverts traditional conceptions of human subjectivity, and this is theorised within Haraway's feminist politics:

> A cyborg is a cybernetic organism, a hybrid of machine and organism, a creature of social reality as well as a creature of fiction. Social reality is lived social relations, our most important political construction, a world-changing fiction (Haraway, 1991).

Her political-fictional (or political-scientific) analysis realised the centrality of social relations which hold together many assemblages. The cyborg conveys a sense of irony and

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problematises the boundary between organism and machine. It also critiques Western cognitive capitalism which is male-dominated, appropriates nature and is colonial. In later work, Haraway expands on the cyborg by introducing the figuration of 'SF': "SF: science fiction, speculative fabulation, string figures, speculative feminism, science fact, so far" (Haraway, 2016: 2). Her witty, parodic writing style engenders linkages between storytelling, power relations, environmental consciousness and social justice. Like all the other figurations mentioned thus far, Haraway's figurations are geared towards subversion, irony, experimentation and an appreciation of complexity.

That dualisms are ideologically questionable is laid bare by Haraway's analysis of three crucial boundary breakdowns: between human and animal, between organism and machine, and between the physical and non-physical. These boundary breakdowns help in the negation of dualisms, and in the development of effective oppositional strategies. In my pedagogy, dualisms and boundaries are observed and actively engaged with in my teaching.

The rhizome

Many writers who have contributed to the body of work on posthumanism have been influenced by the work of Deleuze and Guattari. Deleuze and Guattari's (1987) idea of the rhizome is particularly influential in posthumanist thinking – a rhizome describes the way in which multiplicities connect together, forming assemblages. Posthumanist research sees the limitations in traditional qualitative and quantitative research methods, which geomatics ascribes to. For example, coding assumes 'arborescent' or tree-like relations and logic among individual entities. Deleuze and Guattari (1987) caution against arborescent thought, and propose an alternative model of thought – that of the rhizome:

> We're tired of trees. We should stop believing in trees, roots, and radicles. They've made us suffer too much. All of arborescent culture is founded on them, from biology to linguistics. Nothing is beautiful or loving or political aside from underground stems and aerial roots, adventitious growths and rhizomes… Thought is not arborescent, and the brain is not a rooted or ramified matter (Deleuze & Guattari, 1987: 15).

The arborescent model is a linear argument that creates master narratives or grand theories that strive to dominate thought about various aspects of knowledge. The rhizome stands in opposition to this, as it emphasises that no position can dominate over another, there is no absolute truth, and grand conceptualisations create hegemonies which are exploited by the dominant centre. The rhizome is anti-authoritarian, and came out of the post-structural generation who contributed much to the thinking of the political left, which in turn is a moral compass for the posthuman.

Just as the rhizome emphasises connectivity and heterogeneity, I see much in my teaching that is rhizomatic. Ethical teaching would require a focus on ontology, rather than representation, as well as an awareness of the entanglements of humans and non-humans (Edwards, 2010). Being located within a structured university curriculum, however, there is also much that is arborescent. Hierarchical knowledge, prescribed textbooks, high-stakes tests, timetables and rules of progression all exhibit tree-logic, so it is difficult to become-rhizome in this environment.

Rhizomatic thinking makes us realise that subjectivity is relational, and ethics is emergent. There is no central, unique subject, just as man is not the centre of the universe, and just as

the individualism promoted by advanced capitalism is an illusion (and is indeed dangerous, a point I will return to later). Students are meant to be critical, which means to be sceptical of any professed universal or individualistic truths. They thus have to think about themselves as being embedded in a larger society/multiplicity/assemblage. This points to a posthumanist recomposition of the subject, which is very different to the promoted subject of the capitalist mass media, encouraging individuality, greed and excessive consumption. The traditional masculine, oedipalised, capitalist, racist, violent society that imposes control and domination is problematised (Deleuze & Guattari, 1987; Haraway, 1991; Braidotti, 2006, 2013a; Barad, 2007). The recomposition of the subject that is called for is characterised by border crossing, complexity, ambiguity, and potent fusions; not one that relies on simple binary logic, dualisms and dialectics.

My cartographic and diffractive methodology is in keeping with, and draws on, the Deleuzian rhizome. The rhizome is in opposition to a grand narrative that strives to dominate other regimes and form a macro conceptualisation of the world. Similarly, a diffractive reading draws on the collective insights of many congruent philosophies. Even the criticism of certain philosophers does not necessarily mean the rejection of their insights altogether. A property of the rhizome (Deleuze & Guattari, 1987) is *asignifying rupture*, which alludes to the fact that they cannot be easily destroyed due their non-hierarchical nature. Lines of flight (deterritorialisations) are possible, enabling problematic growths of some philosophies to be amputated, without damaging the assemblage.

3.2.3. The boundary

In this research, I have chosen *the boundary* as a figuration. The boundary is central to geomatics epistemology, and is crucial in the philosophy of critical posthumanism. It is ubiquitous, and pervasive in most aspects of culture. Geomatics and critical posthumanism view the boundary from almost opposite ends of the spectrum. Geomatics, in general, creates hard boundaries, while critical posthumanism critiques the purpose and effect of these and other boundaries. Following the critical posthumanist path, I insert the boundary back into geomatics education, focusing on how boundaries are transitory, permeable and topological. This deployment of the boundary seeks to find the middle ground between posthumanism and geomatics. I also analyse actual boundaries that were created by geomatics practitioners - I trouble the notion of these boundaries being fixed, static or permanent.

The figuration of the boundary is useful to destabilise the certainty of some constructs. The constructs that I have focused on are dualistic constructs, and boundaries are usually created to force a separation between dualistic pairs. Like Plumwood (who focuses on boundaries between dualistic pairs), Tronto (1993) raises several important questions about boundaries. Tronto points out that hegemony results in specific moral boundaries being drawn which effectively exclude women from political life. Tronto stresses the importance of thinking about the origins of these boundaries, questioning their strength, and developing ways of changing them. Although she focuses on these human-centred and human-created boundaries, I take the analysis further in observing boundaries (human and natural) in general. Some dualisms that I focus on in this research are: Black/White, master/slave, mind/nature, civilised/primitive, male/female, past/present and reason/nature. For example, in Chapter Five I will tell the story of Van Riebeeck's hedge, which was a physical boundary that separated White from Black, civilised from heathen. The nature of the boundary hedge was that even though the physical boundary has almost entirely disappeared, it is still present in

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the lived realities of the population of Cape Town. Through the theorisation of agential realism, one can see how the storytelling intervention is an apparatus or a boundary-making practice (Larson & Phillips, 2013). The stories that have been chosen mark what matters and what is excluded from mattering.

The boundary not only divides, but it also joins things together (Lury, Parisi & Terranova, 2012). This can help us to further elaborate on the difference between the classical Cartesian cut (which separates subject and object) and the agential cut. As Barad (2014) notes, agential cuts do not produce relations of absolute separation but 'cut together/apart' in one move. The boundary is a relational construct, keeping two sides connected in the topological relationship of *adjacency*. Besides adjacency, there are two other topological relationships which are important in GIS theory: *connectivity* and *area definition*. In GIS, topology is important because it can answer questions like:

- How many people live within 10km of Koeberg nuclear power station?
- If a specific tributary of the Limpopo River is polluted by an oil spill, which towns will be at risk of consuming contaminated water?
- What is the shortest driving route to go from CPUT Bellville campus to CPUT District Six campus?

Besides being technical in nature, the above three questions are loaded with power relations. Each question forms a part of a much larger narrative with messy, ethical issues.

Figurations are boundary markers and transgressors of boundaries at the same time. The cyborg, the nomad, diffraction and the rhizome open up in-between spaces that allow for exploration across difference. Boundaries are sites across which dualisms can be observed, and challenged. In the analysis of student stories, I carefully look for instances of critique, queering or crossing of boundaries. Whilst most students respect the boundaries set up by the *potestas* contained in the geomatics curriculum, some have used boundary crossing as affirmative and transgressive. This is explored in Chapter Seven.

3.3. Pedagogy and posthumanism

3.3.1. Critical pedagogy

A pedagogy inspired by a posthumanist ethic is radically open to the future, situated, relational, affective and promotes active experimentation (Massey, 2005; Braidotti, 2018a). My agential cut has resulted in my pedagogy placing emphasis on storytelling, counter-mapping, social justice, decolonisation and boundaries. Through engagement with the storytelling intervention, I show that students delve into micro instances of activism and/or decolonisation through inquiry and dialogue.

Braidotti (2013a) believes that critical posthumanism can assist in the facilitation of responsible education in various ways. Firstly, critical posthumanism can help in creating communities of learning that look like the society they reflect, serve and help to construct. Within South African society, there is an urgent need to transform the skewed demographic

profile of success at university level[18]. In addition to this, there needs to be concerted efforts to decolonise the knowledge base and teaching methods of geomatics to make it more accessible, interesting and relevant for local students. Secondly, critical posthumanism can help to produce socially relevant knowledge

> that is attuned to basic principles of social justice, the respect for human decency and diversity, the rejection of false universalisms; the affirmation of the positivity of difference; the principles of academic freedom, anti-racism, openness to others and conviviality (Braidotti, 2013a: 11).

These notions are echoed by Bell and Russell (2000) who remind us that there is compatibility between the principles of posthumanism and critical pedagogy, where educators should pay attention to local contexts and societal narratives, and question the universalistic narratives that shape curricula. In order to develop geomatics graduates into critical citizens, their education should not tell them what to think, but rather

> to empower them with multiple perspectives and questioning habits of mind and encourage them to think and take action on their decisions through inquiry, dialogue, activism, and the daily decisions about how to live so that they help make a better world (Wolk, 2003: 102).

Gough also suggests characteristics of a posthumanist pedagogy (which he calls a 'cyborg pedagogy'), one being that students should be encouraged to situate the knowledge present in the curriculum in their everyday lives (Gough, 2004). This call to embed knowledge locally as part of a posthumanist pedagogy is heeded in my storytelling approach.

Paulo Freire also stressed the importance of context in critical pedagogy – each instance of pedagogical activism should be approached differently, depending on the experiences of the students, the relations between the actors, the conditions of governance and the resources in the classroom (Giroux, 2011). Although widely acknowledged to be one of the founders of critical pedagogy, some of Freire's ideas come in for a posthumanist criticism by Bell and Russell (2000). Freire's anthropocentrism, through describing animals' lack of human self-awareness, establishes human superiority and promotes a human/animal dualism. They also point out that science education (in which geomatics education forms a subset) is a storytelling practice, and the narrative needs to be reflective of the fact that we share the world with non-humans.

Besides Freire's anthropocentrism, his work is also problematised through comparison with the work of postcolonial theorist Franz Fanon. Fanon's work "always positioned the work of liberation in the particularities of colonisation, in the specific structural and interpersonal categories of Native and settler" (Tuck & Yang, 2012: 20), whereas Freire's categorisation of oppressor and oppressed are somewhat ambiguous and fluid. Freire's posits it as redemption, and seems clean, where the oppressor and oppressed can be liberated through their humanity. They can then go on to become real human subjects through their critical consciousness, working on objects in the world and exploit nature. "For Freire, there are no Natives, no Settlers, and indeed no history, and the future is simply a rupture from the timeless present" (Tuck & Yang, 2012: 20) – this eschews the Deleuzian notion of becoming, which is

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[18] See https://pvanheus.github.io/chet_data_exploration/html/CHETdata.html for an analysis of the skewed nature of South African higher education.

contingent upon a production of difference, of movement. This reading of Freire is appropriate because posthumanist methodologies stress the situatedness, historicity and particularity of the phenomenon under investigation. However, this does not represent a wholesale rejection of Freire's ideas, as his insights can be effectively used in a diffractive exercise, bringing to light resonances with posthumanist theory.

A caring posthumanist pedagogy benefits by using decolonising strategies, such as understanding

> how we teach global issues, how we introduce content on particular topics, how students interpret and integrate the knowledge, whose voices are silenced and, more importantly, what gets discussed and what is erased (Razack, 2009).

Barad, in discussing responsibility, says:

> Responsibility is not ours alone. And yet our responsibility is greater than it would be if it were ours alone. Responsibility entails an ongoing responsiveness to the entanglements of self and other, here and there, now and then (Barad, 2007: 394).

Thus, a relational pedagogy is a becoming-with, and we (not just teachers and students, but the material and environment) render each other capable through our intra-actions (Bozalek, Bayat, et al., 2018). In making regular changes to my teaching practice, I am being responsive and responsible to the students who have come before, and to those who are yet to come. I am contributing to their education, as they are to mine.

Of particular importance to critical posthumanism is the cultivation of an environmental ethics through the realisation of the connectedness of everything that inhabits the earth, and the rejection of the anthropocentric view of mankind's superiority over the environment (Haraway, 2016; Shotwell, 2016). A shift in scale is needed to move from the situated knowledge of everyday life to the global.

> A sustainable ethics for non-unitary subjects rests on an enlarged sense of inter-connection between self and others, including the non-human or 'earth' others, by removing the obstacle of self-centred individualism on the one hand and the barriers of negativity on the other (Braidotti, 2013b: 190).

As a pedagogical device, I use affective historical stories to affirmatively link counter-mapping with environmental concerns.

3.3.2. Disidentification

The last two of Braidotti's rules for a critical posthumanist methodology[19] are "the powers of memory and the imagination and the strategy of de-familiarization" (Braidotti, 2013a: 163). De-familiarisation is an important aspect of Braidotti's nomadic ethics, and can be seen as a process of disidentification. This process requires subjects to dissociate themselves from discourses or practices that they have come to identify with. Disidentification does not mean a wholesale rejection of parts of one's identity, but is more subtle, requiring a situating of

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[19] See section 2.2.4.

oneself both within and against certain discourses. Judith Butler points out that disidentification is an important part of democratic practice, but is not easy: "this experience of misrecognition, this uneasy sense of standing under a sign to which one does not belong" (Butler, 1993). Disidentification can be used as a strategy for resistance, to challenge entrenched dualisms such as Black/White, male/female and citizen/foreigner. This strategy resonates well with Plumwood's (1993) remedies for dismantling of dualisms. In particular, disidentification can be observed in the remedies for backgrounding (where the contribution of the underside is recognised), incorporation (the identities of both the underside and upperside are reviewed), instrumentalism (the other is recognised as a centre of needs) and homogenisation (the complexity of the other is recognised). Although it is enriching to go through, pain and a sense of loss is an integral part of disidentification. "Multilocality is the affirmative translation of this negative sense of loss" (Braidotti, 2006: 84). Braidotti (2006) focuses on disidentification from European nationalism, which I relate to South African nationalism. The formation of the European Union leads to some interesting possibilities for subjectivity. It could be used to develop a new form of politics, not requiring allegiance to a nation-state. It could also allow for flexible citizenship, which would "allow for all 'others', all kinds of hybrid citizens, to acquire legal status in what would otherwise deserve the label of 'Fortress Europe'" (Braidotti, 2006: 79). Complex allegiances and multiple belongings could result. However, the new Europe has seen higher levels of nationalist paranoia and xenophobic hostility, especially in the wake of the financial crisis of 2007-2008. Negative stereotyping within EU countries is common, for example resentment among German taxpayers for the Greek bailout. The single currency and European unification has paradoxically intensified existing differences and closed down some borders (Shore, 2012), and there has been a resurgence of micro-nationalism.

Micro-nationalism is prevalent globally, and it practically manifests as groups of people being objectified and demonised. For example, the demonisation of Islam in Western media is clearly observed. In South Africa, certain nationalities (for example Nigerians, Moroccans and Congolese) are vilified, and each nationality has developed a pejorative archetype which serves to intensify xenophobic discourse. Donald Trump's unashamedly bigoted and prejudiced public rants against others (Mexicans, Muslims and women who have had abortions) drew large support amongst the American electorate during his election campaign. The public airing of privately-held prejudices and fears is currently *en vogue* in right-wing Western discourse. In the analysis of the digital storytelling intervention, I show that some students transformed the critique of African xenophobia into affirmative storytelling (See Chapter Seven).

Gayatri Spivak's work has shown how difficult it is to critique the academy from within – she describes her project with the 'impossible no': "This impossible 'no' to a structure, which one critiques, yet inhabits intimately, is the deconstructive philosophical position" (Spivak, 1993). Deconstruction must be done from within a structure, it cannot be transcendental, and one should take up the position of being in the middle, not on either side (Jackson & Mazzei, 2012). These guidelines are useful in assuming a critical posthumanist position within geomatics education. I am situated at the intersection of geomatics practice and geomatics education, within the academy and can identify with both the centre and the margins. Being male and middle class, my sense of inhabiting the centre is not unproblematic. I am also a resident of the margin: having the apartheid-era label of 'Indian' put me in an unprivileged position in the 'old' South Africa and a slightly privileged position in the 'new' South Africa, depending on the context. Like Spivak, I cannot not inhabit either space. I can, and do, have access to the centre, especially taking note of the changing centres of power in South African

academy. The diversity within South African society makes it extremely difficult to define a centre, making clear that "structures themselves are not as stable as they appear, yet they do define and regulate people's ways of living" (Jackson & Mazzei, 2012). So the centre is constantly on the move (it changes with context and in relationality), and by consequence, the margin too. Just as Spivak is placed at the margin by the centres of power who view her as other, so too am I. In America, Spivak identified the zealous imperative to represent the margins within the academy, and I see a similar post-apartheid imperative here in South Africa. If done in an unconsidered way, the fetishisation of ethnic identity results.

The disidentification in the discussion thus far is one that is aligned to an anti-humanist stance. There is also a second type of disidentification, one that is linked to anti-anthropocentrism and is far more difficult to achieve. This is largely due to our anthropomorphic realities as subjects (we cannot not be human). Critical posthumanism requires of us a paradigm shift in the way we conceive of ourselves and our relationships. As a start, it requires a "recognition of the entanglement of material, bio-cultural and symbolic forces in the making of the subject" (Braidotti, 2006: 37). Thereafter, Braidotti's strategy of zoe-centred egalitarianism flattens the species hierarchy and takes seriously the health of the land. How can we take seriously the needs of animals and the environment when their needs are in direct competition with ours? Furthermore, disidentification from anthropocentrism is seemingly unimportant within the discipline of geomatics, whose knowledge base is largely non-anthropocentric anyway. Much of the underlying knowledge is grounded in the natural, mathematical and physical sciences, in which the figure of the human seldom features. Hence there is a false sense of removal from social issues on the one hand (because of the seemingly neutral knowledge), coupled with a false sense of 'being at one with the natural environment' due to the outdoor work that surveyors do.

In the South African classroom, some students feel alienated since their knowledge is seen as less than, and a sense of shame is felt in sharing it in the same forum as privileged, Eurocentric knowledge. The shame provides an indication of the non-recognition of cultural and other knowledge of subordinate groups (Zembylas, 2008). The hegemonic relations that exist in South African higher education are to the advantage of White, male and middle class students and staff (Bozalek & Carolissen, 2012). This dominant group defines the centre of the structure of the academy. Deviation from the dominant norms results in large groups of students being described in terms of lack or deficit (Bozalek & Carolissen, 2012). In this thesis I show that the storytelling intervention allows for subjugated knowledge of Black students to be foregrounded.

3.3.3. Counter-mapping

My pedagogical activism uses a combination of storytelling and counter-mapping and is guided by a posthumanist ethic. The term 'counter-mapping' was first used by Nancy Peluso (1995) to describe mapping work that challenges maps made by government and corporate authorities. Counter-mapping is political and seeks to reveal the hegemonic politics in such maps (Rundstrom, 2009).

The end of the Cold War in the early 1990s saw a concomitant rise in the development and adoption of GIS for social justice activism. GIS combined with other new technologies such as the fast-growing Internet to represent hegemonic abuses in new ways. These abuses were those especially related to land and indigenous peoples, such as visualisations of

dispossession (for example mapping of apartheid group areas), and mapping of resource extraction (such as mining activities on the lands of indigenous people). In addition to these new ways of visualisation, the subsidence of the Cold War rhetoric saw an increase in the airtime dedicated to the plights of subjugated people. The global surge in support for the anti-apartheid movement is a case in point. These factors contributed to counter-mapping practices being taken up by indigenous people around the world in forms of postcolonial politics. Since the 1980s, linkages between indigenous peoples globally have been strengthened. UNESCO sponsors projects that use participatory mapping to promote the recognition of indigenous peoples and their knowledge. One such example is the Indigenous Peoples of Africa Coordinating Committee (IPACC) which is a network of 150 indigenous peoples' organisations in 20 African countries[20].

Participatory mapping practices have gained traction and the integration of local knowledge and stakeholder perspectives in a GIS has been termed Participatory GIS (PGIS) (Musungu, Motala & Smit, 2011). PGIS is a form of counter-mapping because it is bottom-up and ostensibly reflects the will of indigenous people or the poor. It is not always the case as counter-mapping is contradictory: it must use the tools and language of the dominant culture, which might not always be to its advantage. However, PGIS is used to grow awareness of the plight of the poor and vulnerable, and allows for canvasing powerful agencies (such as municipal managers) to address these issues. I use examples of counter-mapping in my pedagogy to draw attention to sociomaterial issues faced by impoverished communities in Cape Town. My Caltex story (see Chapter One) is another example of counter-mapping. By getting students to create maps related to the story, attention is drawn to the plight of the environment and indigenous people who suffered at the hands of Chevron Corporation.
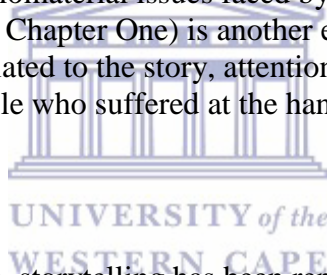
3.3.4. Storytelling

In South African higher education, storytelling has been reported as being an effective pedagogical tool, having both the ability to code discipline-specific knowledge (Motala & Musungu, 2013) as well as being a space in which students engage in emotional and cognitive labour (Gachago et al., 2013). The combination of the ability of narrative to allow students to take on wider perspectives, its natural emphasis on geography, and its power as a learning tool, makes it particularly well suited to geomatics education. The combination of GIS and storytelling has been reported on (Papadaki et al., 2010) but is not as common in GIS education as it is in other disciplines such as history that come from a long tradition of using storytelling as a pedagogical tool.

Storytelling captures students' attention and it reminds them of the complexity of the real world. By including multimedia, it also provides a richer, fuller learning experience through the incorporation of sounds, images and movement. This stimulates multiple senses and includes a strongly emotive experience through their personal stories (Robin, 2008). These personal stories are an exercise in diversity, helping students to connect with each other across difference.

The sharing of stories across cultural groups helps people to transcend limited personal paradigms and take on broader perspectives, which help in the formation of wider communities. Storytelling is as old as South African society itself, and has been the dominant

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[20] See www.ipacc.org.za

way of transmitting cultural information for many indigenous groups who have extensive traditions of oral storytelling (Ladeira & Blake, 2004). GIS provides visual and analytical tools that have been proven to benefit history teaching (Knowles, 2008), and linking African history with GIS analysis has helped students to visualise complex stories (Motala & Musungu, 2013). The genealogical method (Koopman, 2013) can assist to illuminate issues and work towards a decolonising awareness. Manuel DeLanda explains that

> all structures that surround us and form our reality (mountains, animals and plants, human languages, social institutions) are the products of specific historical processes. To be consistent, this type of philosophy must of necessity take real history as its starting point (Delanda, 2000: 11–12).

Posthumanism requires this 'real history' be told in a way that is not anthropocentric, nor humanistic.

Previously marginalised people are for the first time formulating "their own narratives as subjects, producing a multiplication of discourses" (Ferrando, 2012: 12). A step toward understanding one's neighbours is listening to each other's stories, and "story as methodology is decolonizing research" (Kovach, 2009: 103). Stories are enactments, rather than just descriptions (Jackson & Mazzei, 2012). Stories, like figurations, can assist us to imagine alternate subjectivities or realities. They can distil an otherwise complicated theory or ideology into a tangible, understandable product. "We also live with each other in the flesh in ways not exhausted by our ideologies. Stories are much bigger than ideologies. In that is our hope" (Haraway, 2003: 17). Haraway is a strong advocate for situated storytelling as a means of knowledge creation. She stresses the sympoietic nature of becoming-with as an important navigational tool. Rather than focusing on reconciliation or restoration, she focuses more modestly on getting on together, on partial recuperation. Stories help in this regard, but they can go even further, and fulfil the posthuman possibility of being both a navigational and analytical tool. They can assist in diffractive analysis too: "we need stories (and theories) that are just big enough to gather up the complexities and keep the edges open and greedy for surprising new and old connections" (Haraway, 2016: 101).

3.4. Concluding thoughts

In Chapters Two and Three, I have outlined the theoretical framework I use to guide my research. I have started to trace an entanglement of specific theorists and concepts. Braidotti's brand of critical posthumanism has been introduced, together with Barad's agential realism. The importance of relationality, complexity, assemblage, difference, non-representationalism and dualisms has been foregrounded. Ethics has been focused on through reading the works of several theorists together, notably Braidotti, Barad, Haraway, Plumwood and Tronto. A few geomatics concepts have been utilised thus far – I have touched on the role of geomatics technology in analytical posthumanism, and also discussed counter-mapping as a pedagogical device. In Parts Two and Three, some geomatics concepts will be more rigorously interrogated. Finally, I have introduced my figuration of the boundary, which is important in creating transversal linkages of concepts. In the next chapter, I continue to introduce more theory and develop a cartographic and diffractive methodology that is appropriate for my analysis.

CHAPTER FOUR – METHODOLOGY BEYOND BOUNDARIES

4.1. Introduction

The overall goal of this chapter is to outline the methodological framework I employ to analyse the data. I draw on Braidotti's conception of cartography, and put it into conversation with Barad's diffractive methodology. Additionally, I draw on non-representational theory (Massey, 2005; Thrift, 2008; Vannini, 2015) and Plumwood's (1993) characteristics of dualism toward the development of a rigorous analysis of the data in this specific case. Traditional research methodologies rely on a realist ontology or social constructivist approaches (Barad, 2007), which are rooted in Cartesian subject/object, nature/culture dualisms, hence the need for an articulation of a more appropriate methodology that takes into account the complexity, interconnectedness and materiality of the world. Mauthner (2016), in developing what she calls a 'diffractive genealogy', points out that an agential realist approach needs reconfiguration of existing social and scientific knowledge-making practices. In this vein, I propose a reconfigured methodological assemblage which requires attentiveness to both the 'hard' and 'soft' sciences.

4.2. A Braidotti and Barad assemblage

My methodological assemblage is largely based on the theorising of Rosi Braidotti and Karen Barad, and supplemented diffractively with critical cartography, non-representational theory and selected feminist literature. The methods of Braidotti and Barad are distinctive yet there is much resonance and contamination between them, with no hard boundary. Using a spatial metaphor, Karen Barad's agential realist framework is useful for zooming in to the storytelling intervention and analysing specific stories. Braidotti's cartographic method is useful to zoom out, and, drawing on its Foucauldian roots, observe the contingencies (Kendall & Wickham, 1999) that shape geomatics education in South Africa. Braidotti's explicitly political project is a useful way to view the relationships between several powerful agencies, namely the geomatics academy (mainly universities), government, industry and non-human agents. It embeds the profession within a post-apartheid, post-Cold War, globalising, advanced capitalist society in the age of the Anthropocene. It frames the discussion, and analyses the production of hegemonic/subjugated knowledge practices.

It should not be assumed though, that the 'macro' data was exclusively analysed using the cartography, and 'micro' data diffractively – this was certainly not the aim of both theorists. Both methods are employed at all scales, entangled together and drawn on as an assemblage. Both theorists call for learnings to be made by looking outside the boundaries of one discipline (Barad, 2007; Braidotti, 2013a). Their methods should not be viewed on a hierarchical scale, casting judgement on one from the standpoint of the other. This non-judgemental stance is a characteristic of diffractive reading - it is neither dismissive nor reflexive (van der Tuin, 2018). Indeed, the combination of the methods has been diffractive, with each method being read through the other, to see what learnings emerge.

Also, critical posthumanism does not attempt to re-inscribe the humanism/anti-humanism binary, but seeks to destabilise it with the recognition that 'we' (especially those of us who have been classified as other) have never been fully human from the outset (Knox, 2016).

The methodology seeks out the in-between spaces and does not subscribe to the masculine comparative methodology of pitting one theory against another.

Both Braidotti and Barad call for respectful, ethical and detailed readings of situations. Barad says:

> My aim in developing such a diffractive methodology … is to provide a transdisciplinary approach that remains rigorously attentive to important details of specialized arguments within a given field, in an effort to foster constructive engagements across (and a reworking of) disciplinary boundaries (Barad, 2007: 25).

Braidotti makes it clear that a cartographic analysis pays attention to "micropolitical instances of activism, avoiding overarching generalizations" (Braidotti, 2011a: 269). The cartography is specific and is predicated on the embedded and embodied reality of the researcher. For both theorists, the researcher is not external to the phenomenon or problem being researched, hence eschewing subject/object dualism.

Braidotti focuses much of her theory on an affirmative reconceptualisation of the embodied and embedded subject, whilst Barad's agential realism attends to the production of the discursive, the material and the boundary between them. These points of view are indicative of Braidotti's humanities and Barad's physics background, even though both thoroughly explicate the need for a new frame of reference which looks beyond the 'hard' and 'soft' sciences.

My pedagogical activism, in the form of a storytelling intervention, is guided by my ethical stance and analysed with critical posthumanism. This alludes to the knowing-in-being ethico-onto-epistemology that is argued for by new materialists (van der Tuin, 2014), which is similar to how post-qualitative researchers describe as a 'zig-zagging' between theory and practice (Jackson & Mazzei, 2012; Lather, 2014). The posthuman is, for Braidotti "both a genealogical and navigational tool" (Braidotti, 2013a: 5). This allows for not just the zig-zagging between theory and practice mentioned above, but also between critique and affirmation. This is a characteristic of new materialist theory that is allowed for in part by its dynamic conception of time. As Braidotti suggests, it is useful to be in an experimental mode and keep the "process flowing and multifocused, refusing to both monumentalize the past and fetishize the future" (Braidotti, 2014: 239). Seen as an apparatus, the storytelling intervention is "constituted through particular practices that are perpetually open to rearrangements, rearticulations, and other reworkings" (Barad, 2007: 170). Movement is important, and the focus on production is central to the work of Deleuze:

> Because Deleuze's philosophy is one of immanence, he helps us focus not on the question of what is there, but on what is being produced. For Deleuze and Guattari, desire, for example, is about production. Deleuze's production is active, becoming, transformative (Jackson & Mazzei, 2012: 86).

I have also drawn on other researchers who have produced empirical applications of posthumanism. My writing style, like those of Braidotti and Barad, uses the logic of transposition, a term that was inspired from music and genetics (Braidotti, 2006). I leap across codes in a posthumanist transfer that respects difference. Recently, there has been a convergence between methodologies from post-qualitative research (see for example Jackson & Mazzei, 2012; MacLure, 2013a; Lather, 2014; St. Pierre & Jackson, 2014), non-

representational theory (Thrift, 2008; Vannini, 2015) and new materialism (Thiele, 2014; van der Tuin, 2014). New materialists' interest in what is produced by a phenomenon is echoed by post-qualitative research – Manning's (2015) critique of method asks what knowledge *does*, and her reading of Alfred North Whitehead has resonances with other theorists' engagement with Spinoza (e.g. Deleuze, 1988; Braidotti, 2006, 2013a). Manning interestingly notes that Whitehead defined the function of reason (which is one of the key properties of the humanist subject) as the promotion of the "art of life" (Manning, 2015: 57) which resonates with Spinoza's explication of how bodies enter into relations with other bodies (Deleuze, 1988).

4.3. Cartography as a methodology

For Braidotti, posthumanism is a navigational tool to map a set of material and discursive conditions, and this mapping is done by means of a cartography:

> A cartography is a theoretically-based and politically-informed reading of the present. A cartographic approach fulfils the function of providing both exegetical tools and creative theoretical alternatives. As such it responds to my two main requirements, namely to account for one's locations in terms both of space (geo-political or ecological dimension) and time (historical and genealogical dimension), and to provide alternative figurations or schemes of representation for these locations, in terms of power as restrictive (*potestas*) but also as empowering or affirmative (*potentia*) (Braidotti, 2002: 2).

It is a way for critical theorists to represent people's situated historical locations, and should not be confused with traditional (geomatics-related) cartography. The fact that this research is situated within geomatics, with its focus on cartography, makes the analysis all the more interesting. I point out and analyse the resonances and dissonances between the two cartographies, so that each is used as an analytical tool for the other.

4.3.1. Genealogical roots

A purpose of my cartography is to show how a specific type of humanist subject has been promoted and produced through geomatics education in South Africa (Aim 1 in section 1.4). Foucault was against grand theorising, and "emphasized the local character of critique against the grand totalizing claims of theory" (Shani, 2010: 210). He showed how subjugated knowledges which have been disqualified by theory could be identified and analysed by genealogy. The South African education system has traditionally been a favoured site for those in power to subjugate certain knowledges, and to privilege others. These cycles of repression and privilege led to the encouragement and formation of a subject with some important (humanist) characteristics. Currently, the focus on encouragement of the STEM disciplines is a privileging of certain categories of knowledge. Surveyors and GIS practitioners benefit from this privileging, and are seen as individuals whose education has produced problem-solvers.

There is a strong genealogical element to the writing of Braidotti (2006, 2011a, 2013a) and others, such as Manuel DeLanda (2000) and John Protevi (2013). In addition to this, genealogy is crucial in the methodology of new materialism: "These genealogies, or "cartographies" in our vocabulary, are non-dualist approaches to theory formation that allow

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for absolute deterritorializing"(van der Tuin & Dolphijn, 2012). The cartography aims at unveiling the power locations which structure the geomatics position on education in South Africa. The power relations within the academy and industry are analysed in a Foucauldian sense to identify dualisms and observe the workings of the relations between participants in the assemblage. This type of analysis shows how the visible neoliberal agenda in the public sphere (through for example the faith in the market economy and promotion of private property rights) produces statements from universities, which in turn produces curricula from geomatics departments. A Foucauldian approach looks at power as both restrictive (*potestas*) and productive (*potentia*). My research is developed around these two power relations, as attested to by parts Two and Three in this document.

Power formations function at the individual and group level; so do narratives, cultural representations and social modes of identification (Braidotti, 2013a: 26). For example, the technikon surveying learning experience (including curriculum, the learning environment, the technology used, the assessment and the administration) was dictated originally by the government department of education, then power was devolved to the institution, giving the technikon more power. Thereafter, the rise of PLATO (the forerunner to the South African Geomatics Council), followed by the expected dominance of the capitalist agenda and the growing influence of the market was, and continues to be, observed. The relations between these various powerful agencies have had the interpellative effect of producing the current practices of geomatics. The education of surveyors and cartographers thus arose out of a "contingent intersection of a complex array of practical activities that form a kind of basis for both the elaboration of newer practices and the destabilization of older practices" (Koopman, 2013: 105). This implies both the restrictive and productive possibilities found within the power structures of geomatics education. These power relations (mainly as *potestas*) are analysed further in Chapters Five and Six.

4.3.2. The two cartographies[21]

Braidotti believes that the link between humanism and Eurocentrism needs to be decoupled for the humanities to progress: "Humanism must shed its smug Euro-centrism and become an adventure in difference and alternative cultural traditions" (Braidotti, 2013b: 4). She further explicates the rules of a critical posthumanist methodology, and points out that these can assist to redefine the relationship between the humanities and life sciences. The six rules have been listed in section 2.2.4. Rule 1 is cartography accuracy. Dissonances between this type of accuracy, and the accuracy central to geomatics is illustrative of differences between the 'hard' and 'soft' sciences. I will now entangle these two notions of accuracy with elements of a story I tell in class.

Within photogrammetry, the accuracy of a photogrammetric measurement is directly related to the quality and number of photographs of the thing being measured. In laser scanning, a point co-ordinate is generated by measuring the time it takes for a laser beam to leave an instrument, reflect off an object, and arrive back at the instrument. If this process is repeated millions of times, a point cloud of co-ordinates on the surface of the object can be produced. A dense enough point cloud can be used to produce a good surface representation by a

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[21] This heading is a wink to Guattari's Three Ecologies that emphasises the connectedness between the mind, society and the environment. Guattari advocated a change in the way that we view boundaries in order to effect ecological change.

process called *interpolation*, such as the 3-D model of Bet Giorgis in Lalibela, Ethiopia (Figure 2).
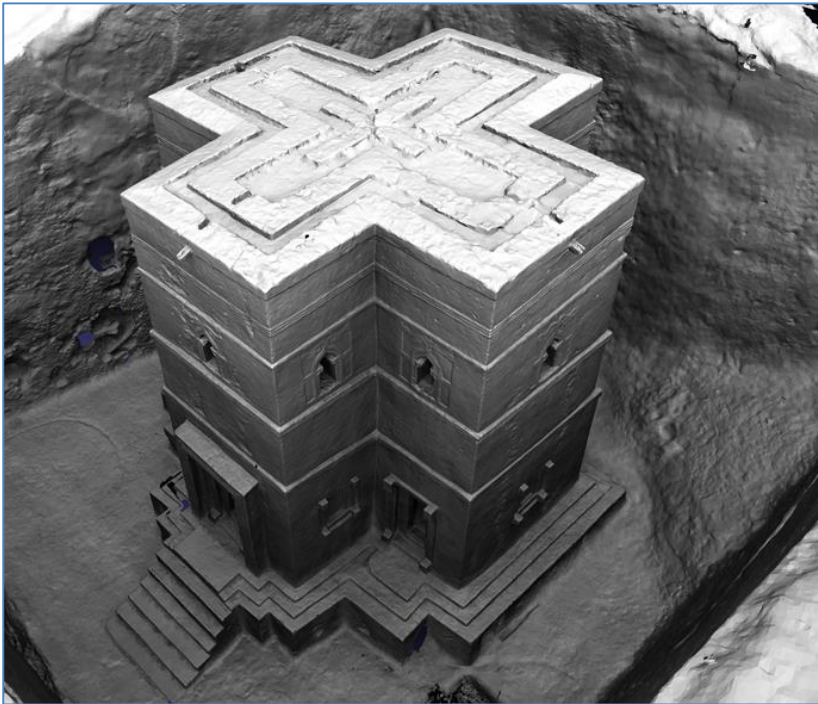
Figure 2 3-D laser scanning model of Bet Giorgis, Ethiopia (Zamani Project, 2015)

This magnificent church was built by King Lalibela in the 12th century, supported by the powerful Ethiopian Orthodox Church in a time when his power over his kingdom was waning. He wanted to create a sacred site for the people of Ethiopia, a local version of Jerusalem. The church, which is part of a larger complex of churches built by the king, is a monolithic rock-hewn church, refined and elegant in its architecture and stonemasonry (Rüther et al., 2001). Centuries later, a team of surveyors from the University of Cape Town would go to it and map it using laser scanners. The Zamani Project documents African heritage using geomatics technology, and produce 3-D models, panoramas and other maps. The project has been documenting sites on the continent for over a decade (Zamani Project, 2015). A problem faced by the Zamani team is the lack of use of such models. I have utilised the model of Bet Giorgis in my pedagogy for storytelling. This brings together (photogrammetric) cartography with (genealogical) cartography, in response to the need for a decolonising pedagogy in geomatics. Students are often enchanted by the idea of the existence of a powerful, sophisticated African Christian kingdom during the European Dark Ages.

In a Deleuzo-Guattarian methodology, a map is set up, consisting of "various kinds of data produced by a multiplicity of desiring agents in various power-producing fields" (Lenz Taguchi & Palmer, 2014: 764). Stylistically, this could read as a series of loosely related writings put together. Like *A Thousand Plateaus*, there are sections which could be read separately or in a non-linear fashion – the cartography draws, rather than writes. Mapmaking, like architecture, is a mixture of art, science and technology, and is a highly creative operation.

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One of the fundamental attributes that geomatics graduates must develop is the ability to communicate spatial information effectively using maps – in other words, cartography. This attribute is developed during the undergraduate learning experience through various interrelated activities. The objective of map design is to evoke in the minds of viewers an image appropriate to the map's purpose. There are many ways that spatial or aspatial data can be represented, and the communication objectives of cartography can range along a continuum from a simple sketch plan to a complex multi-temporal, multi-variable representation. Cartographers should be given the freedom to express themselves creatively, and this is made explicit in my storytelling intervention. Had it not been for such an intervention that deliberately called for creative expression with cartography, the process of mapmaking could seem formulaic, predetermined and rigid – more like a Deleuzo-Guattarian *tracing*. Deleuze and Guattari criticise the tracing because of its logic of reproduction; it is used "to describe a de facto state, to maintain balance in intersubjective relations, or to explore an unconscious that is already there from the start" (Deleuze & Guattari, 1987: 12). It reproduces something, and purports to represent the thing according to Cartesian logic. A *map*, on the other hand, is

> oriented toward an experimentation in contact with the real. ... It fosters connections between fields, the removal of blockages on bodies without organs, ... It is itself a part of the rhizome (Deleuze & Guattari, 1987: 12).

The map allows the cartographer to be creative, and make connections between disparate entities. It involves "experimenting with how to move between things in ways that nullify beginnings and endings" (Alvermann, 2000: 116). In this regard, a map does not have a beginning or end, it is a becoming, constantly changing. My cartographies in Chapters Five and Six are thus open-ended and based on my agential cut.
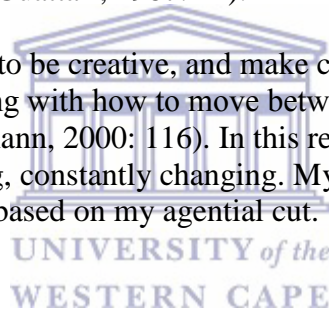
4.3.3. Politics of location

The person producing a cartography needs to be ethically accountable for its accuracy (the corollary of Rule 1 – see Section 2.2.4). Braidotti's suggests that this accountability can be supported methodologically by practicing the 'politics of location', or "situated and accountable knowledge practices" (Braidotti, 2013a: 51). This can help to produce

> politically informed cartographies of one's position, starting not from gender alone, but from a bundle of interrelated social relations. The practice of the politics of location rests on notions like experience, situatedness, accountability and transversal alliances. This politics of locations is best served by a non-unitary vision of the subject that stresses nomadic complexity and open-endedness (Braidotti, 2006: 92).

A posthumanist analysis requires that I report on things from a standpoint, which is the space and time that I inhabit currently. This is, within the aegis of nomadic subjectivity, a difficult task, as the nomad is dynamic, multi-layered, non-unitary, and situated within an ever-changing environment. The cartography attempts to uncover and articulate some of this complexity, whilst situating it within an advanced capitalist society that multiplies difference for the purpose of maximum profit. This thesis was written over a period of five years (between 2014 and 2018) and is contextual. Being embedded within South African society (mainly Cape Town), and having travelled to Utrecht (the Netherlands), Windhoek, Swakopmund (Namibia) and Lusaka (Zambia) during this period affected my subjectivity.

Being afforded the opportunity to travel allowed me to consciously encounter my inner nomad, as well as reflect on previous travels I have undertaken prior to being aware of posthumanism. It is no easy task as I have automatically slipped into the mode of identity politics many times. The nomad, on the other hand, desires an identity of transitions and has relinquished the desire for fixity (Braidotti, 2011a).

A cartography aims at unearthing the complexity, nonlinearity, multi-layered-ness and internally contradictory nature of the phenomenon under investigation. A location is both spatial (that is, embodied and embedded in a place) as well as temporal. We are also located in a specific time, hence the politics of location draws on the power of memory. It is a characteristic of many critical theorists to be haunted by bad memories, such as crime, despotism, violence, injustice and environmental destruction. Critical posthumanism encourages an affirmative transformation of negativity. So practicing a posthumanist pedagogy would require more than making students aware of injustice, it would be to transform the negative passions into affirmation.

Braidotti's project, assisted methodologically by the politics of location, encourages micro-activism that avoids generalisation (Braidotti, 2011a). This relies on one's embodied, embedded, relational and affective capacities to act. It requires courage to speak about the mundane, the everyday. Foucault reminds us that so-called 'global' or 'totalitarian' things / institutions / practices / discourses become intimately related to our bodies in ways that make them familiar (Foucault, 1980: 80). This familiarity makes them very difficult to criticise or even to identify.

Advanced capitalism has also displaced the traditional unitary subject, and the

> unitary vision of the subject cannot provide an effective antidote to the processes of fragmentation, flows and mutations, which mark our era. In ethics, as in many other fields of contemporary social endeavour, we need to learn to think differently about ourselves and our systems of values, starting with adequate cartographies of our embedded and embodied positions (Braidotti, 2006: 31).

The specifics of the phenomenon being investigated are crucially important. Besides Braidotti emphasising the importance of practicing the politics of location to create embedded and embodied knowledge, Barad too dwells on this point. From Bohr, she learnt that concepts are "specific material arrangements of experimental apparatuses" (Barad, 2010: 253). She also points out that phenomena like recognisability, ethical practice, knowing, the difference between subject and object, and human subjectivity all emerge out of specific material arrangements (Barad, 2007). Boundaries are thus not fixed entities, but become determinate through the specificity of the intra-action. It was Haraway that originally suggested the relationship between diffraction and specificity:

> Diffraction patterns record the history of interaction, interference, reinforcement, difference. Diffraction is about heterogeneous history, not about originals. Unlike reflections, diffractions do not displace the same elsewhere, in more or less distorted form, thereby giving rise to industries of metaphysics . . . Diffraction is a narrative, graphic, psychological, spiritual, and political technology for making consequential meanings (Haraway 1997, cited in Barad, 2010: 254).

With regards to situated knowledge, Hughes and Lury emphasise the methodological "necessity of articulating dynamic intra-actions between human and non-human forces"(Hughes & Lury, 2013: 786). In teaching GIS, the intra-actions between students, computers, stories and GIS software are centrally important for learning to take place. When considering power relations, agency does not exclusively lie in the human subject. For example, a digital story can have an existence separate from the storyteller.

I practice the politics of location by acknowledging my experience and situatedness within the South African geomatics and education assemblages. My personal investment over a period of time has resulted in "accumulation, coagulation, and sedimentation" (Deleuze & Guattari, 1987: 159), and while this serves to create a structured subjectivity, a recognition that my position is non-essential and potentially fluid is important. The attention that I pay to observing any deterritorialisations, boundary transgressions or disruptions in my students must also include awareness of my own development. I am, after all, both a co-learner and a holder of hegemonic power. Agency is central to my process of becoming, and is an ethical act. In particular, whose voice (human and non-human) that I choose to foreground has implications for the development of my cartographies. The meta-methodological stance I have taken towards my pedagogy is guided by posthumanist ethics. Practicing a nomadic pedagogy manifests in a challenge of power structures, which may also include a subversion or deterritorialisation of the researcher identity (Fendler, 2013).

As Braidotti points out, globalisation is both a celebrated and maligned phenomenon, combining the euphoric celebration of new technologies, economies, lifestyles, gadgets and weapons, with the

> complete social rejection of change and transformation. In a totally schizophrenic double pull the consumerist and socially enhanced faith in the *new* is supposed not only to fit in with, but also actively to induce, the rejection of in-depth changes (Braidotti, 2006).

Critical posthumanism presents an opportunity for renewed critique and resistance of new master narratives in the form of Western hegemony such as American dominance of world markets and media. Cartographies can serve to provide a better understanding of how various assemblages work, often paradoxically, in this historical era. Moving past critique, the cartographies can also assist in finding "adequate ways of expressing empowering alternatives and of having them socially enacted" (Braidotti, 2006). Donna Haraway's cyborg was a premonition of the posthuman cartography: "So my cyborg myth is about transgressed boundaries, potent fusions, and dangerous possibilities which progressive people might explore as one part of needed political work" (Haraway, 1991).

4.4. Methodological implications

4.4.1. Non-linearity and time

The way I have put the methodology to work in this thesis is to intertwine a number of stories together, and use the stories as 'hooks' on which to hang my analysis. It is diffractive and cartographic, looking at various phenomena historically, yet simultaneously troubling the linear nature of time. It is both analytical and navigational, and utilises the temporal logic of *Aion*. In this thesis, I have chosen stories from my pedagogical repertoire as illustrative of my

practice. They are: my Caltex story (in Chapter One), the Pieter Potter / Krotoa / boundary hedge story (part of which is in Chapter Five), a part of the King Lalibela story (in this chapter) and the District Six story (in Chapter Six). These are stories, but are also important navigational tools that have assisted me to negotiate (and convey a sense of) complexity in these post-human times to my students. They are markers of situatedness. Situated knowledge is a cornerstone of the feminist politics of location. Like the figurations of Haraway, they have inherited non-innocent pasts that can be read diffractively (Sehgal, 2014) for an affirmative transformation to take place.

Braidotti clarifies the relationship between the feminist politics of location and time:

> The temporal dimension is again crucial: a location is a spatial but also a temporal site, because it involves a commonly shared memory and sense of the past that continue to affect the present and will carry on into the future. Understanding this is the key both to citizenship and to the forms of ethical agency that it empowers (Braidotti, 2006: 150).

My cartographic and diffractive analysis (as well as my pedagogical approach) are against linearity. Transdisciplinarity and non-linearity (rules 2 and 4 of Braidotti's rules in Section 2.2.4) are important principles in developing adequate cartographies that cope with the complexities of contemporary culture (Braidotti, 2006, 2013a). Foucault and other poststructuralist thinkers (like Deleuze) in the 1960s started to think about the present in a different way. Previously, academia was focused on thinking about the past, and in very established ways. The humanities deferred authority to the past and its great thinkers. This was contested:

> Instead of deference to the authority of the past, we have the fleeting co-presence of multiple time zones, in a continuum that activates and de-territorializes stable identities and fractures temporal linearity (Braidotti, 2013a: 165).

Diffraction also requires non-linear analysis, and the fracturing of temporal linearity is clearly seen in Barad's work (see for example Barad, 2010, 2014, 2017). She emphasises that time can be queered[22], and is not linear: "Time is out of joint; it is diffracted, broken apart in different directions, non-contemporaneous with itself" (Barad, 2014: 169). Read with Braidotti (2006, 2013a), this is *Aion*, or molecular time.

'Hauntology', a term coined by Derrida (1994) and used by Barad (2010, 2017), is about traces of the past that haunt the present and future. Barad advises us on the importance of being attuned to silence – she says that each worldly entanglement matters "not just for what comes to matter but what is constitutively excluded from mattering in order for particular materializations to occur" (Juelskjær & Schwennesen, 2012: 21). In this regard, the *void* is important. Barad troubles the Democritean ontology of the world, in which particles inhabit the void. This is similar to the surveying worldview, in which space is the empty stage on which the world's action takes place. A posthumanist ontology is different, one by which

> particles no longer take their place in the void; rather, they are constitutively entangled with it. As for the void, it is no longer vacuous. It is a living, breathing indeterminacy of non/being (Barad, 2012: 210).

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[22] Barad (2011) challenges the anthropocentrism of queer theory, which places much importance on human performativity. She calls for a widening of the applicability of performativity to include non-humans and other phenomena, such as time.

Massey (2005) problematises the inert, lifeless characterisation of space itself, in part because of the connotations associated with representation. One of the results of the philosopher Henri Bergson's concern with time (through for example his work on *duration*) resulted in time being prioritised over space, and space being devalued in relation to time. This hegemony exists widely in the societal imaginary. Massey (2005: 5) points out that capitalism and globalisation accomplishes a "sleight of hand in terms of the conceptualisation of space and time [which] turns geography into history, space into time". In particular, we are forced to view all countries of the world on a 'First World – Third World' continuum, and imagine nation states attempting to move away from the latter, towards the former. There is thus an implied temporal progression of bounded states, and thinking outside of this framework is difficult. Furthermore, the logic of the void is linked to colonisation:

> justification for occupying land is often given on the basis of colonialist practices of traveling to 'new' lands and 'discovering' all matter of 'voids': for example, claims of population voids (for instance, lands allegedly unpopulated before the arrival of the settlers), land devoid of property ownership, territorial sovereignty, development, civilisation, or inhabitants with specific labor relations to specific parcels of land. The doctrine of terra nullius is one such tool of empire building (Barad, 2017: 76).

Hauntings of past or future exclusions have inspired some of my stories. For example, the stories of District Six and Pieter Potter show how patterns of exclusion, suppression and violence (during apartheid and the colonial period) have real material linkages to the everyday life of students.

This non-linear conception of time is utilised in the cartographic methodology, which acknowledges that progress (in whatever phenomenon that one is investigating, be it mapping, education or art) occurs in periods of advance and stagnancy. Barad points out that this aesthetic of motion is built into our very structure: "Particles are given to fits, to paroxysms, to spasmodic bouts of e-motion or activity" (Barad, 2010: 245). My commitment to storytelling as both a pedagogical tool and an analytical device is useful in this regard. It isolates critical moments which have had an effect on the development of the phenomenon under investigation. This utilises "episodic forms of historiography" (Pickles, 2004: 127) that acknowledge, for example, that the development of the practice of surveying and mapping occurred as a series of bifurcations in the visualisation of geographic space. A posthumanist analysis can bring to light the non-linear and not necessarily unidirectional nature of progress. The excision of art from the practice of cartography is one such example of 'progress' which, in some respects, served to retard the deployment of ethics in geomatics. Furthermore, non-linearity is a useful device in stories. Stories can harness the richness of partial and embedded points of view to convey an ethical standpoint.

Van der Tuin (2014) advises that capturing movement is important in using the diffractive methodology: "one must take a plunge into thinking in movement"(van der Tuin, 2014: 238). The historical, cartographic methodology must not be seen as a distancing act, where I observe a history that has happened from afar. Rather, the geomatics assemblage on which I report contains me, and moves me along. I am aware and cautious of the fact that this type of writing style risks obliqueness, since I am writing linearly about things that are happening simultaneously (Jackson & Mazzei, 2012). An important aim is to attempt to provide the reader with an affective experience and a sense of becoming. What goes on in-between is important – in constructing the geomatics/storytelling assemblage, I create topologies across

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time, and analyse what is produced. Alvermann (2000) points out the irony of publishing research about a Deleuzoguattarian analysis – it concretises a process that prides itself in being

> open and connectable in all of its dimensions; it is detachable, reversible, susceptible to constant modification. It can be torn, reversed, adapted to any kind of mounting, reworked by an individual, group, or social formation (Deleuze & Guattari, 1987: 12).

I face the same situation in writing this thesis, which has a beginning and end, yet the map seeks out the in-between spaces and attempts to capture movement.

4.4.2. Dualisms

A diffractive analysis explores patterns of difference that help to identify and trouble dualisms. In this thesis, I show examples of dualisms that appear in stories and in the geomatics knowledge base, and I analyse their characteristics. Plumwood's (1993) characteristics of dualism (see Section 2.3.3) are used to make explicit various dualistic relationships. For example, the Black/White dualism is identified in many stories, as well as in the development of geomatics education in South Africa. Methodologically, reading Plumwood, Braidotti and Barad through each other and through stories and geomatics concepts helps towards achieving various goals. Firstly, dualisms are identified and characterised by tracing entanglements in a cartographic way. Secondly, their implications for subjectivity formation of geomatics students or practitioners are examined. Thirdly, strategies for troubling, queering and dismantling the dualisms are explored. This dual move (critique/affirmation, cutting together/apart) points to indeterminacy and the emergent nature of knowledge practices in posthumanism.

Dualisms that correspond to and naturalise forms of oppressions (e.g. male/female, mind/body, civilised/primitive and human/nature) are rooted in historical processes and are preserved in culture (Plumwood, 1993). It is through a complex interplay of power relations, changes in the environment (natural, cultural and technical), differences and repetition, that things get produced. These things could be subjectivities, curricula, stories or other practices. However, this does not mean that it is neither helpful nor necessary to understand the linear (*Chronos*) timeline. Sometimes, my engineering sensibilities have instinctively required me to pin events onto a linear timeline, then step back to get a birds-eye view of the world that I am part of. Other times, the cartography jumps across multiple time zones to identify resonances or dissonances. Making connections across time (working with *Aion*) increases the complexity of the understanding. It does not require me to create a binary, casting judgement upon one by privileging the other, but rather to recognise that both *Chronos* and *Aion* are useful in the analysis to develop creativity. Creative critique, focusing on *Aion* (but not discarding *Chronos*) would thus obey Braidotti's rules 2, 4 and 5.

4.4.2. Knowledge production

The question is not 'why' but 'what did it produce'? The focus is to observe what has been iteratively produced by this specific assemblage. The issue is less about 'what does it mean' than 'how does it work'. This comes from the Foucauldian roots of the cartographic analysis. An analysis of geomatics education and geomatics practice can help us to identify how relations of power are produced (in industry and the academy) and how they work. A

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posthumanist methodology recognises that there might not be a strict causal relationship between events / phenomena / disciplines / subjects. I am not going back in time to try to find an origin story; like the diffractive genealogies of Mauthner (2016), my methodology intra-actively reconfigures the genealogies it produces.

Braidotti emphasises that the posthuman is both a navigational and analytical tool. I would include in the analytical part, that the methodology is also a creative tool. This creativity does not only imply artistic creativity, but creativity in the vein of Harley's conception of mapping. That is, maps help to create the world, not just analyse it.

Diffraction troubles traditional, sedimented knowledge – it cuts apart some of the most stable binaries (such as animate/inanimate, Black/White, past/future and wave/particle). However, even this cutting-apart is troubled, and Barad calls it "cutting together-apart" in one move (Barad, 2014). The dualistic 'either or' logic is replaced by the logic of 'both and'. Thus 'in/determinate' refers to something that is both determinate and indeterminate. Diffraction requires an iterative re-turning of knowledge, thus producing new knowledge, or returning to old knowledge. Transdisciplinarity, non-linearity and de-familiarisation (Braidotti's rules 2, 4 and 6 respectively) are central to diffractive and cartographic methodology.

With respect to transdisciplinarity, I aim to trace the entanglements of geomatics and posthumanism that have been facilitated through this research and my pedagogy. In order to read posthumanism and geomatics through each other, I do not presume the dominance of methods inherent to the 'soft' or 'hard' sciences (for example, traditional qualitative or quantitative methods). As noted by Clough et al. (2015) post-World War II sociology presumed that the social world could be objectively studied with the aim of allowing state institutions to harness social data to further their aims. This involved a rationalisation of the human subject for state instrumentality. In my analysis, I sketch out the entanglements that produced the figure of the surveyor or cartographer. The flattened ontology of posthumanism allows for non-hierarchical thinking, and hence an investigation into alternate subject positions. My specific methodological and theoretical assemblage produces insights into geomatics from the standpoint of critical posthumanism. Posthumanist theory too is strengthened by an in-depth interrogation of specific relevant geomatics concepts (such as cartography and interpolation).

4.4.3. Performativity, post-qualitative links and other non-representational characteristics

My research methodology takes seriously the tenets of non-representational theory (Thrift, 2008). It pays attention to movement, affects and materiality; it strives to be anti-biographical (yet biography is not discarded, particularly in some stories); it is concerned with practice; and is experimental. In the diffractive analysis, I will read student stories together with the work of Braidotti, Barad and Thrift to show resonances and dissonances in the pursuit of new knowledge.

A posthumanist data analysis has been described as 'post-qualitative' (MacLure, 2013a) because, unlike traditional qualitative research, it does not consider coding as a fundamentally important method of extracting meaning from qualitative data. Coding has in fact been described as 'offensive' for a number of reasons (MacLure, 2013b).

Firstly, coding in traditional qualitative research assumes that language describes a pre-existing reality. This is a legacy of the seventeenth-century Enlightenment, which inaugurated the hegemony of the rationalist, humanist worldview. This worldview translates into a methodology that positions the researcher at a distance from the objects (most often human objects) of enquiry. It is concerned with the macro by producing broad themes (Mazzei, 2014) and has the effect of taking the researcher away from the data, and can undermine an ethic of responsibility. Posthumanism posits that truth is always situated and knowledge is always partial. Knowledge is created as a result of power relations, situated in context. My research extends this insight to mapping, and puts critical cartographers like J.B. Harley into conversation with posthumanism.

Secondly, coding is offensive because it assumes and imposes arborescent logic (Deleuze & Guattari, 1987) on the data being analysed. In this way, things being researched are locked into representations of pre-existing relationships. For example, stories may be classified as belonging to the category of documentary or autobiography, and sub-categories of these two main categories. It does not allow stories to deviate from these two categories, thereby disallowing the creation of something new. In this way, the data is sacrificed to the code, and the importance of a story in itself is minimised.

With regards to my research and biography, I utilise biography paradoxically to work towards an anti-biographical stance. This subversion emerges out of the influence of non-representational theory. Thrift's (2008) second principle states that non-representational theory is anti-biographical and pre-individual. I use autobiographical stories as part of a pedagogical assemblage. This assemblage is diffractively constructed with/through the analysis, and is nomadic. Autobiographical stories are very important in the context of my pedagogical intervention. Part of my agential cut grants agency to specific stories, and a critique of the hegemonic subject of humanism emerges. Stories that negotiate complexity and boundary crossing, often from the standpoint of marginalised others, are chosen. My Caltex story, for example, is autobiographical and portrays my trajectory through the world of work. My subjectification is multiple and often contradictory. I don't underplay my enjoyment of the Caltex experience, with all the pleasures that came with having more money. At the same time, I criticise the company for their terrible environmental and human rights record. This forces students to reappraise the good/evil dualism. Following Thrift, I do not believe that lives are meant to be known and understood – it would be more useful to describe and re-describe them to trace complex and contradictory entanglements.

In my research, I take a conciliatory note between qualitative and post-qualitative methodologies. Following some post-qualitative researchers (Jackson & Mazzei, 2012; MacLure, 2013b; Mazzei, 2014) I do not discard coding, and instead choose to deploy it diffractively. I use the logic of coding with a specific goal in mind. I have analysed students' digital stories to extract themes that show the hegemonic influence of humanism within geomatics education. So I have deployed a humanist methodology (that is, to extract themes *a la* traditional qualitative research) in a subversive way. I then take the analysis further, by identifying two digital stories that evaded the capture of humanist logic. Importance is given to data (digital stories) that 'glowed'[23] for me – note that this implies some agency on the part of the data. In the post-qualitative part of the analysis, attention is paid to outliers, my intuition, differences, affect and movement.

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[23] Maclure (2013b: 175) notes that during the process of coding, "some things gradually grow, or glow, into greater significance than others, and become the preoccupations around which thought and writing cluster".

4.5. Data and analysis

4.5.1. Emergent data

This is a deeply personal thesis. Texts, theorists, events and material that mattered to me are what have been gathered (Edwards, 2010) and included – things that have glowed and made themselves intelligible to me are all considered to be 'data' in a post-qualitative sense (MacLure, 2013a). I have been fortunate enough to have met both Rosi Braidotti and Karen Barad, and have garnered some of their thoughts on my research. I am not only restricting myself to the material and events that I have observed during the course of this research, rather, this is a lifetime of 'data' collection. The agency behind this collection is posthumanist – it has collected me, just as much as I have collected it. Besides being a geomatics academic, I was a practitioner in industry (I worked for an aerial mapping company, a private GIS company and a corporate oil company) and in the employ of the state (I worked for the Surveyor-General Cape Town), so my experiences contribute to this research too. I am not aiming to propagate the idea of an unchanging, stable identity (that of the author – myself) at the centre, describable by a list attributes that define who I am. Rather, I am multiple, ambiguous, and in a state of constant becoming. I am part of multiple assemblages that are constantly on the move: the geomatics community, the university, an Indian diaspora, the land that surveyors impose boundaries on, and the earth.

The 'data' that was used in the analysis comes from multiple, overlapping sources, such as interviews, documents (for example textbooks, media articles and research papers), my own subjective opinions, observations and student digital stories. These are typical data sources that are suggested in qualitative research, however, a posthumanist methodology understands 'data' in a different way. In traditional qualitative research, researchers "build their patterns, categories, and themes from the bottom up, by organizing the data into increasingly more abstract units of information" (Creswell, 2009). This attempts to represent the thing being researched, where

> the researcher begins with a large body of information and must, through inductive reasoning, sort and categorise it and gradually boil it down to a small set of abstract, underlying themes (Leedy & Ormrod, 2005).

Epistemologically, posthumanism is anti-representationalist. Representationalism is criticised for its production and reinforcement of the humanist subject (Barad, 2007), because it derives from a Cartesian worldview, where objective outsiders observe insider subjects through apparatuses like interviews (Kuntz & Presnall, 2012). This privileges the disembodied spectator in a power relation that abstracts language from bodies and produces a transcript that represents (and stands in for) an embodied event. Donna Haraway recognised the danger of 'textualisation', which creates an "utopian disregard for the lived relations of domination that ground the 'play' of arbitrary reading" (Haraway, 1991).

Allowing data to emerge occurs when attention is paid to the encounters between bodies. For example, I pay attention to my pedagogical encounters, and investigate the emergence of student digital stories. Besides being non-representational, my attentiveness stems from a pedagogy that is attuned to an ethic of care (Tronto, 1993). A diffractive move applies theory

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to data, whilst being aware that there is no clear-cut boundary between data and theory (Jackson & Mazzei, 2012).

Deleuze reminds us that bodies are comprised of relations, and when bodies encounter each other, relations combine affirmatively or decompose one another (Deleuze, 1988). We then need to be aware of what the encounter has produced – its effects. Spinozist philosophy holds that there are positive and negative affects, which are the effects of the intra-action. Positive affects preserve relations of motion, and negative affects decompose relations, slowing them down. In this research, I analyse various 'bodies' encountering each other and the resulting effects.

Disrupting humanist thought, the posthumanist researcher recognises that materiality and discourse are co-constituted (Lenz Taguchi, 2012) so the observation needs to be extended further than the humans being investigated. The material and social, in traditional qualitative research, are seen to be as mutually exclusive. This notion is eschewed in posthumanism, as "discourse and matter are mutually implicated in the unfolding emergence of the world" (MacLure, 2013a: 659–660). It is worthwhile to note that digital artefacts can also have materiality (Leonardi, 2010), and these particular artefacts (such as digital stories or GIS software) play a central role in the current investigation.

4.5.2. Data collection and analysis

Various types of data were collected and used in my analysis.

Digital stories

Forty six digital stories were collected from the Spatial Analysis course for the years 2012, 2013, 2014 and 2015. Appendix 6 contains a table showing detailed information about all the stories that were produced over the four years, including story titles. In Chapter Seven, I analyse the digital stories by using traditional qualitative methods of extracting useful themes or codes. These codes help towards an understanding of the subjectification of geomatics students. In addition to these codes, I conduct a post-qualitative analysis by focusing on two stories that refuse to conform to coding, and exhibit boundary crossing. Stories that are cited in the analysis are available on YouTube, and the links to these selected stories are found in Appendix 9.

Interviews and discussions

I draw on interviews that were conducted with academics, geomatics practitioners, and ex-students.

One-on-one interviews were conducted with the following people:
- Seven academics currently employed within academia, and who are actively involved with geomatics teaching and/or research. Five are currently based at universities or universities of technology within the Western Cape. Two academics are employed by the Faculty of Geo-Information Science and Earth Observation (ITC) at the University of Twente in the Netherlands;
- Two employees of government institutions that carry out geomatics-related work;

- Three previous students who has been through the storytelling intervention and who are now employed in governmental organisations.

To ensure anonymity the South African academics are identified as Academics A – E, and the Netherlands academics are T1 and T2. The geomatics practitioners are practitioners F, G and H. Lastly, the ex-students are called students J, K and L. Although labelled as students J, K and L, they were all working at the time of their interviews, so they are situated across the student/practitioner boundary.

I also utilise recorded plenary discussions between myself and students after the screenings of their stories. These were recorded in 2014 and 2015.

Additionally, students completed questionnaires in 2013, 2014 and 2015 that required them to articulate what they had learnt after the storytelling intervention. The questions are shown in Appendix 3 (digital storytelling task assessment rubrics).

When I started this research, I had intended to analyse interview data for the purposes of supplementing the cartography of geomatics education. In addition to this, the interviews and discussions with students were conducted to supplement the analysis of student digital stories. My original intention was to analyse the interview data by traditional qualitative means, by extracting meaningful themes. This changed after realising that my research would be better served by post-qualitative methods for the reasons outlined above. I started off with a specific set of questions in mind at the beginning of my research process. They were intended to obtain information on a few themes, namely: the explicit focus on accuracy at the expense of ethics; an articulation of the power relations within modern geomatics; and more generally the geomatics worldview. See Appendix 8 for a list of the questions that I initially developed. As time passed, the interviews became less structured, and took the form of emergent conversations. I was aware that as the process of the storytelling intervention unfolded, data was produced via my pedagogy, the student stories, and the conversations I had.

It is important to note the peripheral and supportive nature of the interviews – they are used to augment the cartography and build up the argument for the *potestas* contained in the geomatics learning experience, as well as the *potentia* that was harnessed by means of the storytelling intervention. Hence the interviews are not exhaustive – for example, I did not interview all of the geomatics academics in South Africa (considering it is a relatively small population), but my analysis is subjective and conveys a sense of the dominant subjectification of geomatics academics and practitioners.

In Chapters Five and Six I focus on an analysis of geomatics in general, and geomatics education in South Africa respectively. I thus draw on (but am not limited to) historical documentation, interviews and geomatics concepts from geomatics documentation. Being a methodological assemblage, there is a diffractive component of this analysis, where these datasets are read through posthumanist theory to produce new learnings.

For Chapter Seven I analyse selected student stories and their interplay with geomatics theory. Students were asked to tell stories with maps – in other words, stories were produced as a result of intra-active engagements during the intervention. Following the method of Jackson and Mazzei (2012), the data (stories and geomatics theory) is plugged into posthumanist theory.

4.6. Research ethics

This study started off as part of a larger institutional research project investigating the construction of teacher identity through digital storytelling. The next step looked at how some of the learnings from the education pilot could be transferred to other faculties, hence my involvement in the institutional project. Ethical approval was sought and was granted for this larger research project from 2010–2015 at CPUT. Ethical clearance was also sought and granted through the Senate Research Committee at UWC. Furthermore, permission was granted to conduct research on students and their digital stories in the Department of Civil Engineering and Surveying at CPUT.

Two different information sheets and consent forms were produced for student digital stories, and for interviewees. See Appendix 5 for the two sets of forms. There were particular ethical aspects considered for both sets of participants.

Securing confidentiality of students who produced digital stories was difficult, as students often chose to produce personal stories (which contained images or videos of themselves), or credited themselves in the digital stories. They were informed that they could assume fictitious identities in the stories, so as to anonymise their identities. Most students were not concerned with anonymisation and chose to produce their stories in their own names. Students were also given the option to opt out of the research without fear of being penalised. For students who gave approval for their stories to be researched, they were given three options on how their stories could be used:
- Teaching and learning, classroom and community settings,
- Educational research, trainings and conferences,
- Potential inclusion in the CPUT digital story repository on YouTube.
Most students chose all three options, but some did not wish their story to be included in the CPUT digital story repository.

Lambert (2013) outlines several core principles to consider during digital storytelling. These were adopted during and after the storytelling intervention. They include: placing the well-being of the storyteller at the centre of the project; providing the storyteller with information needed to make informed choices; be respectful of the local context of the particular project; and view ethics as an ongoing process.

For the interviewees, confidentiality was assured. They were also reminded that their participation was entirely voluntary, and they could also choose not to be involved, even after interviews were conducted.

PART 2 - POTESTAS

Part 2 is based on what Braidotti refers to as *potestas*, which is a type of power that can be seen as restrictive, hindering and controlling. This section is focused on how geomatics promotes a specific brand of subjectivity, namely the hegemonic subject of humanism. Specific attention is paid to the *potestas* that is imbued in the geomatics learning experience, and is observable in: the deep faith in representationalism, the power of cartography as a creator of worlds, the importance of accuracy, the association with the 'hard' in the hard/soft science dualism, the promotion/demotion of specific knowledges, the silence of the land and natives, and the focus on professional ethics at the expense of justice.

Chapters Five and Six subscribes to an aesthetic of motion, zooming in to the phenomenon under investigation, whilst simultaneously being embedded in it. Stories of hauntings over time trouble boundaries and supplement the analysis. Chapter Five looks at geomatics broadly. Chapter Six zooms in and investigates the geomatics education assemblage in South Africa.

CHAPTER FIVE – GEOMATICS DIFFRACTED

> Each moment is an infinite multiplicity. 'Now' is not an infinitesimal slice but an infinitely rich condensed node in a changing field diffracted across spacetime in its ongoing iterative repatterning. (Barad, 2014: 169)

5.1. Introduction

The intention of this chapter is to account for the present, with respect to geomatics practice and concepts. In the main, this chapter focuses on the aspects of geomatics and geomatics education that affect the subjectification of students and practitioners. It is the start of a diffractive and cartographic analysis, continued in Chapter Six, and contains a particular reading of power relations within my context which informs my pedagogy. The analysis of some geomatics concepts in this chapter, together with the cartography of geomatics education in South Africa (Chapter Six) shows how power relations within industry and the academy have changed over time, reinforcing and maintaining the dominant, unitary Eurocentric humanist subject. My analysis combines the critical cartographic insights of J.B. Harley with counter-mapping and storytelling, and this is read together with posthumanist theorists, to accomplish the dual aims of critique and affirmation. Patterns of difference are identified which bring to light dualisms in geomatics knowledge. These dualisms are complicit in the furthering the hegemony of Western humanism. I use affirmation and creativity to imagine ways that geomatics can be used to promote a posthumanist brand of ethics.

Through various storied examples, I show how traditional cartographic practice is focused on accuracy, fixity, ordering and representation. I single out the concept of interpolation that is ubiquitous in the geomatics base, and serves to condition students and geomatics practitioners into thinking rationally, scientifically and hierarchically. This conditioning to ordering is propagated in the workings of the academy, and extends through to modern mediated society, in a type of interpellation. The algorithmic logic of interpolation is a method of control which has an influence on the constitution of subjectivity. Thus power relations are propagated through the focus on specific technical content areas, at the expense of others. Silence, erasure and avoidance are tactics that have been (and continue to be) used in violent colonialism. This chapter pays close attention to geomatics concepts that are shouted loudly, and other concepts that are deafeningly silent. This analysis will also show that there are parallels between interpolation and traditional qualitative research. As an antidote to this linkage, I propose the adoption of a posthumanist ethics, which guides post-qualitative and non-representational methodologies.

In this chapter, I tell the story of the Khoi-Dutch contact, and use it as a 'hook' on which to hang my analysis. I focus on the Dutch-Khoi relationships, boundary creation and cartographic practice to investigate the relationship between colonialism and cartography. This approach is diffractive and cartographic, looking at various phenomena historically, yet simultaneously troubling the linear nature of time. It is both analytical and navigational, and utilises the temporal logic of *Aion*. Another aim of this chapter is to identify resonances between the 'hard' and 'soft' sciences. I also trace the dissonances – in particular, I discuss why cartography has come to be identified more with science than with art.

I link the learnings made in this chapter to the subjectification of geomatics students and practitioners in Chapter Eight. In Part Two of this thesis, I investigate the possibilities of introducing posthumanist, post-anthropocentric ethics into geomatics education, and its implications on subject formation. Ultimately, this study makes an argument for an engineering pedagogy that is attuned to social, political, economic and ecological justice. A diffractive methodology traces the entanglement of knowledge practices and historical erasures that are always/already imbued with power relations. I diffractively and cartographically analyse some fundamental geomatics concepts which serve to propagate the humanistic ideals of rationality and scientism. A deployment of relational ethics shows how the silence on other fundamental concepts helps to entrench the dualistic nature of geomatics practice.

5.2. Khoi, maps and boundaries

5.2.1. Story C: Pieter Potter and the living boundary[24]

In 1657, Pieter Potter is asked by Jan van Riebeeck to map the locations of the farms of the first free burghers. Although Potter is acknowledged to be the first Western surveyor that conducted work in South Africa, he actually had no technical training other than as an artist.

At the time, this artist/scientist boundary crossing was not unnatural, as it was prior to what would be called the 'cartographic reformation' by some historians of cartography, a period of approximately 100 years (between 1670 and 1770), when cartography progressed from being recognised as an art to a science (Edney, 2011). It is only over the last fifty years or so that a re-convergence between art and mapping has been seen – this destabilisation of the 'new' practice of cartography-as-science and the re-insertion of the 'old' art back into cartography is analysed genealogically later in this chapter.

The land was allocated along the banks of the Liesbeeck River, so as to provide a water source. This part of the Cape Peninsula was visited by some of the Khoi tribes, as part of their annual migratory routes.

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[24] This is a shorter version of the story I tell in class. The story is shown in italics.
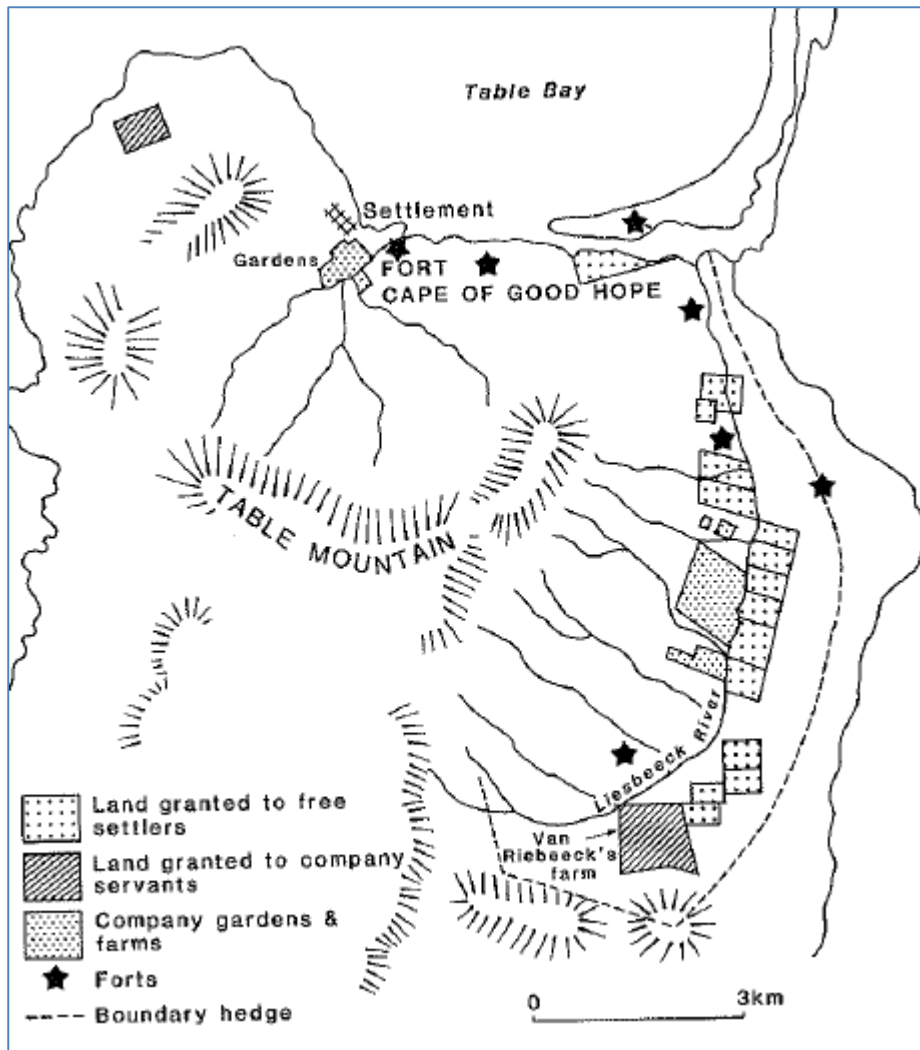
Figure 3. Locations of the first free burgher farms at the Cape (Source: Christopher, 1994: 14)

Maps of the early demography of Southern Africa at the time of the arrival of Europeans (mid-1600s) show the presence of the Khoi in different ways. The vast majority of the maps simply ignore their presence. Figure 3 is illustrative of this, which is a map that focuses on the land ownership of the Dutch. Containing no information about any indigenous people at all, such maps effectively erased their presence and normalised the idea of the land being empty and unconquered - *terra nullius*.

Other maps show their dwellings in fixed positions, such as the "Village de Hottentots" shown at the bottom right of an early map of Table Bay (Figure 4).

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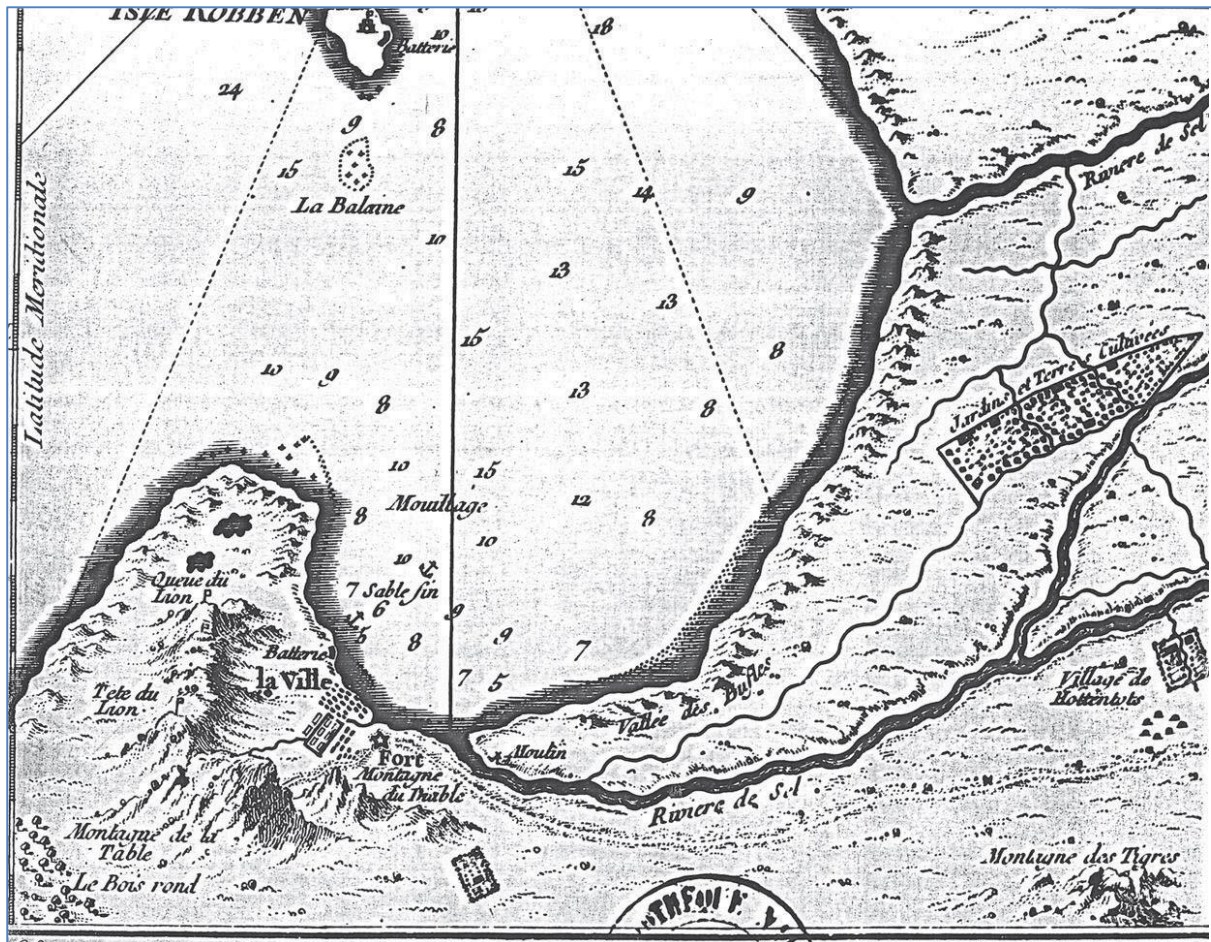
Figure 4. Carte de la baye de la Table (Map of Table Bay) (Source: Glatigny, Estelle & Viljoen, 2008)

Yet another type of map accounted for their temporary status in one way or another.
Figure 5, a more recent map, shows the transitional nature of the Khoi by acknowledging
their presence over large areas. This could be due to the scale of the map (it represented a
large part of the country) so generalisation was required. It shows relatively homogeneous
groupings of indigenous people, located over larger geographical areas. The nomadic lifestyle
of the Khoi was foreign to Western surveyors and cartographers, and consequently they
would have struggled to find ways of representing their transitional nature.
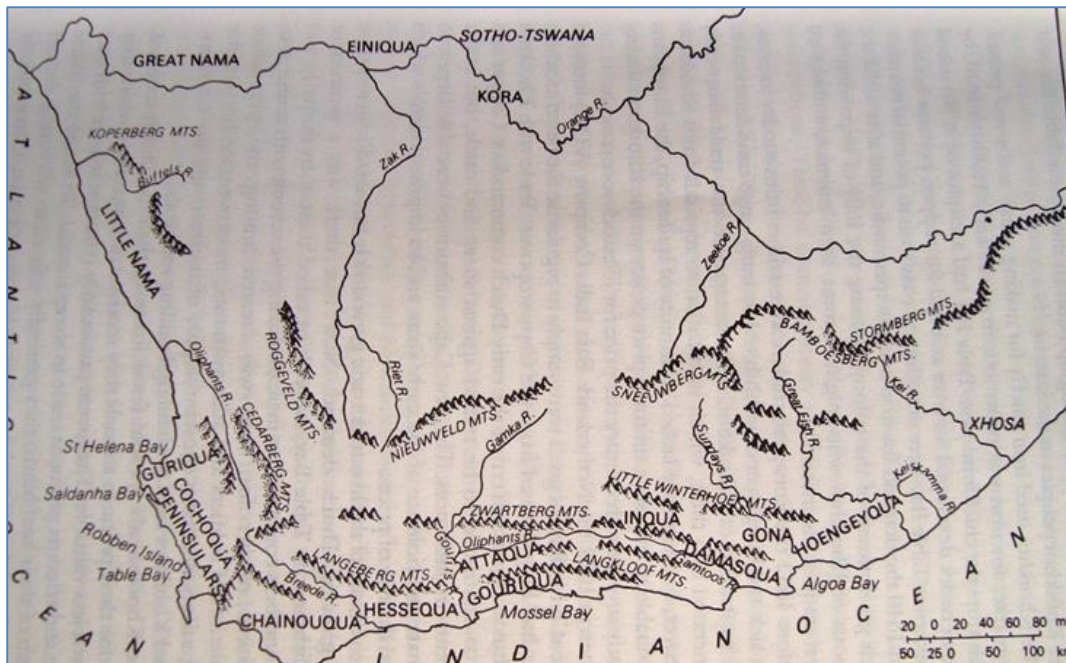
Figure 5. Approximate locations of Khoikhoi before contact with Europeans (Source: Elphick, 1977)

Figures 4 and 5 are single static maps and hence limit the effectiveness of conveying spatio-temporal information, such as dynamic positions of Khoi tribes. The movement and interconnections of the Khoi cannot be inferred from a static map, even one that intended to show their transitive nature (Figure 5). Static maps or animated mapping (or indeed any other kind of mapping) have limitations to what they can represent (Dawood & Motala, 2015). The map in Figure 5 was ostensibly intended to communicate spatial information on a specific theme, in this case the approximate locations of the Khoi tribes. While doing this, the mapping also participates in the creation of sociomaterial reality, which in this case was the creation of colonial South Africa. This link between the map as representation and the conception, articulation and structuring of the human world according to hegemonic social relations was one of J.B. Harley's major insights (Harley, 1989, 1990, 2009).

The first Westerners who came into contact with the Khoi were astonished by their relationship with the land, more specifically, that it was not "linked to property but rather to land use, and consequently the notion of boundaries would evolve according to the seasons of the year" (Glatigny, Estelle & Viljoen, 2008: 301). These fluid boundaries, communal living spaces, non-hierarchical inter-tribal relationships and nomadic wanderings were seen as savage and backward. A shift in this attitude is seen in posthumanism, which promotes these traits.

The relationship between the Dutch and the Khoi was complex. On the one hand, the Dutch studied and reached out to the Khoi in the early years (primarily for assistance in acquiring cattle and information for survival); on the other hand, they viewed the Khoi as a hindrance to their setting up of the Cape settlement. Pieter Potter and other early surveyors looked at the foreign land through the eyes of a society that was heavily influenced by Roman literature. The Roman-Dutch law to which they subscribed required the land to be surveyed and documented so as to allow ownership of land parcels. This saw the introduction of the

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cadastral boundary, the powerful inscriber of marks on the land[25]. This would change the landscape of the Cape (and subsequently the rest of the colony) forever.

Guided by the Christian morals of the time, Van Riebeeck felt some responsibility to improve the lives of the Khoi, to 'civilise' them and introduce them to the Christian way of life. This would be done effectively by conditioning Khoi children. Krotoa, about ten years old, was taken into the Van Riebeeck household. She was renamed Eva, learnt how to speak Dutch and adopted Christianity. She maintained contact with her Khoi people and was very useful to Van Riebeeck, who soon used her as an interpreter and negotiator. She helped Van Riebeeck to develop a good relationship with the powerful Cochoqua tribe, who were able to provide cattle to the Dutch. Over time, Krotoa found herself in a difficult position. She was not fully accepted in Dutch society, and her own people distrusted her because she was seen to be a traitor when the Dutch-Khoi relations soured.

Following Plumwood (1993), various dualisms can be observed in the story and in the cartographic depictions of the Khoi. For example, civilised/uncivilised, Black/White and nature/culture are dualisms which are maintained by the dualistic characteristics of backgrounding (or denial), radical exclusion (hyperseparation), instrumentalism (objectification) and homogenisation (stereotyping). The Dutch masters depended on the land and the Khoi for their survival, yet focused attention away from the dependency through their mapping (backgrounding). The early settlers were particularly vulnerable and dependent on the Khoi for their supply of cattle. The Khoi were seen as a means to an end (instrumentalism) - their value was denied and subsumed under that of the colonisers. The Dutch went to great lengths to forge cordial relationships with the Khoi to secure their supply of cattle, such as the 'taming' of the 'savage' Krotoa. Their Christian morality also justified the objectification and homogenisation of the Khoi.

Although the representation of the locations of the Khoi on old colonial maps was varied, and the Khoi were acknowledged a degree of 'presence' on these maps, there is no doubt that the mapping assisted in the dispossession, removal or extermination of the indigenous people. The dominated Khoi are stereotyped in their depiction, and all internal differences (such as the difference between clans) are ignored – this is homogenisation. For example, the "Village de Hottentots" (in Figure 4) is iconic in that all Khoi settlements were depicted as a simplified circular village, ignoring any local variances. The nomadic Khoi's relationship to the land was viewed as primitive to the Dutch, and the discourse of the Dutch (including the mapping) normalised the hierarchy of human worth. By the logic of the Dutch, land ownership was superior to the agrarian and nomadic Khoi relationships. Most of the early maps, such as Pieter Potter's (similar to Figure 3) focus attention on the ownership of land by Whites, and omit the Khoi. This exhibits the dualistic mechanism of radical exclusion, in which the differences between cultures were magnified to create maximum separation, and naturalised the Dutch domination of the Khoi. This over time culminated in the horrendous extermination of much of the Khoi and San population. Years later, Khoi and San were treated as sub-human by the European settlers, who were granted licences to kill the indigenous people who trespassed on their land. Associated with animals, Black bodies were given less worth than the land on which they were subjugated and killed.

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[25] Cadastral surveying involves the surveying of property boundaries for the purpose of security of land ownership. The cadastre is a public register of property parcels in a country.

The colonial maps were made for specific audiences in mind. These audiences would have often been European, curious to see the interesting new worlds that were being 'discovered'. They also were done during a period of intense competition between European nations to find trade routes and goods (including human and animal goods). Thus, there were other agendas controlling the actions of the surveyors and cartographers of the time. One can therefore see that a real interest in learning about the social realities of the Khoi and other indigenous people was highly unlikely to have emanated from cartographers or surveyors.

Prior to Pieter Potter's surveying, the land of the Cape was considered to be the commonwealth of all the Khoi, regardless of tribal membership. The tribes that would have been most directly affected by this act were the Cochoqua, and the Goringhaicona (led by Autshumato).

Pieter Potter, through his use of surveying, marked the land and changed the way it would be seen and used. It would also lead to indelible changes in the fauna, flora and topography. The mapping played a part in the successful normalisation of colonisation. Every cartographic act was a performance intended to comply with, and propagate, specific social orders. These were Cartesian cuts that were enacted by surveyors or cartographers, separating objects of inquiry from subjects of empire. The ethics of the actions of surveyors are often dictated to them by the imperatives of their masters. For Pieter Potter, it was the VOC and Jan Van Riebeeck. For modern surveyors, it is the companies they work for, the allied professions who employ their services or others who have the economic power to influence land development. Modern-day surveyors are complicit in upholding and reimagining dominant discourses. In large projects, surveyors work as part of large multi-disciplinary teams, as they might have during colonial times. Due to specialisation and a 'chain of command' of sorts, surveyors are made to feel that they do not have significant influence in ethical decision-making. This distance between geomatics practitioners and ethics (as prescribed to them by the geomatics education assemblage) has an influence on their subjectification[26].

The settlement thus led to conflict, and Van Riebeeck decided to erect a line of defenses, comprising forts, a strong wooden fence, and a line of wild almond trees comprising a boundary hedge. These were intended to keep out the Khoi, and thereafter transformed their nomadic wanderings. This boundary still can be observed physically – part of the hedge is still alive in the Kirstenbosch Botanical Gardens. Figuratively, one can say that the whole hedge is still alive if one zooms out and looks at the map of the demography of Cape Town.

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[26] See Chapter Eight for more on specialisation and subjectification
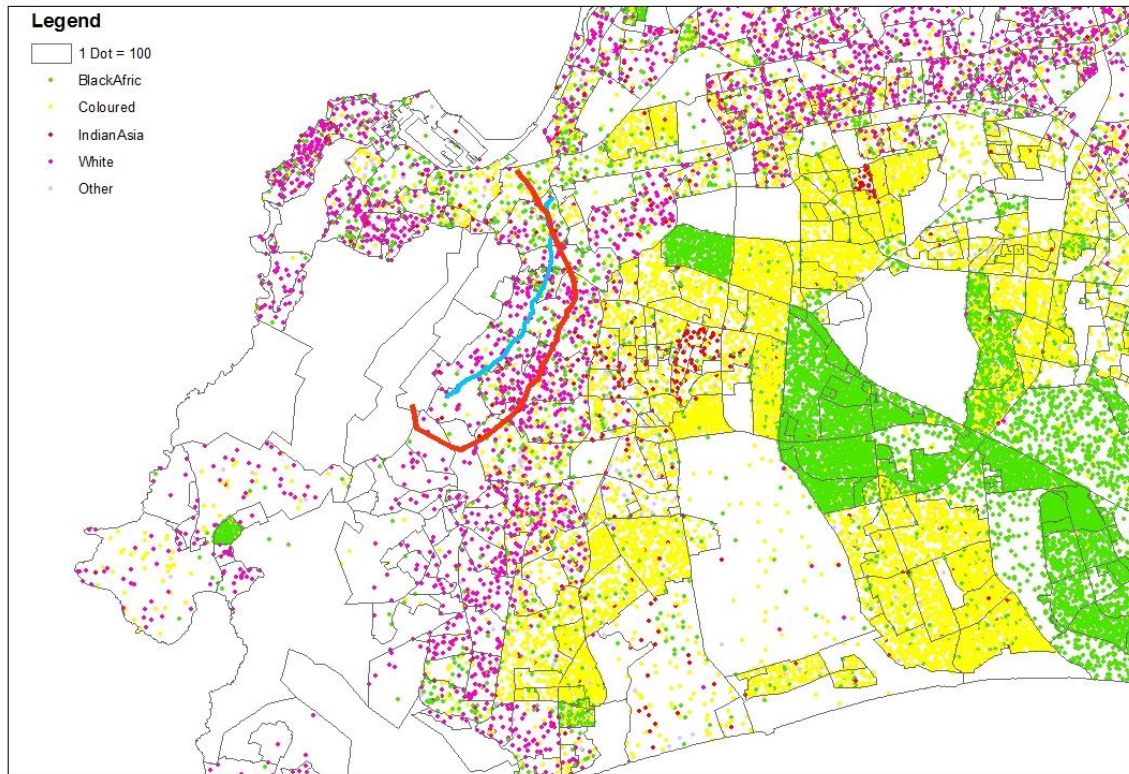
Figure 6. Location of Van Riebeeck's boundary overlaid on dot density map

This is a dot density map, showing the population by race groups. One purple dot = 100 White people, one yellow dot = 100 Coloured people, one green dot = 100 Black people and one red dot = 100 Indian people. The Liesbeeck River is shown as a light blue line, and the boundary hedge is shown as a red line. One can see that the location of the original hedge is close to the apartheid boundary between White and Coloured areas, which is largely still in place in post-apartheid Cape Town.

The location of Van Riebeeck's hedge haunts the descendants of the first conflict. The boundary between settler and native, White and Black gets iteratively materialised. While public discourse shows a conscious effort at post-apartheid land reform, most of the race-based spatial boundaries still exist and are propagated in South African cities and towns. Land reform initiatives are failing (Hull & Whittal, 2017), and the reasons are multiple. These include a lack of political will by the ANC-led government, seemingly contradictory viewpoints enshrined in the Constitution[27], the downplaying of the historicity of the current situation, the cumbersome legal processes that need to be followed and, more generally, the neoliberal economic environment in which capitalism thrives (Ntsebeza, 2011).

Another tactic of colonisation is control and repression through surveillance of colonised peoples (Foucault, 1980).

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[27] For example, the provisions of section 25 on the one hand "protects existing property rights, while at the same time making a commitment to redistributing land to the dispossessed majority" (Ntsebeza, 2011: 304).

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I plotted the locations of Van Riebeeck's forts, then I created viewsheds[28] for each fort. If I combine all the viewsheds together, we can see the total area that the Dutch had under surveillance:
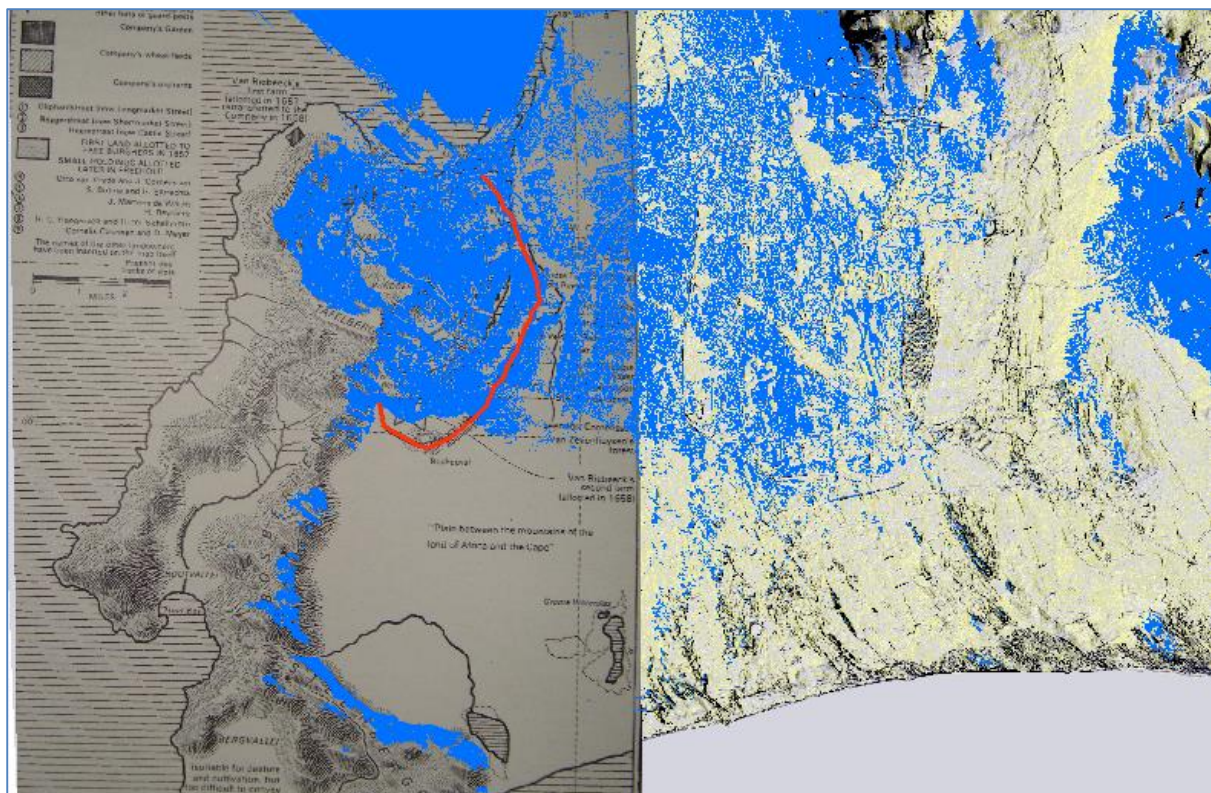
Figure 7. Viewshed map showing visible land from Van Riebeeck's forts

The seven Dutch forts are shown as black stars in Figure 3. Individual viewsheds were calculated for each of the seven forts and then combined to produce the combined viewshed map in Figure 7. The location of the boundary hedge is shown in red, and one can see that the vast majority of the Dutch settlement (which fell between the boundary hedge and Table Mountain) was fully visible from the forts. The forts thus formed a panoptic chain, covering what would later become Cape Town.

When Pieter Potter introduced the Western practice of surveying in Southern Africa, he started a process that was supported by very powerful agencies. The insertion of the Western, rational Man onto African soil (first through religious proselytising) took place over a period of time and was reinforced by many intersecting, complex vectors of activity. This process continues today. The colonial Dutch (and later British) authorities introduced an array of practices (such as land appropriation and ownership, centralised authority, the hierarchies of Christianity, technology, scientific education and currency) which elevated the humanist subject, creating a hierarchical scale of pejorative differences. In addition to this, the practices of surveillance and control would entrench hegemony.

Barad points out that the past-present-future timeline is not linear or fixed, and that each re-turn of a phenomenon (for example the racialisation of space) is implicated in the conditions

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[28] Viewshed analysis (or intervisibility analsysis) uses elevation information to indicate areas on the map that can and cannot be viewed from a specific vantage point. It can answer the question: what points on the surface be seen from point A? In this specific case, multiple viewsheds were calculated and combined.

of possibility of its other appearances. In this case, the violence of the cut (the original colonial and apartheid racialisation of the land) is re-iterated in the violent realities faced by poor people of colour due in part to the failure of government to undo apartheid town planning. This analysis, being diffractive, shows that the hauntings in my stories (for example, the hedge haunting) are not mere recollections of the past, but are part of existing material conditions. The hauntological continuity between colonisation/apartheid/present-day urban South Africa is revealed through a reading of power, and illustrated in the stories.

Helen Zille, the Premier of the Western Cape and the previous leader of the opposition Democratic Alliance party, has recently (in 2018) been heavily criticised for her repeated comments suggesting that colonialism brought benefits to South Africa. Zille's comments exhibited hyperseparation and homogenisation (which maintained the civilised/uncivilised dualism), and failed to recognise the connected, rhizomatic nature of indigenous society[29] by claiming that only the colonisers brought progress. Re-turning the stories of indigenous people does not imply that there should be a re-production of some romanticised time[30] before colonisation or apartheid, but rather a responsiveness to the entangled and complicated nature of the world. Haraway (2016) advises that rather than focusing on restoration, we could focus more modestly on getting on together and partial recuperation.

The tactics of radical exclusion, incorporation, instrumentalism and homogenisation are observable in my Pieter Potter story. Radical exclusion can be observed because the colonial authorities magnified the differences between the settlers and natives, so as to create maximum separation (hyperseparation). The qualities of the natives that were seen to be inferior were their religious or cultural practices. For example, the Dutch observed the Khoi rituals with disdain, and often described their clothing or huts as 'primitive'. This is linked to the tactic of incorporation, where the native population was described in relation to the settler population. The Dutch (and later the British) focused on the aspects of their culture that was not present in that of the natives, like the absence of highly technological weaponry, schools, or a transcendent monotheistic god. Furthermore, through instrumentalism, the native population and the natural environment were objectified. The colonial masters viewed themselves as unrelated to the natives, and viewed the environment/animals/land (and Khoi) as resources to be exploited. This is related to the tactic of homogenisation, in which the dominated class must appear homogeneous. This was indeed the case, where all indigenous people were treated as not-White, hence of less value. This was despite the rich diversity of cultural practices and knowledge among the different tribal groups of the country.

5.2.2. The silence of the land

The therianthropic figures seen in Khoi and San art are ancient precursors to the boundary crossing, nomadism and cyborg hybridisation that posthumanism contains. Within the shamanic trance dance, species met, coalesced and formed a figuration that informed and produced the lives of the people, other species and the material of the time. Through the rock

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[29] For example, the Khoi engaged in extensive trade with other people of Southern Africa. By the time of the arrival of the first Europeans, there was a well-established trade network in the region in the form of small inter-tribal links, from the Cape all the way through to central Africa (Schoeman, 2009).

[30] The ancient nomadic Khoi and San people, whose imagery is etched into the rocks of Southern Africa, are good exemplars of such romanticisation. Fetishised since colonial times, most notably in London and Paris in the early 1800s with the parading of the "Venus Hottentot" Saartjie Baartman (Ruiz, 2012), the sentimentality towards the Khoi and San still exists in South African society.

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art, oral tradition and information from multiple sources, the ancients converse with us through an "assemblage of multiple historical, present and future encounters"(Kuntz & Presnall, 2012: 736). Khoi and San rock art was an onto-epistemic practice that Westerners who first saw it did not understand and appreciate. Totemic, traditional and documentary knowledge was combined in ways that represented a very different way of being in the world. In addition to this, the rock upon which the art was produced was not treated as a canvas would by Western artists (that is a passive medium upon which the art is put). Rather, it was a living surface, a part of nature that the artists considered themselves a part of. Ironically, the heretical Dutch Spinoza was writing about and promoting a similar monistic relational ontology during the time that the Khoi were starting to be subjugated by the Dutch. The late 17th century saw the relations between the Khoi and the land being adversely affected, largely because of land appropriation by the colonists.

The encounter between the Dutch and the Khoi was emblematic of further similar encounters regarding land in years to come. For example, the case of Zululand at the beginning of the twentieth century shows how the Zulus were subjugated and systematically stripped of their land. This was despite initial public gestures by the British of feigned concern for the indigenous Zulus (Davenport, 2004). This was usually followed by periods of accelerated land-grabbing by settlers, who cared little for the land use methods employed by the indigenous people before them. In Zululand, good quality land for sugar farming and grazing was the incentive for Zulu displacement. The Zulus, like the Khoi, showed sensitivity and care for the land by practicing seasonal transhumance. This allowed for periods of use and re-generation of the land.

The land legislation that perhaps had the most dramatic and far-reaching effect on the relationship between people and land was the 1913 Natives Land Act. This act created 'native reserves' or 'homelands' and effectively prohibited Black South Africans from buying or hiring land in 93% of the area of the country. In addition to this, Black people living in areas outside the homelands were removed to them. The number of people who were displaced between 1960 and 1983 alone was estimated to be over 1.7 million. The aim of resettlement was twofold: to 'whiten' the rural areas of South Africa, and, conversely, to 'blacken' the designated Black national states or homelands (Christopher, 1994). With regards to the Natives Land Act, the native voice was not entirely silenced. Sol Plaatje, one of the founders of the South African Native National Congress (which became the ANC), gave a detailed account of the effect of the absurd Act on native life (Plaatje, 1914). His impassioned plea to the colonial authority for respect fell on deaf ears, and the Act was in fact the forerunner to a slew of cruel and racist land legislation.

By 1994, the homelands constituted 13 percent of the total land area of South Africa, and housed approximately 50 percent of the Black population. Homelands were overcrowded and unemployment was rife. The soil quality in homelands was often poor and hence they were not able to support agricultural activity. Indigenous people who lived harmoniously with the land were deprived of these relations. Ancient practices stopped. In the overcrowded landscapes of the homelands, environmental and human health were adversely affected.

5.2.3. Thoughts on my Khoi story

In section 5.2, I have used the story of the Dutch-Khoi contact to introduce and trace some entangled histories that are pertinent to my argument. Following the situated storytelling

encouraged by Haraway (2016) I have found the story to be a useful aid to foreground various entanglements such as colonialism, Cartesian logic, conquest, surveying, mapping, place, capitalism, land use and cooperation. My storytelling as a Baradian apparatus grants agency to a host of material/discursive phenomena which are relationally entangled across space and time. Both Barad (2007) and Haraway (2008, 2016) insist on the importance of details and differences. In telling this story in class, I am able to trace patterns of difference that help to trouble dualisms such as settler/native, past/present and Black/White. During these storytelling sessions, I work towards the modest aim of activating or growing of a critical attunement (in relation to various phenomena, such as the racialisation of space) in my students.

In the following sections, I aim to trace specific threads relating to geomatics, so as to make clear their value in a posthumanist analysis. What follows is a cartographic, diffractive reading of the development of cartography. In particular, I focus on J.B. Harley's insights and read them through posthumanist theory; I also conduct a cartographic analysis on the development of cartography-as-science; I then 'zoom in' and analyse some specific aspects of geomatics theory which are emblematic of the underlying ethos of the geomatics knowledge base.

5.3. A cartography of cartography

As a means by which humans make sense of the world, mapping has been present in almost all societies. Harley has noted that the human impulse to create maps is ancient and "there have been relatively few mapless societies in the world at large" (Harley, 1987: 1). The cartographic knowledge being transmitted in South African geomatics curricula have followed and pay homage to the Western cartographic tradition. The standard cartographic texts that are used in curricula make it seem as though "the history of cartography was largely a Western achievement and part of the history of European science" (Harley & Woodward, 1992: xix). There are two important points to note about the quote above.

Firstly, the normativity of European knowledge is promoted through mainstream texts that are used in the education of geomatics practitioners and uncritically transmitted by academics. This is further entrenched by comments such as those by Helen Zille on colonialism (see Section 5.2.1). Of course, this hegemonic order owes much to other, non-Western societies for their development of cartographic knowledge. For example, the Arabic origins of the word 'alidade' hint at its Islamic development. The alidade is a sighting device used for measuring angles and is at the heart of modern surveying equipment. Modern texts describe the first uses of the alidade in Europe or the U.S.A. in the 1800s – it is these types of descriptions that promote the perception of the exclusively Western origins of such instrumentation. In fact, there is a rich history of cross-cultural exchange between Islamic and Christian cartography that helped in the development of both (Brentjes, 2009). This is an example of backgrounding that further entrenches the civilised/uncivilised dualism. The nature of hegemony is that the knowledge gets appropriated and assimilated into the canon of the oppressor (Plumwood, 1993; Taylor & Pacini-Ketchabaw, 2015). Secondly, the incorporation of cartography into science (as opposed to art, the humanities or any other branch of knowledge) is also taken for granted as normative. As will be seen later in this section, cartography-as-science followed a set of contingencies which caused the excision of art from the definition of cartography.

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5.3.1. Maps as representations

The essence of cartography was sought by Western academics in the 1960s and 1970s, and they focused on "the flow of data from the world through the map to the user" (Edney, 2011: 308) as if the underlying world is an unambiguous, single, discrete entity. This is the underlying premise of surveying - there is a stable ground 'out there' that can be measured.

Mapping practices, as representations, vary enormously around the world and over time, and are largely dependent on each society's world view. It is worthwhile to note that there is a difference between *mapping* and *map-making:*

> The physical creation of maps which embody the 'world-view' of such societies is the process of *map-making*. This can be distinguished from the mental interpretation of the world which is termed *mapping* (Dorling & Fairbairn, 1997: 3, italics in original).

This can be read with Braidotti and Thrift. Braidotti's cartography is more like mapping and less like map-making, with the added philosophical complexity of subjectivity analysis. Thrift (2008) reminds us that non-representational theory is about performance, practice and movement, as opposed to representation.

A diffractive reading helps us to understand how the practice of surveying/mapping gets co-constituted with the creation of the world (see Section 5.3.2 below). What gets mapped, therefore what gets surveyed, is dependent on specific (mainly scientific) factors. The choice of the surveying instrument and the mapping software is perhaps the most obvious choice of apparatus, but there are other decisions to be made. Accuracy, as we shall see later, is the biggest contributing factor in the choice of equipment and method. The needs of the client, the powerful agent on whose behalf the surveyor acts, is paramount as remuneration depends on it. The map reader, who is often an agent of the state (or their proxy) is also of crucial importance as the acceptance or rejection of the final representation (map) is at stake. There is a Cartesian cut being enacted in the traditional practice of surveying – the surveyor-as-subject surveys the land-as-object and then represents it on a map through the act of mapping. Moving from a humanist mindset of the Cartesian cut, to a posthumanist agential cut, is difficult. It requires a disidentification from White, Western, humanist, rationalist, Eurocentric and anthropocentric hierarchies, all of which are strongly enforced in the geomatics knowledge base.

Western culture has a deeply entrenched faith in representationalism. Barad points out that

> the asymmetrical faith we place in our access to representations over things is a historically and culturally contingent belief that is part of Western philosophy's legacy and not a logical necessity; that is, it is simply a Cartesian habit of mind. It takes a healthy scepticism toward Cartesian doubt to be able to see an alternative. (Barad, 2007: 49)

Barad's agential realism argues that the primary ontological units are not independent objects (which have boundaries and associated properties), but phenomena. These phenomena are "ontologically primitive relations" (Barad, 2007: 139) and it is through intra-actions that the boundaries of these phenomena become discernible. This understanding acknowledges that surveyors do not stand at a distance and represent something 'out there'; rather, surveyors are part of the materiality of the world that is being surveyed. The world has agency too, and

<div align="center">90</div>

ethics is central to this view. So Pieter Potter's mapping practice was an important component in the creation of various phenomena such as the Cape colony, the lived reality of the Khoi, and the material reality of present-day Cape Town. As Barad (2007: 91) points out "practices of knowing are specific material engagements that participate in (re)configuring the world". Promoting a relational ontology, she emphasises that not only humans are involved in practices of intelligibility, and matter also participates in the world's becoming.

There is a need in geomatics education to critically interrogate the ethics that exists on multiple levels. What we choose to represent, and what technical choices we make about how to represent those things, are ethical decisions. We shall later see how accuracy has become conflated with ethics in geomatics practice, but a posthumanist ethics (or nomadic ethics as elaborated by Braidotti) requires a far greater appreciation of complexity.

5.3.2. J.B. Harley and critical cartography

> As a discourse created and received by human agents, maps represent the world through a veil of ideology, are fraught with internal tensions, provide classic examples of power-knowledge, and are always caught up in wider political contexts. Such an interpretation challenges the now time-warped claim of cartography to be a modern science, a symbol system complete with 'foundationalist' or 'essentialist' qualities of 'objectivity,' 'truth,' and 'reality' (Harley, 1990: 1–2).

In this research, I advocate possibly the most well-known poststructuralist cartographic theorists, J.B. Harley's view that what is shown on the map is not a representation of a pre-existing world, but it helps to *construct* the world. Harley, being one of the founders of critical cartography[31], used Foucault's and Derrida's insights in the development of his seminal article *Deconstructing the Map*.

Critical cartography, like other critical practices, calls into question the claim by cartographers that cartography is a science (Crampton, 2010). Critical cartography examines the relationship between knowledge and power, and in particular, how cartographers (often unwittingly) reinforce hegemonies by propagating powerful knowledge. Harley advocates "an epistemological shift in the way we interpret the nature of cartography" (Harley, 1989: 1). His insights show us that knowledge creation within mapping is far from objective. The fact that mapping is based on the scientific method makes map users believe that maps are value-free. Posthumanist thought takes this a step further and shows how, when we internalise this supposed objectivity, the subjectivity that follows further entrenches humanism. There is an ontological insertion into geomatics of the Western subject via the rational scientific method. Harley points out that the current climate of thought in cartography has not caught up with complexities of modernity (which require, for example, an appreciation of ethics in cartography) and cartographers are prisoners of their own past. This is because of the over-reliance on 'scientific' or 'objective' knowledge, and cartographers' unwillingness to attempt an epistemological shift in their interpretation of the nature of cartography. Read with Braidotti (2013a), a troubling of the deference to the authority of the past is needed. Harley claims that cartographers' understanding of maps is not subtle enough for the realities of this increasingly complex world. I agree with this premise, and this thesis

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[31] Although critical cartography is widely acknowledged to have started in the 1980s by Harley, Pickles, Wood and others, Crampton (2010) argues that mapping as a practice has been contested throughout its history.

attempts to show that a posthumanist injection of *potentia* can benefit the inculcation of a different sensibility in geomatics students.

For Harley, provoking self-criticism was the point of intellectual work in cartography. Other than shift the sensibilities and practices of cartographers, such intellectual labour could

> contribute not only to a new richness in historical studies but also toward an enhanced social awareness that mapping must surely be "for people rather than for Man" (Harley, 1990: 2).

Reading this quote with Braidotti, one can appreciate his anti-humanist stand, but one can also identify a deep anthropocentrism, as he cannot conceive of the value of mapping outside of humanity. Posthumanism, and Braidotti's insights in particular, can help to trouble his anthropocentric thought further. In order to accomplish this, a geo-centred sensibility is required. This sensibility envisages subjectivity at a global level, but also sees technology as an unbounded phenomenon and being as intimate to us as the nature we are part of. This is a difficult task, as it requires a decentring of the human subject. Braidotti's strategy of zoe-centred egalitarianism flattens the species hierarchy and takes seriously the health of the land. This anti-anthropocentric view "potentially pitches the competitive needs of animals and plants against those of both privileged and underprivileged humans" (Braidotti, 2011a: 352). Geomatics practitioners thus need to ask: how can we relate differently to the land that we (and our technologies) are surveying with such accuracy? Is there a way to trouble our deeply-ingrained humanism and anthropocentrism to listen to the land? With regards to the former (our humanism), Harley's anti-authoritarian insights can help. With regards to the latter, our ethics need a re-think in order to achieve this.

Working towards a posthumanist sensibility is a modest and epic task at the same time. One opens oneself to new and responsive ways of conceiving and participating in the becoming of the world. Nomadic ethics are not teleologically ordained and ascribe to local knowledges over grand totalising schemes. Professional ethics in geomatics, on the other hand, subscribes to the logic of capitalism and is associated with accuracy, reliability and professional behaviour. Harley identified the importance of a responsive ethics for cartography, and called for the discourse about maps should be made

> more responsive to social issues such as those relating to the environment, poverty, or to the ways in which the rights and cultures of minorities are represented on maps (Harley, 1990: 2).

Like many feminist philosophers (Plumwood, 1993; Braidotti, 2002; Barad, 2007), Harley alerts his readers to the dangerous reductive logic of binary opposition. He was aware of the risk of conflating his work with traditional cartographic criticism and reducing his insights to a set of dualisms:

> We thus move the reading of maps away from the canons of traditional cartographical criticism with its string of binary oppositions between maps that are "true and false," "accurate and inaccurate," "objective and subjective," "literal and symbolic," or that are based on "scientific integrity" as opposed to "ideological distortion" (Harley, 2009: 129).

Harley points out that

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the surveyor, whether consciously or otherwise, replicates not just the "environment" in some abstract sense but equally the territorial imperatives of a particular political system (Harley, 2009: 130).

My story of the Khoi links Pieter Potter's map to the colonial project. In early colonial maps of the Cape Colony, the locations of the indigenous Khoi communities were shown in very different ways, but in the majority of the cases, their presence was simply ignored (Glatigny, Estelle & Viljoen, 2008). The Roman-Dutch legal framework conditioned subjects into a belief that land ownership was the correct (and perhaps only) relationship between humans and the land. To the map reader, the Cape would have looked like a *terra nullius*, and following biblical guidance, a place whose natural resources were to be exploited.

Reading Harley with Braidotti, one sees that the state apparatus promotes a specific view of the world, and this powerful view helps to construct the world at the same time. Both Braidotti and Harley reference Foucault whose work on discourse (Foucault, 1977) helps us to see that State maps are endowed with political currency. This allows maps to give ideology an amount of scientific legitimacy. In addition to this, the panoptic mechanisms of surveillance of the colonial and apartheid states have morphed into more decentralised methods under the effects of advanced capitalism. There is a genealogical connection between war, colonisation, cartography and control. Garuba sums it up succinctly:

> The surveillance and control of land, body and subject was the object of colonial geographies and, in securing this objective, the map as text, as model, as document and as claim was central to its project (Garuba, 2002: 87).

A small representative example of the colonial discourse propagated through maps can be seen in the topographical maps produced by NGI (the South African national mapping agency).
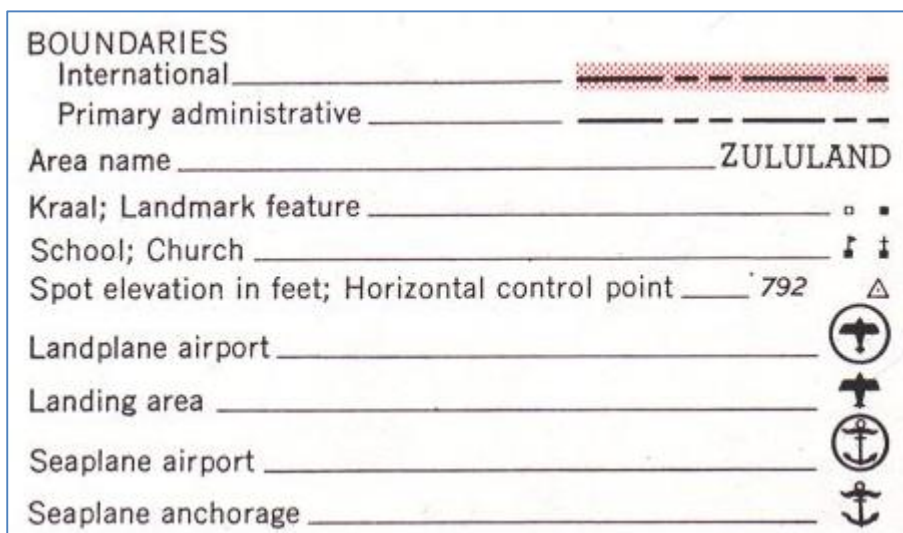
Figure 8. Detail of topographic map of Durban, 1955

In the 1: 250 000 topographical map of Durban from the 1950s (Figure 8), the symbol used to represent churches is a cross symbol. There is no acknowledgment of non-Christian places of worship, even though these did exist in apartheid South Africa. This was a backgrounding of

non-Christians, relegating them to the status of non-human, and promoting the civilised/heathen dualism. This practice continues to be perpetuated. Although the legend item in the modern topographic map has now changed to "places of worship", they are represented by a "K" symbol, an abbreviation for "Kerk" which is the Afrikaans word for church. Although a more subtle reference to Christianity, it still entrenches colonial, hegemonic power relations (including the legitimisation and promotion of Afrikaans).

In quantum physics, in the two-slit experiment, the essence of light (particle or wave) was arrived at by observing what was on the screen (Barad, 2007). Similarly, what is on a map tells us more about the cartographer's conception of reality and the dominant discourses of the time. This is the map as a Baradian apparatus – it is material-discursive and part of a phenomenon. My analysis is diffractive, and shows how maps help in the process of subjugation and subjectification. Cartographers are more often than not passive about issues relating to social justice and ethics. A look at cartographic journals around the world shows practitioners to be largely pursuing excellence or innovation in technical areas (such as accuracy enhancement). Surveyors and cartographers often believe that they are 'observers' – even the term 'surveyor' helps to propagate this belief – and others (like politicians) decide on the cartographic agenda. The 'model Apartheid city' (see Figure 9) was conceived by apartheid-era politicians with the assistance of town planners and surveyors. Surveyors helped to formalise the boundaries that have become so difficult, even in post-apartheid South Africa, to break down.

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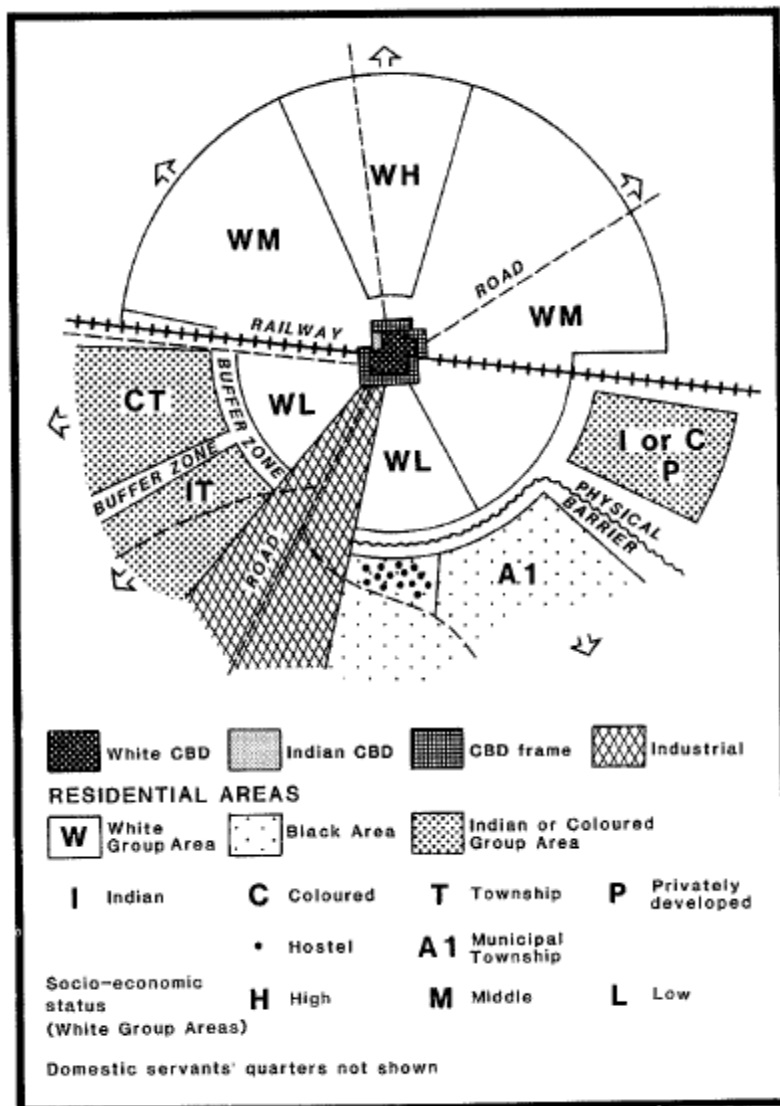
Figure 9. The model Apartheid city (Source: Christopher, 1994: 107)

Figure 9 is a tragic example of how the map, as a socially constructed image, went on to destroy the lives of many. It was used as the reference for the ideal spatial arrangement of the apartheid city. Note how the primary factor that determined location was race. White group areas were separated from all other group areas by means of barriers such as railway lines or industrial areas. The map served as the blueprint for cities and towns in South Africa, and was effectively and violently implemented (for example in District Six in Cape Town). Note in Figure 9 that there was maximum separation between Whites of 'High' socio-economic status and Blacks – the entanglement of race and economic status was formalised, and poorer Whites were placed closer to Blacks, Indians and Coloureds. Note too how the High socio-economic White group is placed at the top of the map, with the Black population placed at the bottom. This further entrenches hierarchisation and Black/White dualism formation, but by visual means. We can analyse this map using Plumwood's characteristics of dualism. Backgrounding was used to deny the reliance of the White population on Black labour. The map tellingly states that "Domestic servants' quarters not shown". These 'domestic servants' would be allowed to stay in White group areas to cater for the needs of Whites. This also exhibits the characteristic of incorporation, where Black 'servants' in particular, and Blacks in general, were defined in relation to White needs. The spatial arrangement of the 'lower'

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groups in relation to the White groups is an example of instrumentalism, where the lower groups are incorporated into the fabric of the apartheid city as objects of production. Lastly, all lower groups are homogenised into their group areas, disregarding any internal differences. Conversely, the White group areas are divided into socio-economic zones, with upper, middle and lower income Whites each recognised as discrete groupings.

Harley notes that maps can speak volumes by their silence. Like feminist philosophers (see for example Plumwood, 1993; Spivak, 1996; Braidotti, 2006; Barad, 2017), he points out that silencing is an important aspect to note, so as to learn about the inappropriate/d other. Urban maps, for example, are not at the human scale and do not contain information about the quality of human life – the differential between the quality of White life and the life of others in South Africa is stark. Harley's point was about the qualitative shortcoming of maps to describe the human experience. Furthermore, mapping as we know it follows the Western paradigm of placing boundaries around 'resources'. These resources also included native people, who were viewed as raw material to be exploited (Mbembe, 2001).

5.3.3. Accuracy

The development of cartography is closely linked to improvements in surveying and mapping instrumentation, and most importantly, accuracy. Accuracy became the primary metric by which progress in cartography was measured (Harley & Woodward, 1987; Perkins, 2009), and still carries much weight in geomatics educational practice. Observation, measurement and verification of phenomena are still the cornerstone of present surveying practices. The emerging science of cartography developed rapidly during a period that was punctuated by an explosion of European exploration and colonisation. The mission of the scientist (a newly developed profession in the nineteenth century) was to discover and make sense of the world. Thus, empirical knowledge was required, first in the form of topographic mapping, then later as thematic mapping. The Enlightenment principles of rationality and accuracy were promoted by the great surveyor-explorers (such as Sir Thomas Maclear, the astronomer/surveyor who was a close friend of David Livingstone) who were subsequently seen as heroes who helped to bring order to undiscovered lands.

Mapping became accepted as a scientific discipline during the neo-positivistic period, which roughly corresponds to the beginning of the twentieth century (Fernández & Buchroithner, 2014). The centrality of data and its accuracy is reinforced in modern cartographic practice. In GIS education, there is much focus on data – in the GIS curriculum at CPUT, courses like 'Data Quality Management', 'Spatial Analysis' and 'Spatial Data Acquisition' attest to this. The analysis and geometrical representation of spatial phenomena, as well as their prediction through models, hypotheses and theories are widely used neo-positivist cartographic practices. The course entitled 'Spatial Analysis', in which the student digital storytelling intervention is situated, is primarily dictated by these principles. The storytelling intervention is a moment of *potentia* within the *potestas* of traditional cartographic knowledge. It acknowledges and pays homage to the important neo-positivist foundations of cartography, but situates them within a local context. This is a decidedly poststructuralist shift in the epistemology of the course. It is done intentionally, and is aimed at troubling the universal/particular dualism. A diffractive reading of the knowledge base of the course helps to identify such dualisms and puts to work anti-dualist remedies.

In the assessment of most practical surveying tasks, teachers use the accuracy of the solution as the first assessment criteria. The student will only pass the task if they achieve an acceptable level of accuracy first. For accuracy to be achieved, students are taught to rigorously follow the tried and tested scientific method. This link between accuracy attainment and method is inculcated in the geomatics learning experience across years and across courses. For example, in elementary surveying, position fixing (the calculation of co-ordinates of points) requires specific observational and mathematical techniques to be followed. If correctly followed, the accuracy of the calculated co-ordinates will be acceptable. This measure of accuracy is often the main metric used to decide on whether to accept or reject a survey.

Accuracy is so important in that it has become entwined with a geomatics conception of ethics. Crampton notes that

> in GIS and cartography ethical behaviour has become equated with good conduct, such as adhering to accuracy standards - an internalist judgment rather than an externalist (contextualized) one (Crampton, 1995: 84).

This internalist judgement can be seen to be a blanket, universal conflation of ethics and accuracy, rather than seeing ethics as relational, particular and emergent in different ways. I show later how geomatics practitioners and academics all stress the importance of ethics, yet exhibit real difficulty in letting go of the primacy of accuracy and other scientific aspects to forward an ethical education. In the storytelling intervention, I re-insert ethics, but with a posthumanist orientation.

5.3.4. The art / science boundary

The scientific view of cartography did not always exist. In the supposed march of cartographic progress, art has been dropped from the definition of professional cartography. This was not forward progress, as the excision of art helped to mask ethical aspects. The dropping of art corresponds with the acceleration of the impact and reach of technology and computerised cartography. The latest strategic plan (for the period 2011-2019) of the International Cartographic Association defines cartography as

> the discipline dealing with the conception, production, dissemination and study of maps (International Cartographic Association, 2011: 8).

In the previous strategic plan (2003-2011) cartography was defined in two ways:

> Short definition: (a) The art, science and technology of making and using maps. Long definition: (b) A unique facility for the creation and manipulation of visual or virtual representations of geospace – maps – to permit the exploration, analysis, understanding and communication of information about that space (International Cartographic Association, 2003: 17).

Note that the word 'art' has been dropped in the latest definition.

Cartography has seen a change in the *form* of maps – clay tablets, inscriptions on buildings, paper sketches, navigational charts, draughting films and pixels on a computer screen are all

ways through which spatial information has been communicated. Cartography went from being regarded as an 'art' to a 'science' during the approximately century-long 'cartographic reformation'. It saw the decline in decorative artistry on maps, usually produced by single skilled craftsmen. This was replaced by neutral white space, produced as a result of large-scale institutional surveys, using increasingly specialised instrumentation (Edney, 2011). Thus the cartographer went from being able to express themselves artistically to being part of a specialised production line. Today, the national mapping agency (NGI) produces anonymous, standardised mapping. As noted in section 5.3.2, the scientific nature of maps helps to give them ideological legitimacy.

A very important development that paved the way for Western cartography-as-science was Claude Shannon's 1948 *Mathematical Theory of Communication* (Crampton, 2010). Shannon's theory contributed toward the process of the excision of art from cartography. Shannon, an American engineer, worked on predicting the path of enemy aircraft so as to develop an intelligent missile firing system. His invention of communication theory[32] was crucial in the development of computers. He was a pioneer in linking technology, mathematics and social theory. These linkages, as in so many other geomatics-related applications, were facilitated by the business of war. Traditional cartographic texts (see for example Robinson, Sale & Morrison, 1978) conceive of mapping as a system of communication, similar to Shannon's model. They imply that there is a stable external reality, waiting to be represented by cartographers who use logic, scientific method and practical skills to best represent the 'real' world. In this ontology, the apparatus is used to represent the fixed world, not create it in any way. I am challenging this view of the world by reading the insights of Harley alongside posthumanist and non-representational theory.

Another important figure in the development of cartography as a scientific discipline was Arthur Robinson (1915-2004), the Chief of the Map Division of the Office of Strategic Services (OSS, which later became the CIA). Being the head of the OSS, his views had a big impact on the maps that were widely produced and consumed by the public. After World War II, Robinson started deliberately distancing cartography from art. For him, form followed function, and he suggested analysing how people used maps. These cognitive and perceptual studies of cartography deliberately excised the artistic part of cartography in the name of objectivity, reason, logic and functionality. These distinctly humanist characteristics of maps triumphed over artistic elements like aesthetics. Cognitive and perceptual studies still remain popular today in research on cartographic design (see for example Dibiase, 1990; Dawood & Motala, 2015). Robinson believed that a map's purpose was purely functional and should not unduly sway the map reader into a point of view about other people or territories. Harley (Harley, 1989, 1990, 2009) shows us the impossibility of this, as maps, by their very nature, are more than communicational and informational[33]. Crampton points out that Robinson's implicit view was that

> maps should behave with a sense of propriety and good manners, and that to transgress beyond these proper behaviors was worse than just an exercise in bad taste, it was also a sign of a bad map (Crampton, 2010: 55).

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[32] His radical idea was that a thing (like a sound, a photograph or a map) could be converted into a signal, transmitted through a medium, received at another location, and reconverted into the original thing.
[33] This insight resonates with Deleuze and Guattari's (1987) argument in their chapter on the postulates of linguistics.

This tongue-in-cheek comment by Crampton has posthumanist resonances, in that it recognises the agency of the map itself. Robinson's work was part of a growing influential corpus of work on cartography that saw a boundary being drawn between art and science. Harley points out that maps are often viewed as models, ways of portraying reality, and are different from pieces of art, like paintings. He says that

> although cartographers have continued to pay lip service to the 'art and science' of mapmaking, art, as we have seen, is being edged off the map. It has often been accorded a cosmetic rather than a central role in cartographic communication (Harley, 1989: 4).

Powerful individuals like Shannon and Robinson shaped the development of cartography and by extension, geomatics education. Their commitment to the United States war machine, and their influential positions were contingencies that helped to set cartographic development along a specific trajectory. This was a humanist trajectory that focused on conflict, ideology and reason. By focusing on specific aspects in the development of cartography, others were silenced. Objectivity was promoted, while art was demoted; the interests of the West (in particular the USA) was focused on, while other nation states were ignored. These silences had direct material consequences on lives, lands, education and practices. The geomatics knowledge base owes much to military innovation. The imperatives of the early developers remain largely implicit, and had not been critiqued until critical cartographers like Harley started interrogating the ethics behind cartography. The task of conceiving of a cartographic practice and ethics that is outside of the control of the current discipline is difficult and relies on resistance of hegemony, as well as a concerted creative effort. Posthumanism and non-representational theory can help in this regard.

The propagation of humanist discourse through maps, as well as the view of cartography-as-science should not be seen in isolation. There were numerous co-evolving elements that culminated in this nexus of power and knowledge. The development of the modern state and increases in spending on war and scientific research saw the creation of a centralised spatial information knowledge base and standardised practices of surveying and mapping (such as the introduction of the metric system and common sets of instrumentation). This almost panoptic system points to the consolidation of biopower in governments and their agents.

Harley described mapping as a 'discourse of opposites' and identified a series of binary characteristics that could be used to separate 'artistic' maps from 'scientific' maps (Crampton, 2010: 57). Examples of these differences are: subjective/objective, inaccurate/accurate, manual/machine, old/modern, and place/location. The usurping of cartography by science was made easier in an environment which saw epistemologies across the world being increasingly characterised by scientific and positivist paradigms, as described in section 5.3.3. This resulted in the insertion of an overtly binary or dualistic conception of cartography. The conception still exists today and is comfortably in place as the hegemonic order, especially amongst the geomatics community. Interviews with academics and practitioners confirm this (see Chapter Six).

The material associated with the practice of geomatics exerts *potestas* on people. Prohibitive costs, specialised equipment and technical knowledge prevent its widespread use by people outside of the geomatics community; but this is changing. Our current era is one of rapid technological development, resulting in a multiplication of virtual possibilities as well as actualised deterritorialisations. One of these deterritorialisations has served to "undiscipline"

mapping (Crampton, 2010: 40). The contingencies that contributed to this undisciplining include: increasingly advanced geomatics technology[34], an increase in sophistication of computer use of the general populace, and the concomitant popularity of web mapping applications like Google Earth. Artists have appropriated mapping practices, and the geospatial web has encouraged a flourishing of creativity. This has contributed to the control of the discipline of cartography partially transferred away from powerful elites (such as large corporate companies and governmental organisations) to others. This incursion (as seen by some spatial science practitioners) of non-cartographers into the arena of map-making is destabilising older cartographic practice. The Open Source geospatial community for example, as exemplified by OSGeo[35] fosters linkages between diverse groups, and challenges the hegemony of the traditional GIS software providers. The practicality of making GIS software available to a larger audience fosters the elaboration of newer cartographic practice. At the same time, geomatics techniques and technologies are playing an increasingly important role in peace-keeping, environmental advocacy and social justice activism. This 'undisciplining' of mapping can have a powerful counter-hegemonic message for geomatics practitioners and students; this is an example of the *potentia* that I wished to introduce into the curriculum through the storytelling intervention.

The surveying profession has drawn a boundary around its educational practices, in order to mitigate perceived threats to its sustainability or survival, as well as to capitalise on changes in the world of work. When a boundary is drawn, it can result in the creation of two dualistically opposed categories, seemingly worlds apart. This is the case of the boundary that has been drawn between art and science, which now seem almost unrelated in geomatics. Yet these boundaries have been produced in processes of mattering, at intersections of specific material practices. It is ethically pertinent to remind ourselves of the performative aspect of these boundary creations, and to resist them when pertinent. As Snaza et al. remind us:

> Since racism, heterosexism, and ableism are not immaterial ideologies and concerns of individual psychology but economic, institutional, "bio- logical," and medical matters, our politics has to intervene directly in the material processes and assemblages that allow them to emerge and support their endurance (Snaza et al., 2016: xix).

I am attempting, through dialogue and storytelling, to influence my students' process of subjectification in a changing geomatics landscape. Gone are the days when studying geomatics was the only entry-point into the practice of cartography. Cartography has been freed from the academy by the 'undisciplining' of mapping, as mentioned. This movement in the cartographic environment requires a concomitant response that is ethical, and not only fear-based. As I will show in Chapter Six, there is a real fear from within the geomatics profession of encroachment over the disciplinary boundaries between itself and others. This fear stems largely from the loss of potential income production, and although this fear is allayed in some ways by my pedagogy, that is not my prime concern. My ethical response comes from an awareness of the art/science dualism and an attempt to transcend it in some ways. So besides teaching my students the science of cartography, I am also encouraging them to dabble in art through an exercise in counter-mapping and storytelling.

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[34] Besides traditional geomatics technology (like total stations and GPS instrumentation) I am also referring here to technology that could be used for mapping but might not have been expressly developed for that purpose, e.g. digital cameras and remotely operated vehicles.

[35] A non-profit organisation which aims to promote adoption of open geospatial technology. See http://www.osgeo.org/

5.3.5. Interpolation as humanist interpellation

A geomatics concept that has important implications on the subjectification of practitioners is interpolation. This section explores how the ubiquitous logic of interpolation within geomatics has an effect on the subjectification of its students and practitioners. It is also intended to illuminate the algorithmic logic at the heart of many socio/techno systems, which has implications on power relations in broader society.

Interpolation is a mathematical method used to construct new data points within a range of a set of known data points. It is used extensively across a wide variety of disciplines in mathematics, engineering and science. The typically quantitative and scientistic logic of interpolation is ubiquitous in the geomatics knowledge base, and serves to condition students into specific ways of thinking. There is an interpellative power in the logic of interpolation that geomatics students are subjected to. Interpellation was initially theorised by Louis Althusser, who investigated how the capitalist system reproduces itself through institutions such as the church, family, prisons, the police, schools and universities. These institutions are called Ideological State Apparatuses, and they help to create subjects who become their instruments, thereby ensuring their continuation (Mansfield, 2000). Geomatics education, situated within the university, is complicit in this system. The *potestas* contained in the geomatics knowledge base contributes to the creation of subjects who are answerable to specific laws and to the system behind it. This system is the hegemonic system of the humanist Man and the exclusively human Anthropos. In this section, I argue that being interpellated into the world through the conditioning of interpolation is ceding to the dominant subject of humanism. It is necessary to move beyond the subject-object binary suggested by Althusser's initial theorising (van der Tuin, 2014), and adopt a posthumanist orientation towards interpellation.

Interpolation explained

In the process of interpolation, a three-dimensional surface is created from discrete points. These discrete points can be points that have been surveyed and whose three-dimensional co-ordinates have been determined. They are often called *control points*. In a type of 'join-the-dots' children's exercise in three dimensions, a surface appears. The surface is computed in between the control points, and can vary depending on the algorithm used (Tolpekin & Stein, 2013).
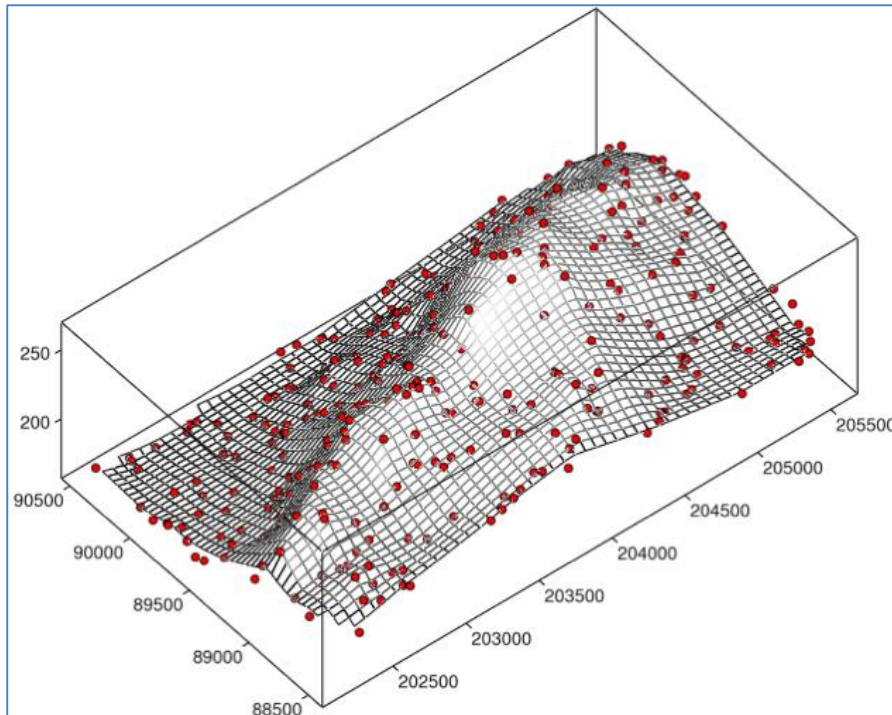
Figure 10. Three-dimensional surface created by interpolation
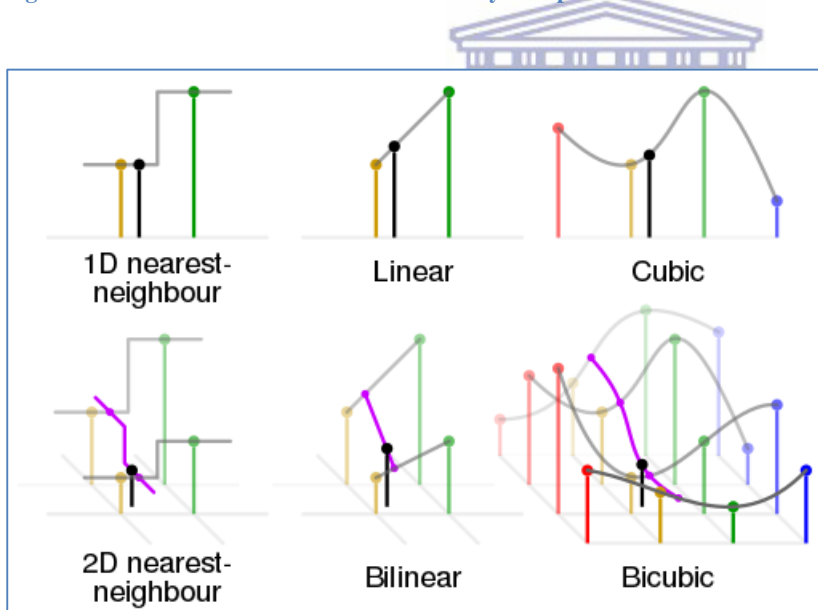
Figure 11. Different types of interpolation can create different surfaces (Source: https://en.wikipedia.org/wiki/Interpolation)

Figure 10 illustrates a Digital Elevation Model (DEM) that is created from a discrete set of observed heights (shown as red dots). DEM creation is one of the capabilities of GIS software, and geomatics education requires students to understand the intricacies of various types of interpolation. Different types of interpolation can create different surfaces, such as Inverse Distance Weighted interpolation, Splines, Kriging, and Nearest Neighbour interpolation. In Figure 11, black dots represent the interpolated point, and red/yellow/green/blue dots correspond to the neighbouring observed points. When these black dots are calculated and displayed all over the area of interest, the interpolated surface is thus created. The interpolation algorithm gives a weight to each observation. Weights are assigned differently for different types of interpolation. Interpolation works where values are

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spatially correlated and near things are more related than distant things. This underlying topological assumption, based on Tobler's well-known first rule of geography, is problematic in nomadic thinking.

Interpol(pell)ation

A diffractive transposition of ideas can link interpolation to interpellation. Current consumerist society interpellates subjects according to the market. There is a topological logic to this interpellation, and can be understood through interpolation. Nigel Thrift also linked the logic of interpolation and interpellation, albeit in passing (Thrift, 2008: 14). I go further, and expand on it by theorisation through posthumanism. Whilst critiquing the logic of interpolation, I also add an affirmative take on it by making explicit its links to strategies of overcoming dualisms.

Lury, Parisi and Terranova (2012) show how culture itself is becoming-topological, and I suggest that the process of interpolation is metaphorical in that it describes and ascribes a spatial logic to interpellation. My premise in this section is that the logic of interpolation that conditions the geomatics community into specific ways of thinking is insufficient as an analytical and navigational tool in our worlding practices. The logic of interpolation serves to interpellate subjects into humanist thinking, which propagates hegemony. A new, posthumanist sensibility is required, one that sidesteps the *potestas* contained in following the logic of interpolation. By itself, the logic of interpolation is not sophisticated enough to adequately account for the present.

The context of this interpolation-as-interpellation is the highly technologically-mediated world. The posthuman subject is complex and transversally linked to a material web of human and non-human agents. This is a departure from some

> fundamental premises of the Enlightenment, namely the progress of mankind through a self-regulatory and teleological ordained use of reason and of secular scientific rationality allegedly aimed at the perfectibility of 'Man' (Braidotti, 2013a: 37).

Man is no longer the exclusive holder of rationality, but rationality is very much alive and well, albeit in new forms. Rationality is now implemented by computational algorithms and distributed networks. New technologies like dynamic modelling systems, which benefit from interpolation algorithms, are proponents of new rationality. In the context of advanced capitalism, computing power as a method of control is deployed for the sake of profit and consumption. For example, the derivatives of financial markets and algorithms that control social media software such as Facebook are implicated in the will of hegemonic forces. There is a paradox observable in this, as the human is decentred in this post-anthropocentric twist of power relations. Yet, through this new form of rationality, humanism is strengthened.

It has recently been reported that some of the danger of Artificial Intelligence (AI) and machine learning algorithms are that they are opaque and biased (Knight, 2017). Once incorporated into larger computer-based assemblages, complexity is multiplied. This multiplication of complexity can defy analysis, as opacity is a characteristic of these systems. A cartographic and diffractive analysis is useful in this regard because it maps where the *effects* of difference appear – whether in the geomatics learning experience or the practice of geomatics in industry.

The opacity of big data processing is making us rethink

> sociality as moving from an operational logic of closed systems and its statistically
> predictable populations to algorithmic architectures that override the possibilities of a
> closed system and predictable populations, opening sociality to the postprobabilistic
> (Clough et al., 2015: 147).

Being intimately entangled with technology, the posthuman subject does therefore not ascribe
to the predictable, rational logic of statistical analysis, for example as contained in
interpolation algorithms. There is thus a need for a new posthumanist sensibility.

The 'algorithmic bias' is present in computer systems that, like maps, describe and create our
realities. As algorithms become more complex and play an increasingly important role in
processing natural/cultural data, a new ontology (not just epistemology) emerges. This 'onto-
logic' is based on the intimate entanglement of big data in our everyday lives, and is seeing
the inanimate becoming sentient. In describing the production of content on 'YouTube Kids',
Bridle notes that real humans are producing nonsensical content suggested by algorithms that
analyse the searching behaviour of children and parents. "This is content production in the
age of algorithmic discovery—even if you're a human, you have to end up impersonating the
machine" (Bridle, 2017). Thus the human/technology boundary is further blurred. Lury,
Parisi and Terranova (2012) notes that the blurring of the boundary between human and
machine is seen in the 'liveliness' of contemporary media (such as television), which can be
seen as a space of topological mediation. The boundaries between now/then, near/far,
here/there, fiction/reality and connected/disconnected are troubled. There is a relationship
between the local and the global, and the spatio-temporality of politics is being re-constituted
by techno-mediation.

Algorithmic methods of control have an influence on the constitution of subjectivity. We
have seen the humanist impact of surveyors' obsession with accuracy, as well as the excision
of art from geomatics. Interpolation, as contained in the knowledge base of geomatics,
together with its presence in algorithms in geomatics and other techno-mediated methods of
control, serves to promote and maintain hegemonic apparatuses. This logic is captured by the
digital economy in complex ways that convert action into profit. There is thus a contradictory
way of working that the global capitalist order easily handles. The power/knowledge nexus of
the dominant subject operates in ways that defies the logic of linearity. Hegemonic power is
non-linear, transdisciplinary, creative and can transition between different identities. These
qualities are reminiscent of Braidotti's rules of practicing critical posthumanist theory[36]. The
complexity of the middle, the milieu defies capture by traditional identity politics. Silicon
Valley companies are equally as capable of self-critique as left-leaning academics. One such
company says:

> The asymmetry in the digital economy is obvious, when the cleverest data scientists in
> the world are concentrated not in universities but in digital businesses (where they work
> on new ways to sell ads). Data is collected, synthesized, refined, traded and integrated,
> all behind our backs, in ever more complex, proprietary and invisible ways. If data is
> "the new crude oil", then we're surely approaching crunch time, when this vital yet
> explosive raw material needs better regulating. (Wilson, 2017)

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[36] See Section 2.2.4.

Interpolation is a constituent part of more complex algorithms and systems, and its logic is instructive in that it conditions geomatics practitioners into thinking in certain logical ways. I am arguing that the ontology promoted by interpolation is one that is suited to the traditional subject of humanism, not the posthuman subject. Algorithmic logic promotes certain power relations across the nature-culture continuum. Indeed, algorithms are used to describe nature by mathematically processing and reducing observations of natural phenomena. Meteorological algorithms for weather prediction, and land surface modelling using interpolated digital elevation models are examples of these 'natural' models. Examples of 'social' models are: social media algorithms for online behavioural prediction, algorithmic identification of 'at-risk' students in higher education, and sentiment-based algorithms controlling buying and selling of financial products on stock markets. Taking a posthumanist, non-anthropocentric stance, one can see the relations on the nature-culture continuum. Far from being restricted to one way of analysis and description, algorithmic thinking can be harnessed by combining relations that are zoe-, geo- and techno-mediated. The new materialist shift sees the emphasis on codes which could be bio-genetic and geo-informatic at the same time. Thus there is a need for new additions to language (or a new language altogether) that will allow us to adequately describe the contradictory nature of material-discursive reality. This language is being constantly developed, with significant contributions from posthumanist philosophy.

The dominant epistemological understanding of cartography is that it is a mediating process between the 'real world', as observed by surveyors, and the map reader. Interpolation is a key algorithmic method at play in this process of mediation. In interpolation, smooth continuous surfaces can be created from discretely observed points. For example, property values in a city can be viewed as a continuous surface. One can be deceived into thinking that this map is a description of a 'natural' phenomenon – it hides the underlying social premises which emerge out of power relations. For example, all South African cities were socially and materially engineered according to the 'model Apartheid city' (Figure 9), and house prices today still reflect this. When social phenomena are represented as continuous representations, for example a map of vulnerability (e.g. Figure 12), it could mask the underlying conditions that created the social conditions in the first place.
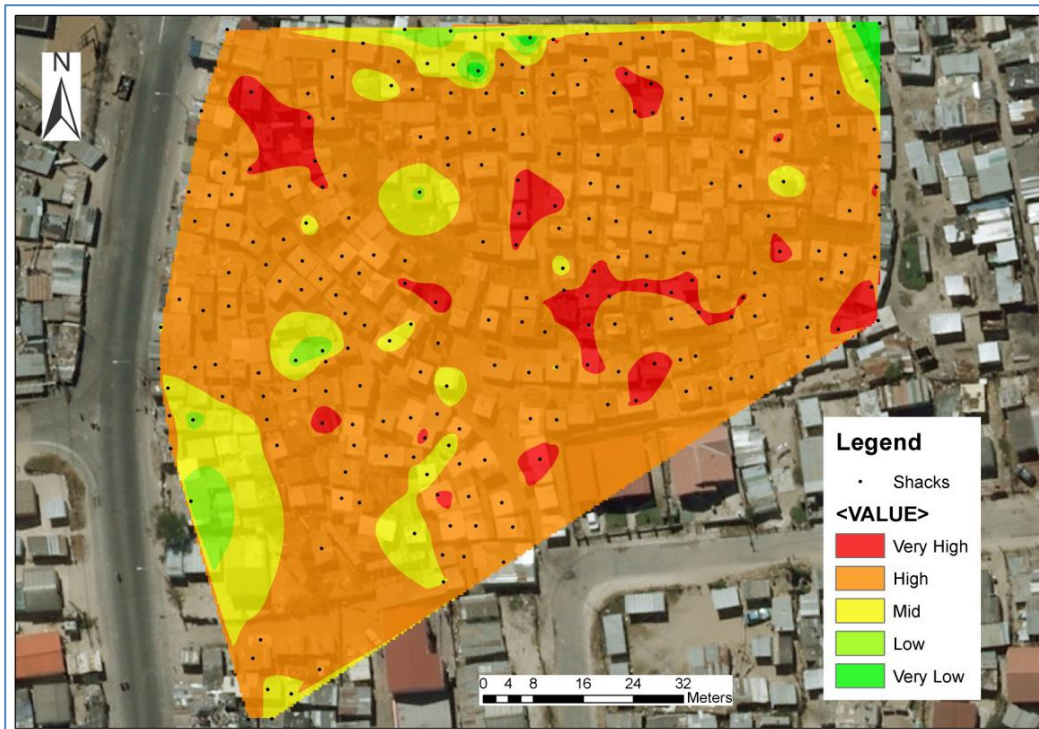
Figure 12. Raster map of vulnerability of shacks (source: Musungu, Motala & Smit, 2012)

Figure 12 shows a continuous surface map of vulnerability of shacks in an informal settlement to a combination of factors. The informal settlement is located in Cape Town, and is called Graveyard Pond. We (Musungu, Motala & Smit, 2012) conducted the data collection and analysis by means of Participatory GIS (PGIS) which can be seen as a type of counter-mapping. The data from the map was obtained from the community of Graveyard Pond, who identified the hazards to which they were exposed. The vulnerability of each shack to specific indicators (namely fire, flooding, sanitation, disease and income) was calculated by means of a multi-criteria assessment. The map in Figure 12 was produced by means of interpolation, and gives an overall indication of the vulnerability of the informal settlement. As noted, the reasons for the existence of informal settlements in Cape Town are not interrogated. Following Sato, Silva and Jaber (2014), a critical cartographic and post-colonial critique of our method would be that we are not helping to change the structure of land ownership, nor bringing awareness to the reproduction of new colonial forms. This was not the aim of the study, but it should be noted that there is a danger in that such maps promote the normativity of such socio-economic conditions in a place like Cape Town. There is a further danger in the viewing of residents in an informal settlement as objects, subject to the panoptic gaze of technology in the hands of power. This danger can be obfuscated when one considers the context in which this map was produced. It was produced as a participatory mapping exercise, ostensibly for the benefit of the community.

Deleuze examined the self-organising nature of matter and material systems, and his theorising helped to encourage a paradigm shift away from Kantian philosophy, which epitomised "the epistemology, metaphysics, ethics, and aesthetics for a world of Euclidean space, Aristotelian time, and Newtonian physics" (Bonta & Protevi, 2004: vii–viii). Deleuze, on the other hand, provided the philosophical concepts that helped to make sense of fragmented space, twisted time, and non-linear effects in science. The complexity of the world makes its interpellative power difficult to pin down with the logic of interpolation.

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Deleuze and Guattari's chapter on the postulates of linguistics is a critical look at how language works – it is not just informational / communicational, but it orders us too. Language hails us into being subjects, and is one vector in the intersection of diverse practices that constitute subjectivity. Similarly, an interpolated surface is not just the average surface against which everyone is judged, it also interpellates subjects to strive towards it. Harley challenged the idea of the map as being primarily for communication/information – he saw the epistemological power of cartography as the creator of space. Ontologically we are interpolated/interpellated into becoming subjects by the power contained in the knowledge that we are exposed to. This power is the distributed, algorithmic power of the global capitalist order, to which the underlying philosophy of cartography conforms. This modern order emerged out of the Enlightenment logic that reduced the world to representations, designed by the European humanist subject (Man). Colonial mapping functioned within this logic, which was systematic and mathematical. These maps contained colonised subjects, but also created these subjects (Garuba, 2002). Following colonisation, apartheid town planning was a particularly violent manifestation of the use of maps to subjugate people.

Even in the task of compiling a history of cartography, an interpolation of sorts is used. Harley, the eminent historian of cartography, points out that the study of the history of maps and mapping is characterised by gaps and discontinuities, due mainly to the lack of original source material (in this case, maps). Many maps that survive today are descendants of older maps. Other surviving maps were not original at all; they were reconstructed from old texts, thus inevitably contained distortions and assumptions. So depending on what map historians know about the period under study, the context, the power relations, the cartographers and the available technology, the maps were constructed in specific ways. In some cases, it is not always clear that a map - as opposed to a verbal or textual description – even existed (Harley & Woodward, 1987). These 'invented' maps were thus interpolations based on other cartographic products (or derivatives) of the time. This phenomenon of producing maps from other source material was also seen in some of the exploratory maps of South Africa produced in the 19th century (Liebenberg, 2004). Being written into the official (*Chronos*) molar timeline, these inventions are given credence and power. They are interpolated into the smooth topological surface of the development of cartography.

A further transposition can link the logic of interpolation to qualitative research, and then contrast it to post-qualitative research. In traditional qualitative research, when themes (or codes) are extracted, a representation of something is created. To create these themes, certain observations are given more weight. A major problem with coding is that it "assumes, and imposes, an 'arborescent' or tree-like logic of hierarchical, fixed relations among discrete entities" (MacLure, 2013b: 168). These entities are often words, spoken in interviews and grouped into themes, perhaps processed by statistical programs or counted. A problem associated with this is that the interviewer has already determined what is important by asking the interviewee leading questions. This also presupposes a Cartesian subject/object dualism, where the data is *out there*, separate from the interviewer (St. Pierre & Jackson, 2014). One can draw parallels between this process and the practice of producing a topographic map (within which the process of interpolation is situated). The topographic surveyor must select and observe a set of discrete points with the aim of producing the best possible representation of the earth's surface. The data is then reduced to a set of points containing three-dimensional locational co-ordinates. If important points are omitted, the landscape represented in the final contour map will not contain enough detail. In a similar way, the codes selected are used to describe the qualitative 'landscape'. Feminist philosophy teaches us that when something is selected, other things are omitted. In interpolating a

landscape, unimportant points are omitted, or data points which appear to be incorrect are omitted as outliers.

My analysis combines coding with post-qualitative methods, which looks at a surface that has been extracted from themes, and also looks beyond, at the 'data' itself, at movement, at intensities and at other elements that are difficult to pin down. Additionally, I would suggest that seeing the world through a qualitative/quantitative binary is inadequate, as we are still left in the realm of representation, attempting to hold things down to a frame of reference that has been pre-ordained. Post-qualitative methods and non-representational theory attempt to transcend this binary.

<u>Affirmative interpolation/interpellation</u>

Thinking diffractively, I do not wish to reject geomatics' obsession with accuracy, nor do I wish to downplay the importance of the scientific method. I rather want to demonstrate that an injection of an *Aion*-based, *potentia*-inducing micro-instance of activism into the rigid geomatics curriculum can greatly benefit the practice of contemporary science.

Reading the logic of interpolation through feminist new materialist insights opens up a space of possibility – a space for an alternative (ethico-onto-) epistemology. This space is literally the in-between space that is erased by dualist logic. Interpolation computes the locations of points between others, albeit in a formulaic way. It acknowledges the virtual field of possibilities that exists between elements. It acknowledges that multiple possibilities of locations, depending not just on characteristics of the end points, but on the choice of interpolation method. The interpolation algorithm can thus be seen as a Baradian apparatus, granting agency to specific factors, and resulting in the emergence of something new (an interpolated surface).

Posthumanist interpellation troubles well-established boundaries. The human/nature dualism boundary is porous when it comes to interpellation. Barad (2011) ascribes an interpellative force to clouds in the creation of lightning strikes. Thus, "interpellation, hence, *subjectivity* is on the part of non-humans" (van der Tuin, 2014: 241, emphasis in original). Because a diffractive analysis complicates causality, I cannot ascribe simple cause-and-effect linear logic in the analysis of the storytelling intervention. This is especially pertinent to the digital stories that were produced, as there is an acknowledgement that more-than-human agency is at play. The materiality of digital stories, for example, is a powerful contributor to their affective and pedagogical power. They were produced by human/technology assemblages which also acted as boundaries or mediating instruments between the subjects of the stories and the audience. In my intervention, stories were used affirmatively: to challenge the hegemony in capitalist logic; to trouble dualisms; and to make students aware of the historical development of specific phenomena.

There is an acknowledgement that interpellation works on a far more complex "grid of intersecting positions" (van der Tuin, 2014: 242) – and all factors cannot be known. Hence the analysis of subjectification will always be incomplete, but the choice of what to include in the analysis is a boundary-drawing practice, based on one's ethical stance. By putting aspects of geomatics in conversation with posthumanist philosophy, there is a dynamic conception of knowledge. Following Barad, my analysis is

attentive to the iterative production of boundaries, the material-discursive nature of boundary-drawing practices, the constitutive exclusions that are enacted, and questions of accountability and responsibility for the reconfigurings of which we are a part (Barad, 2007: 93).

Since this type of analysis does not take boundaries for granted, particularly boundaries between 'object' and 'subject', interpolation is treated with suspicion. This is because interpolation creates surfaces, which are three-dimensional boundaries (between for example the ground and the air). Viewed creatively, the logic of interpolation can be deterritorialised to produce various virtual futures. These could be: a different contour map created from different sets of control points; differently interpellated subjects based on an exposure to different sets of knowledges; and different conclusions based on new analytical techniques, when compared to traditional qualitative or quantitative research methods. The key to accessing these virtual becomings is creativity, experimentation, and defamiliarisation from sedimented habits of thought.

5.4. Concluding thoughts

In this chapter, I have carried out a cartography of some aspects of geomatics. It is through the intersection of a diversity of practices that the modern practice of geomatics has coagulated and congealed. Taking my cue from Braidotti and Barad (see the quote at the beginning of this chapter), accounting for the present practice of geomatics requires an awareness that 'now' is an infinitely rich condensed node across spacetime, and diffraction thickens our understanding of the present.

It would be remiss of me to take a purely critical role of maps and mapping in South Africa. South Africa has one of the most admired and stable cadastral systems in the world, largely due to its rigorous adherence to and development of accuracy standards. South African surveyors are respected internationally, and have found work in all parts of the world. Geomatics-related innovators have pioneered transdisciplinary innovation, and South Africans have been significantly involved.

Being an umbrella term for a number of related practices, it should be noted that geomatics is not one thing. Like the global economy (and related to it intimately), it is "web-like, scattered and poly-centered" (Braidotti, 2006: 31). Whilst there are complex agencies that force the limiting power of *potestas* upon the education of geomatics practitioners, there are also agents that encourage and enhance their *potentia*. What is required is a direct engagement with this diversity of evolving hierarchies and boundary transgressions.

CHAPTER SIX – GEOMATICS EDUCATION IN SOUTH AFRICA

No longer was reference made to African culture, it became barbarism. Africa was the 'dark continent'. Religious practices and customs were referred to as superstition. The history of African Society was reduced to tribal battles and internecine wars. There was no conscious migration by the people from one place of abode to another. No, it was always flight from one tyrant who wanted to defeat the tribe not for any positive reason but merely to wipe them out of the face of the earth.

No wonder the African child learns to hate his heritage in his days at school. So negative is the image presented to him that he tends to find solace only in close identification with the white society (Biko, 2004: 31–32).

6.1. Introduction

This chapter continues with the cartographic and diffractive analysis, and focuses on geomatics education in South Africa - an assemblage that is multiple, complex, contradictory, and hence difficult to represent. The South African social, political and physical past/present is one of boundaries, domination and segregation. While the previous chapter has adopted a broad approach, examining geomatics in general and mapping in particular, this chapter zooms in to geomatics educational practices in South Africa. My agential cut follows the lead of Braidotti and investigates power relations and subjectification.

In this chapter, I do not intend to recount in detail the sedimented version of the development of geomatics education in South Africa – this has been iteratively documented (see for example Fisher, 2004; Landman, Akombelwa & Forbes, 2017) and canonised via institutions such as universities, institutes and governmental organisations[37]. I aim rather to point out aspects of the education of geomatics practitioners and their subsequent practice that relate to humanist subject formation (and the associated promotion of anthropocentrism), and how this has been propagated over time.

I use the story of District Six to continue to showcase my pedagogical approach. The combination of storytelling, counter-mapping and history also complements the cartographic analysis. It helps to bring to the fore characteristics of dualisms that have been set up to propagate the subject of humanism. The regular appearance of the subject of humanism in geomatics students' education is contrasted with the voice of some subjugated others, specifically people of colour and the natural environment. I focus on difference between the experiences of dualistically opposed agents (e.g. Black/White and human/nature) in an attempt to problematise the boundary between them.

My critical practice emanates from my embedded and emerging subjectivity in South African society, in which I aim to affirmatively transform critique. I draw transversal links between the structural others of postmodernity, namely the racialised, sexualised and naturalised others (the native, the woman, and the environment/earth/animals respectively), whilst practicing the politics of location. Being marked as Indian and Muslim in South Africa, I am a structural other. I am simultaneously a hegemonic centre of power (being a middle-class

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[37] There is a permanent exhibit in the office of NGI in Mowbray, Cape Town, which focuses on the early surveying and mapping of South Africa. The Surveyor-General's office in Cape Town, too, has a similar, but smaller exhibit.

lecturer) wielding *potestas*. I am also largely subservient to the will of powerful agencies such as the university or the South African Geomatics Council. Subjective location is important in my analysis.

Continuing with the storytelling method used in Chapter Five, I use stories as hooks on which to hang my analysis. For example, I use the story of District Six to highlight the horrific forced removals as emblematic of the violence meted out by the apartheid state. I contrast this to the silence on ethics and related issues in the geomatics education research of the time. Storytelling is a useful device to creatively leap across time and space to transversally connect phenomena that traditional qualitative and quantitative research methods cannot accomplish.

The following cartography, being local and specific to South Africa, does not intend to promote any sort of nationalistic aims. The international boundary is the 'natural' holder of this study as the surveying programmes within South Africa have a degree of sameness when compared to other (even regional) programmes. A larger study encompassing all geomatics programmes in Southern Africa, for example, is beyond the scope of this study. Furthermore, the cartography emanates from my embodied and embedded experience of geomatics education, first as a student at the University of Natal (now called the University of KwaZulu-Natal[38]), then observing its effects from the world of work, then within academia as a geomatics lecturer (at CPUT and UCT). Nationalism, being a characteristic shortcoming of humanistic thinking, is to be resisted by nomadic thought. After all, the process of globalisation, which is a trait of advanced capitalism, extends beyond nation-states and is hegemonic. So I acknowledge the South African flavour of this analysis, reject South African nationalism, and affirm my embeddedness in this unique society which shapes my becoming.

As mentioned in Chapter Four, I draw on five interviews that I conducted with Cape Town-based geomatics university educators, two geomatics academics from ITC in the Netherlands, three geomatics practitioners, and three of my ex-students who were employed within government organisations. For the sake of anonymity, the interviewees are identified as Academics A – E (the academics from South African universities); Academics T1 and T2 (the Dutch academics); Practitioners F, G and H; and Students J, K and L. I am examining the subjectification of students and academics mainly but also, by relation, geomatics practitioners.

As mentioned in Chapter Four, this research utilises both traditional qualitative and post-qualitative methodologies. Focusing on the affirmation of difference is a characteristic of a posthumanist methodology, rather than traditional qualitative methodologies which seek out sameness and stability. However, this does not mean that sameness is unimportant – patterns of similarity are used. As pointed out by Jackson and Mazzei (2012), the *transgressive* voice should be given credence, but for the purposes of this research, the normative voice is important too. A further point they make about voice is that there is a problem with privileging interview data. Traditional qualitative research assumes that voice (obtained from interview data) is categorised as normative, truthful and contains meaning which is static. I have therefore not given coding the final say, but taken the analysis further by means of post-qualitative methods.

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[38] This is a grafted name joining a previously dualistically opposed pair, displaying nationalistic efforts at symbolic reconciliation.

Besides the interview data, I have also included the voices of numerous other academics and practitioners. South African geomatics journals and conference proceedings were particularly helpful for the perspective of the local geomatics community. Texts from overseas authors were consulted for a more international perspective, as were the interviews with the academics from the Netherlands.

But first, a story…

6.2. Story D: CPUT in District Six [39]

Before 2009, our department was situated on the Cape Town campus of CPUT. CPUT is the product of the merger between the old Cape Technikon (in District Six) and the old Peninsula Technikon (in Belhar, where we are now). One day when I was still at the Cape Town campus, I stood outside and I looked around me. I felt unsettled, because I knew that I was standing in District Six, yet I didn't recognise it as District Six. Most traces of it were removed, but the memory of it lingers on in the people who used to live there. As I looked around I asked myself a simple question: what was here before? I then realised that I could answer it using GIS technology.

Here is a map of the outline of District Six, overlaid over the current aerial imagery:

Figure 13. District Six, 2011

You can see our campus clearly in the middle of the old District Six. Let's zoom in to the campus and turn on the current road network, shown in green:

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[39] This story has been told to students, staff and others who have been involved with District Six in various ways. The story, as it appears here, was told to students.

Figure 14. District Six, 2011 with current roads overlaid

I'll turn off the current streets, and turn on the old street network, that was mostly destroyed when the apartheid government forcibly removed the (mostly Coloured and Black) residents and destroyed their homes. The old streets are shown in yellow:

Figure 15. District Six, 2011 with old roads overlaid

Our department was situated in the Engineering building – you can see it bounded by Caledon Street, Clifton Street, Stone Street and De Villiers Street. The old streets sitting on

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top of the current aerial imagery doesn't make much sense because the streets seem unrelated to the ground. Let's replace the new aerial image with an aerial image from 1983:

Figure 16. District Six, 1983 with old roads

This is where the majority of the change can be observed. The full destruction of District Six was complete – most of the houses were demolished, and the people were forcibly removed. It looks like a war zone. I'll turn off the streets so you can get a better picture of the destroyed landscape:

Figure 17. District Six, 1983

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Notice that there were only a few buildings left standing – these were mainly churches and mosques. By this time, more than sixty thousand people were forcibly removed out of District Six to Coloured and Black townships far away. Cape Technikon, a Whites-only institution, was built shortly after this, and the first buildings appeared in 1986.

Let's go back to 1977:

Figure 18. District Six, 1977

The destruction of the buildings is still happening. This was taken in the 1970s, when apartheid was in full force. A reminder of what happened then:

In 1970, the Bantu Homelands Citizenship Act strips blacks of their South African Citizenship. In 1977, the Bantustans[40] of Transkei, Bophuthatswana, Venda and Ciskei gains so-called independence or self-government.
White youths are now forced to do 2 years military service.
230 000 people are arrested for pass law offences.
Steve Biko was murdered in police detention.
The Cape Technikon was formed after the promulgation of the Technikons Act of 1976, a year before this picture was taken, and it was located in Longmarket Street in the City centre. It hadn't yet moved to District 6.
In 1978, P.W. Botha replaces John Voster as Prime Minister.
Mandela, Sisulu and others are sitting in jail on Robben Island, having been there for over a decade already.
South Africa, through ARMSCOR, makes its own missiles.

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[40] A pejorative term referring to the Blacks-only 'homelands' which were created as separate administrative territories.

Through 'petty apartheid', the government agrees to eliminate racial segregation in theatres but not in cinemas. Cinemas were some of the very important places of entertainment in District Six. The Star Cinema was located where our Sports Centre currently is.
1978 was international anti-apartheid year.

Let's go back to 1968:

Figure 19. District Six, 1968

Two years before this picture was taken, on 11 February 1966, the government declared District Six a Whites-only area under the Group Areas Act, and the removals starting in 1968.
Here you can see that most of D6 is intact, apart from this section which shows where the demolitions and forced removals started. This was the block bounded by De Villiers Street, Caledon Street, Clifton Street and Stone Street, and about two decades later, the Engineering Building of our campus would be built there. It is the epicentre of the destruction of District Six.

Some highlights (lowlights) from the 1960s:
The Extension of University Education Amendment Act bans Black students from attending White universities.
The ANC and PAC are banned.
Robben Island is turned into a prison.
CR Swart is the first President of the Republic of South Africa, after the Union of South Africa is dissolved.

Let's go back to 1953:

Figure 20. District Six, 1953

In 1953, the residents of District 6 did not know what was about to hit them. Although it was a crowded inner-city area, it had a vibrancy that is romanticised and still spoken about today. Some of the most repressive apartheid laws were promulgated in the 1950s, such as the Group Areas Act 1950, the Bantu Education Act 1953, the Natives Resettlement Act 1954, the Population Registration Act 1950 and the Reservation of Separate Amenities Act 1953. The destruction was about to begin.
The end.

The destructive force of the government in District Six is a stark and extreme example of *potestas* over people and land. The land of District Six would be surveyed and re-surveyed by White geomatics students at Cape Technikon, and then later by racially diverse groups at CPUT. Surveying students would pay close attention to the scientific method of surveying the land, but the significance of the land itself would escape them.

6.3. Powerful agencies

I have identified the main agencies as the universities, the government, industry and non-human agents. Note that these agencies are not 'objects' in the Cartesian sense, being manipulated by 'subjects'. Rather, both subjects and objects are iteratively constituted on an ongoing basis through relations. The entanglements between these agencies serve to produce geomatics knowledge and practices, which will be analysed in the next section (Section 6.4). Each of these agencies are further explicated below:

1. Universities – I am restricting myself to the universities that produce geomatics graduates, and, in particular, offer qualifications in surveying. Teaching and learning happens in the universities, so students and academics are assumed to belong to this part of the assemblage. The following universities offer surveying qualifications: the University of Cape Town (UCT), the University of KwaZulu-Natal (UKZN), Cape

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Peninsula University of Technology (CPUT), Durban University of Technology (DUT), Mangosuthu University of Technology (MUT) and Tshwane University of Technology (TUT). In recent years, the number of universities offering GIS-related qualifications has grown. For example, Stellenbosch University, the University of the Free State (UFS) and the University of Pretoria offer BSc programmes in Geo-informatics, but do not offer surveying qualifications. This is largely due to the growth in demand for GIS practitioners. There is a close relationship between South African universities and the government - universities receive subsidies from the government through the Department of Higher Education and Training.

2. Government – There are several government agencies that have a direct influence on the geomatics profession. Related to the universities are the departments of education. Since 2009, there are two ministries of education, namely the Department of Basic Education (overseeing schools), and the Department of Higher Education and Training (overseeing post-school education, including universities). Prior to 2009 there was a single Department of Education. The statutory body that regulates all qualifications in South Africa (including geomatics qualifications) is the South African Qualifications Authority (SAQA) which has been in existence since 1995. SAQA oversees the development of the National Qualifications Framework (NQF) which is a framework that provides a philosophical vision for qualifications in line with the South African Constitution.
There are other government departments which relate more to the actual practice of geomatics. The Department of Rural Development and Land Reform has replaced the old Department of Land Affairs, and has under its jurisdiction the offices of the Surveyor-General (both the Chief Surveyor-General and the provincial Surveyors-General), and the national mapping agency, National Geo-spatial Information (NGI). A significant number of geomatics graduates would be employed by these government departments. The South African Geomatics Council (SAGC, formerly called PLATO) is the statutory body that is responsible for regulating the geomatics profession and have a direct influence on university curricula, through the Educational Advisory Committee (EAC). At a local level, municipalities (such as the City of Cape Town) influence the profession too. These government departments often provide bursaries to deserving geomatics students, who are then expected to work at the departments after graduating.

3. Industry – This is a very broad category, and refers to companies or entities in which geomatics graduates could be employed. Examples include surveying companies (specialising in cadastral, engineering, hydrographic, mining or photogrammetric work), companies selling geomatics hardware or software (for example GPS hardware or GIS software), and corporate companies who use GIS (such as retailers or insurance companies). Under this category, I include institutes that represent certain portions of the geomatics industry, for example the South African Geomatics Institute (SAGI), and the Geo-Information Society of South Africa (GISSA).

4. Non-human agents – Without the inclusion of the land and geomatics technology, this list risks promoting anthropocentrism. Perhaps the most important agent is *the land*. It is the agent which is surprisingly silent in much of the literature on land surveying and cartography. This is largely due to the humanistic nature of the dominant geomatics epistemology, as outlined in Chapter Five. Other ways of relating to the land, for example via indigenous knowledge systems, is not common, but has of late

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been garnering more attention in South Africa because of the rise of the issue of decolonisation. This agent (the land) is the most directly connected to all others in a multiplicity of relations. In addition to this, the other non-human agent that is intimately entangled in the geomatics education assemblage is *geomatics technology*. Unlike the land, there is much attention paid to this agent in the literature. Geomatics journals and conference proceedings are replete with research on hardware (such as robotic total stations, photogrammetric cameras, or GPS receivers) or software (such as photogrammetric, remote sensing or GIS software). Given the focus on technical aspects in the geomatics academy, this attention is not as surprising.

These agencies are not always discrete entities with fixed boundaries. This can be seen especially clearly in agents 1, 2 and 3 – there is much movement within each groups, and between groups. The subjectification of geomatics students is of primary concern to my analysis. It should be noted that students start off in the university and after graduating may go on to join another agency in the assemblage. The relations between the agencies are paramount in a relational ontology, and contain power relations (exercised as *potestas* or *potentia*). The way that power is expressed between and within agencies changes over time, and hierarchies are dynamic.

6.4. A cartography of surveying education

6.4.1. A timeline

The education of surveyors in South Africa was started by Louis Thibault, who was the Government Land Surveyor in the early 1800s. He mentored several aspirant surveyors, and was also ultimately the judge of their professional competence. In 1815, Thibault (who was educated as an architect and engineer in Paris) started teaching land surveying at the Freemasons School in Cape Town (Fisher, 2004). This was during a turbulent time in Anglo-Dutch relations, and was shortly after the British re-occupied the Cape Colony in 1806. A prospective land surveyor (who was always White and male) would be issued a certificate if they successfully completed a number of assessment tasks, including a geometry theorem, a description of how he would survey a specific piece of land, a practical in plane-tabling[41], trigonometry and area calculation problems and finally a field test. He would then have to swear an oath of allegiance to the Crown and swear that he would conduct all future work professionally and with impartiality. The ethical stance of these men was shaped under the tutelage of the master surveyor. This model is still implicit today, in which university graduates go on to be trained by masters whose ethics are assumed to be of the highest calibre.

Ironically, the progress of the profession and its underlying knowledge benefited directly from the subjugation of the structural others (women, ethnic others and the natural environment). Women and Black subjects were not allowed to study surveying. Following Christian morality, the natural environment was seen as an inert backdrop against which man goes about his business. The man/woman, Black/White and human/nature dualisms exhibit all five of Plumwood's dualistic characteristics (backgrounding, radical exclusion,

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[41] Plane tabling is a type of surveying that allows the surveyor to plot a plan and take observations simultaneously. It has become obsolete due to it being replaced by digital and mechanical instrumentation, but it is very useful for the education of surveyors.

http://etd.uwc.ac.za

incorporation, instrumentalism and homogenisation). The structural others serve the important role of boundary markers for the definition of rational Western Man. The exclusion of these others allowed him to go about the business of conducting surveying work in an ethically questionable environment.

As the British colony grew, surveyors were produced in this way, and all land to which legal title was granted, required to be surveyed and needed a land surveyor's diagram. Large numbers of errors were found in the title deeds and diagrams, and the government's concern resulted in some formalisation of training and examination of land surveyors. The beginnings of the conflation of ethics and accuracy can be observed around this period. The increasingly legalistic nature of land surveying was also being formalised. The office of the Surveyor-General was established in 1828 and all candidate land surveyors had to be examined by the Surveyor-General.

To this day, the Office of the Surveyor-General sets trial surveys for prospective land surveyors. Nowadays, however, the central office of the Surveyor-General has been devolved to provincial level. After completing my university land surveying education, I took the Western Cape Surveyor-General's tests – a trial survey and a theoretical test which covered legal content. The establishment of this very important office, ostensibly for the purpose of minimising errors by surveyors, also formalised a very important and lasting link between government and education. It is pragmatic for educational institutions to tailor their instruction to give their graduates the best chance of succeeding at the trial surveys set by the government. From the point of view of the government, the individual offices of the Surveyor-General provides a decentralised panoptic gaze, identifying disorder and propagating its will through localised agents of State power. I am not ascribing agency of the knowledge/power nexus totally to the government, through its Surveyors-General. Rather, as Foucault notes, "[t]he systems of domination and the circuits of exploitation certainly interact, intersect and support each other" (Foucault, 1980: 72). The geomatics agents of power are never static.

Moves toward the formalisation of surveying education started in 1858 with the establishment of the Board of Public Examiners in Literature and Science. Certificates were issued by the government of the Cape Colony in a variety of disciplines, one of them being land surveying. The examinations were of a higher standard as the previous tasks set by the Surveyor-General. The Board of Public Examiners was dissolved in 1874, when the University of the Cape of Good Hope was set up. The university thus took over the theoretical examining of land surveying students, but it should be noted that the syllabus of the university remained virtually the same as that of the Board of Public Examiners. The practical examination continued to be the responsibility of the Surveyor-General. Another very important State office had (and continues to have) a close connection to the education of surveyors. The national mapping agency, National Geo-spatial Information (NGI) was instrumental in the setting up of the first diploma courses in surveying and cartography, offered in 1956 in Cape Town and Pretoria.

The development of the first diploma courses in surveying and cartography followed the phenomenal growth in industrial development in South Africa, creating the need for technically proficient people in surveying and cartography. In 1964, the director of the mapping agency allowed the admission of women into the cartography diploma. Women started studying towards the diploma in surveying in the 1970s, and the first two women surveyors graduated from Cape Technikon (Raubenheimer & Mitchell, 1985).

In addition to the direct relationship between geomatics qualifications and government, there are direct connections to industry too. The diploma courses in geomatics have an in-service training component, which requires students to leave the university and obtain employment in geomatics. After they have obtained the required experiential training, they either return to the university to complete their academics (in the case of the diploma in surveying) or go on to graduate (in the case of the GIS diploma). One can thus see the entangled nature of the relationships between the powerful agencies of the university, industry and government in the geomatics learning experience.

In 1987, the makeup of Cape Technikon's student population slowly started changing after the institution was granted permission to have the government's regulation lifted on the quota for Black students. Twenty nine Black students started studying at Cape Technikon in 1988, which was approximately one per cent of the student population (Barnes, 2009). These were a few black dots in a sea of white dots, like those on the dot-density map in Figure 6. Peninsula Technikon, the technikon set up during apartheid mainly for Coloured students, started offering a surveying diploma on a part-time basis in 1976. Peninsula Technikon was situated in Belhar, a far-flung Coloured township some 20km away from Cape Town. Many of the dispossessed families from District Six were forcibly relocated to Belhar, which had few opportunities and would become a breeding ground of many social ills, such as gangsterism and drug addiction. There was only one full time White lecturer in charge of the surveying programme at Peninsula Technikon, and the rest of the lecturers were brought in on a part-time basis. The fragmented nature of this education continued in the early 1990s, and corresponded to a time of tumultuous political change in South Africa. Students were then told that the first year of the diploma only would be offered, and they would have to find another institution to continue with their studies. This resulted in these (mainly Black and Coloured) students transferring to Cape Technikon, in what used to be District Six. I wonder if there were some children of those who were forcibly removed from District Six who were again ironically forced to go back to District Six from Belhar. I can only imagine what this affective experience must have done to those bodies, and the bodies of their parents. A Spinozist take on these types of encounters is partially explicated by Deleuze:

> when we encounter an external body that does not agree with our own (i.e., whose relation does not enter into composition with ours), it is as if the power of that body opposed our power, bringing about a subtraction or a fixation; when this occurs, it may be said that our power of acting is diminished or blocked, and that the corresponding passions are those of sadness. (Deleuze, 1988: 27)

The sad passions that resulted from the encounters between the apartheid state (via its educational institutions) and the bodies of the subjugated prevented action, diminished the relations within the body of the subjugated, destroyed the relations with the stolen land, and slowed down the intensities. Black students who made the move to the White institution stepped into a hostile world. At the same time, I was studying at the University of Natal in Durban, feeling like an outsider inside the university. Academic E pointed out that the lower academic standard of the Black students at Cape Technikon, particularly in mathematics, was clearly evident:

> *But we did find unfortunately ... that their maths especially ... was not really that good when they got to the third year.*

<div align="right">

(Interview with Academic E)

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This discrepancy between the mathematics ability of Black and White students was largely due to the different standards of education at Black and White schools. This is a legacy of the deliberate plan (in the form of Bantu education) by the architects of apartheid to deprive Black children from studying mathematics and science.

6.4.2. PLATO

The Professional and Technical Surveyors Act 40 of 1984 provided for the establishment of the South African Council for Professional and Technical Surveyors (PLATO). The committee tasked with issues around the education of surveyors was the Educational Advisory Committee (EAC)[42]. The EAC developed a model which assessed university geomatics curricula in a number of categories (e.g. professional land surveyor or surveying technician). Compliance with the model would allow graduates from a successful university to be registered with PLATO under the appropriate category. One can thus see the interpellative nature of surveying education, through the *potestas* contained in the PLATO model.

Over time, we notice that the state had varying degrees of involvement (either directly or indirectly) on the surveying and cartography learning experiences. For example, the technikon surveying learning experience (including curriculum, the learning environment, the technology used, the assessment and the administration) was dictated originally by the government department of education, then power was devolved to the institution, giving the technikon more power. Technikons had the most say in curriculum development saw their power being indirectly transferred to PLATO which developed the PLATO model, mentioned above. More recently, the rise of the capitalist agenda and the growing influence of the market can be observed. For example, advisory board meetings are mandatory annual meetings that all university geomatics departments must conduct. Industry representatives at these meetings exert a strong influence on the direction taken by university departments. The choice of equipment, specific practical exercises or examination questions are aspects that are often influenced by industry partners at advisory board meetings.

6.4.3. The dominance of the North

When surveying education was started in the 1800s by Thibault, the dominance of the colonial overseas master was further entrenched. New surveyors had to swear an oath of allegiance to the Crown. Around the period of the Anglo-Boer War (1899-1902), Britain realised the military importance of good mapping of South Africa in order to sustain its imperial influence. British surveyors were despatched to South Africa during this period to undertake topographic mapping of the colony. Other forms of mapping were done to collect as much intelligence of the land that was being fought over, such as compilation maps which were pieced together from title diagrams of farms filed in the Surveyors-General offices (Liebenberg, 2004).

There was a clear emphasis on science in the early curriculum of the first surveying degree in Cape Town, and its similarity to other European qualifications at the time has been noted

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[42] The EAC largely replaced the Board for the Recognition of Land Surveyors' Examinations established by section 16(b) of the Universities Act 61 of 1955.

(Jones, 1982; Landman, Akombelwa & Forbes, 2017). This Western colonial dominance on knowledge practices has been unbroken: from colonial times, through apartheid, and even in the present post-colonial, post-apartheid academy. The neo-imperial influence is exerted in different ways, yet manifests in a system that privileges humanism and maintains the 'knowledge economy'. Nowadays, the colonial masters are not necessarily nation-states as they were in the past. Corporate capital works in concert with national governments, and the capitalist system produces a global economy that is web-like and poly-centred (Braidotti, 2013a). The GPS is a case in point – it was developed by the U.S. military and its ongoing development is intimately linked to that government.

Focusing on the U.S. academy, Chatterjee and Maira (2014) note that, since the events of 11 September 2001, there has been a systematic attack against scholars who have challenged, amongst other things, U.S. foreign policy with particular reference to wars and occupations. The growing privatisation of public universities and policing of access to higher education, has seen a restructuring of the academy. This is a global phenomenon and can be seen in South Africa too. State policing and surveillance serve to propagate racial, gendered and class practices in the neoliberal academy in the US. Chatterjee and Maira's premise is that the U.S. academy is imperial, and is one very important agent of U.S. global expansion and repression.

The dominance of the West can be observed in efforts of universities in the Global South to maintain academic standards that mirror or work in concert with those of the West. American and European universities and their spheres of influence are seen as the standard against which other universities are judged. For engineering departments in South African universities, international standards are very important. For tertiary level engineering qualifications, there are three international agreements governing mutual recognition of the qualifications and professional competence. These are: the Washington Accord, for qualifications in professional engineering; the Sydney Accord, for qualifications in engineering technology; and the Dublin Accord, for qualifications in technician engineering (International Engineering Alliance, 2013). CPUT is a signatory of the Dublin Accord, and the engineering diplomas are designed to align with the desired graduate attributes outlined in the Accord. Curriculum developers are actively encouraged by university management and the Engineering Council of South Africa (ECSA) to comply with the standards prescribed in these international accords.

For geomatics qualifications, the SAGC does not require adherence to any of the accords mentioned above, but links to international standards and benchmarking are evident. In particular, standards such as those defined by the UCGIS[43] have a significant influence on GIS qualifications in South Africa. In the U.S.A. in 1997, the UCGIS initiated a framework for the assessment of Geographical Information Science and Technology (GIS&T) undergraduate curricula, and the body of knowledge (BoK) was subsequently developed (Dibiase et al., 2006). Although intended for a mainly American GIS&T curriculum, the UCGIS BoK has been widely adopted as the international standard for GIS qualifications (du Plessis & van Niekerk, 2013). This is largely due to its comprehensive coverage – it has ten knowledge areas[44], 73 units, 329 topics and over 1600 educational objectives. It is a

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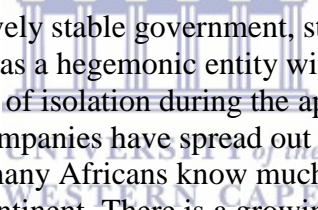
[43] See Chapter One
[44] The ten knowledge areas are: Analytical Methods, Conceptual Foundations, Cartography and Visualisation, Design Aspects, Data Modeling, Data Manipulation, Geocomputation, Geospatial Data, GIS&T and Society, and Organisational and Institutional Aspects.

"collective effort by a community of researchers and educators to specify a comprehensive body of knowledge that defines the GIS&T domain" (Dibiase et al., 2006).

In South Africa, GISc was professionalised in 2004, and this required standardisation of GISc qualifications offered by tertiary institutions. This led to a process that culminated in the development of the GISc Unit Standard Based Qualifications (USBQs). This was a requirement of the South African Qualifications Authority Act 58 of 1995. In addition to the GISc USBQs, the PLATO model for GIS qualifications was also developed (du Plessis & van Niekerk, 2014). Research has been done to identify comparability of the UCGIS BoK, the PLATO model and the GISc USBQs (du Plessis & van Niekerk, 2013). It was concluded that the "USBQ and the PLATO model for professional GISc practitioners correspond well with the BoK", and "significant duplication was identified between the different components of the three models" (du Plessis & van Niekerk, 2013: 215).

In the relationships described above, a north/south dualism can be observed. In relation to GIS, northern knowledge would be primarily from the U.S. and Europe. The characteristic of incorporation (relational definition) can be identified. The 'lower' member's GIS knowledge is defined in relation to the 'upper' member. The BoK is defined as being primary and South Africa's GIS requirements were constructed in relation to the dominant qualities.

6.4.4. African power plays

South Africa, because of its relatively stable government, strong economy and natural resources, has differentiated itself as a hegemonic entity within the region. In addition to this, South Africa comes from a legacy of isolation during the apartheid years. The South African media and telecommunications companies have spread out into the rest of Africa very successfully, with the result that many Africans know much more about South Africa than South Africans know about the continent. There is a growing pan-African student presence in my classroom. Foreign African students disparagingly refer to this country as the 'United States of Africa'. The South African popular worldview can indeed be likened to (and linked to) that of the U.S. The economic superiority of South Africans breeds a type of 'privileged irresponsibility' (Bozalek, 2014) in relation to other African subjects. Through mechanisms of dualism, South Africans do not recognise the needs of other Africans, and they remain oblivious of their own privilege. The dualism of citizen/foreigner is used to create maximum separation between South Africans and our African neighbours. Furthermore, debates around White privilege in the current identity-based media have the effect of focusing attention away from anti-African xenophobia onto another dualism (Black/White). This serves to uphold the South African/African separation. This is the schizoid working of advanced capitalism in Africa, similar to Braidotti's cartographies of Europe (Braidotti, 2006): the attempts at unification of Africa through the African Union coexists with calls to shut down its borders; calls for a common African citizenship coexists with increasing regionalism; the promotion of a new African identity coexists with xenophobia, tribalism and religious fundamentalism. Other Africans' contribution to the South African labour force is denied (backgrounding) and they are used as a source of cheap labour (incorporation). In addition to this, they are maligned for taking jobs away from locals (instrumentalism).

South African hegemony is also observable in the academy, and is defended by the hierarchical logic of ratings. In 2017, South African universities occupy 9 of the top 10 highly ranked universities in Africa. There is very little coordination amongst geomatics

academics in Africa, and a vast differential between geomatics offerings within Africa. Furthermore, South Africans strive to strategically publish research in international or national journals with higher impact factors. This serves to further South African isolation. In the early 2000s, Rüther painted a bleak picture of the realities of university geomatics departments in Africa. There were many challenges that many, if not most, African universities had to contend with, such as poor resourcing, inadequate infrastructure, and poor pay for academics (Rüther, 2003). The need to maintain high rankings serves to focus the South African academy inward, and the needs of the others are ignored. This South African single vision promotes the normativity of Man, the humanist subject, who in turn defers authority to the West. I challenge this South African brand of humanism within academia by adopting a posthumanist pedagogical stance. My storytelling, combined with a conversational style, encourages exploration, openness, contamination and cross-fertilisation. In addition to this, student stories that promote pan-African alliances are foregrounded.

6.4.5. An insecure profession

Besides being a profession that literally draws boundaries, geomatics draws boundaries around its own practice through relations of interiority and exteriority. The original surveying qualification was in a later period (mainly in the 1990s and 2000s) split into two offerings – currently, CPUT offers separate diplomas in surveying and cartography/GISc. This was largely due to the increasing specialisation of the constituent disciplines. However, we should not forget that surveying constitutes mapping and vice versa. They are two parts of the same phenomenon and practice, yet surveyors and cartographers are becoming increasingly alienated due to their different educational routes and employment options. There is a boundary that is increasingly being inscribed between surveying and mapping, and one of the reasons for the introduction of the term 'geomatics' can be seen as an attempt at reconciliation between the constituent sub-disciplines. If viewed through the logics of the capitalist market, however, this can be seen as an economic and political action in response to a perceived future loss. For example, the sub-discipline of remote sensing has taken on a life of its own, so in an attempt to secure financial benefit to geomatics practitioners, it was brought under the geomatics umbrella. This was to mitigate against losses that were experienced for example when town planning was lost to surveyors[45].

The capitalist underpinnings of the power relations between industry and the academy are also laid bare by Rüther (2003). He criticised academics for capitulating too easily to the will of practitioners, who believed that education should be driven by the needs of industry. This capitulation can be observed in university geomatics departments' advisory board meetings, as mentioned. Rüther believed that research should guide innovation and provide guidance on trends in geomatics. These researchers could also extrapolate and help to draw the new boundaries of the profession of the future. If this was not done, he believed that other professions would encroach on work that traditionally was the uncontested domain of surveyors. This would result in areas of expertise of surveyors being taken over by others, such as architects, civil engineers or town planners. This indeed is the case as the development of geomatics technologies make them easier to use by others. In this regard, surveyors perceive external threats from other non-professionals such as recreational GPS

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[45] In the past, land surveyors were allowed to conduct small town planning projects, but this has recently been challenged by some municipalities after the promulgation of the Spatial Planning and Land Use Management Act (SPLUMA). The battle ensues, and town planners are now in direct competition with surveyors for certain types of work (see http://www.ee.co.za/article/spluma-municipalitites-reservation-planning-work.html).

users or private individuals who carry out aerial surveying work with drones. Other organisations (e.g. market research companies) who use spatial technologies (e.g. GPS) to carry out their work could encroach on the domain of geomatics practitioners.

Although self-proclaimed members of the geomatics profession see these threats by the others as infringements on the work that should be reserved for geomatics professionals, I argue that these exterior parties present the geomatics profession with affirmative possibilities. The reason for the othering is, first and foremost, economic. Geomatics practitioners see the threat as a taking away of income generation. The geomatics community has, by defining itself, defined the others. These others are akin to what Knox calls 'the monstrous':

> aspects of our human condition that are excised or rejected by the laws of the human community, yet which haunt the boundaries as necessary facets of life. The monster is thus an outsider that is always and already within (Knox, 2016: 173).

The monstrous other can be utilised affirmatively for the development of the self. The development of GIS in particular was because of the vision of early developers, who saw beyond previously held boundaries. The sophisticated software, hardware, procedures and skills that make up current GIS could not have been possible had it not been for collaboration between many contributing disciplines, including geography, computer science, operations research, surveying, town planning, mathematics and cartography.

The insecurity exhibited by the profession was also observable in the academy. In the early 1970s, surveying departments at universities and colleges went through a period of growth. Following the political turmoil in the mid-1970s (most notably the Soweto student uprising of 1976 which spread countrywide), a period of economic uncertainty followed, and surveying student numbers dropped. Focusing on the education of Black surveying students in the 1970s, Eekhout (1978) noted that there was a very small number of surveying graduates exiting from the two educational institutions set up for Black students. These were the University of Fort Hare and the Mmadikoti College. Whilst Mmadikoti College produced diploma graduates in relatively small numbers (generally less than 10 per year during the 1970s), Fort Hare was much worse. Eekhout hoped that 1977 would see Fort Hare's first professional land surveying graduate. In the 1980s and 1990s, academics saw the surveying profession as a profession that was under threat. The political instability, linked with international sanctions (in the 1970s and 1980s) created financial instability in the surveying sector. Besides the surveying departments not running at capacity in the 1980s and 1990s, they were (and still are) expensive to run and maintain. This is mainly because of high running costs, the need for staff with specialised knowledge and expensive equipment. By the 1980s, there were five departments of surveying offering degrees in surveying[46]. In the 1990s and the early part of this century, there was a real fear of geomatics departments closing down. The five departments was soon reduced to two, namely the universities of Natal and Cape Town.

At both traditional universities and universities of technology, some of the surviving departments were absorbed into other, more financially secure departments. For example, at UCT, the Department of Surveying joined the architecture and planning departments to

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[46] These were: University of Cape Town, University of Fort Hare, University of Natal, University of Pretoria, and University of the Witwatersrand.

become the School of Architecture, Planning and Geomatics. At CPUT, the new department was called the Department of Civil Engineering and Surveying.

As confirmed by Academic C:

> *[The absorption of our department into another] was driven, well we were put over a barrel to be honest, it was driven by a non-academic argument, driven by a financial argument.*

<div align="right">(Interview with Academic C)</div>

In addition to the economic relationship between geomatics and related disciplines (like architecture and civil engineering), the relationship has an effect on the way that ethics is dealt with. This will be dealt with in section 6.6.

At the turn of the century, PLATO took the bold step of opening up registration categories in GIS. This was a departure from the narrow focus on surveying that it previously had. The legislation and licencing of GIS as a profession was effectively appropriated by PLATO and the surveying profession. In light of the fear of closure of the departments of land surveying, this move turned out to be the shot in the arm that they had hoped for. New qualifications in GISc were developed that conformed to PLATO's requirements, thus allowing graduates to be registered as GIS practitioners. This effectively formalised the alliance between surveyors and GIS practitioners.

6.5. Dominant and subjugated geomatics knowledge

The reporting of the historical development of surveying and surveying education in South Africa follows a specific trajectory. The repetition of this history produces sedimentation of facts in the minds of surveyors, and canonisation of the achievements of the great surveyor-explorers of the past. Geomatics academics extol the virtues of the brave colonisers and largely uphold the view that surveyors help to bring progress. Pieter Potter, Nicolas-Louis de Lacaille, Henry Georges Fourcade, Sir Thomas Maclear and Sir David Gill are White men whose triumphant, masculine narratives prevail in the story of surveying in this country (see for example Adams, 1975; Jones, 1982; Hurly, 2004; Lloyd, 2004). These names appear in most, if not all, surveying students' curricula, and their stories follow the formula of the heroic Jan Van Riebeeck narrative, which I (and many other children of apartheid) remember hearing in school. The repetition of the achievements of the bold colonists is dominant in the historical record, and overshadows the repetition of the resultant dispossession and domination of the indigenous population and other Black people, together with the degradation of the natural environment in the name of 'progress'.

Monuments and documents pay tribute to the pioneering surveyors in South Africa. For example, Figure 21 shows the cannon that was used to mark the terminal point of a baseline established by Thomas Maclear. This cannon is displayed in the Golden Acre shopping centre in Cape Town - the deterritorialisation of an instrument of war for the purposes of surveying, placed in a temple to capitalism, should be noted.

Figure 21. Maclear's Cannon

Names like Autshumato and Krotoa are slowly starting to become more mainstream in the 'new' South Africa, now that history is being re-iterated[47]. The othering of the native that was perpetuated in the name of humanism is now being attempted to be corrected by a postcolonial consciousness. It is not simply a matter of revisiting a set of events in the past and filling in the blanks – Barad reminds us of the queer nature of spacetime: "past, present, and future, not in a relation of linear unfolding, but threaded through one another in a nonlinear enfolding of spacetimemattering" (Barad, 2010: 244). There is no original, but diffraction and cartography sheds light on a set of heterogeneous histories, a set of differences, a set of displacements. Official history, written about the accomplishments of the powerful, by the victorious, is one vector cutting through space and time. A non-representational understanding of space recognises that space is the dimension of multiplicity – it is composed of interrelations, is heterogeneous, and is in a state of constant change (Massey, 2005). This resonates with a Deleuzian becoming, and posthumanist research oriented towards the spatial recognises that there are a myriad of stories and interrelations taking place in space at any one time.

6.5.1. Morality and education

As mentioned in Chapter Three, morality is the normative stance taken by a society in a particular context and exerts the power of *potestas* over subjects. Posthumanist ethics, on the other hand, is more interested in how subjects responsibly deal with alterity. It pays close attention to political agency and the management of power relations (Braidotti, 2006).

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[47] For example, a movie about the life of Krotoa has recently been released in South African cinemas.

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Through the dominant Christian morality of early surveying education, alterity was not considered. Surveyors were always White and male.

In contrast to the education of White land surveyors, the nineteenth century saw indigenous Africans slowly being introduced to the mission schooling system. By the end of the 1800s, there were many Western missionaries who had set up mission stations and mission schools, in order to convert the indigenous people to Christianity, to spread Western cultural ideas, to teach them work values, and generally to 'civilise' the 'heathens' (Christie, 1985). The promotion of property rights, economics and Christian values (like diligence) served to promote merchant capitalism and at the same time subjugate Black bodies into slavery. The quality of mission schooling was, in many cases, on par with schools for Whites. Some Whites also attended these schools, and there was less of an emphasis on separation of the racial groups - the separation happened along class lines. Some prominent Black South Africans (such as Sol Plaatje, Nelson Mandela and Oliver Tambo) attended mission schools. Colonial texts discuss the education of the native, yet the native voice is silent (see for example Loram, 1917).
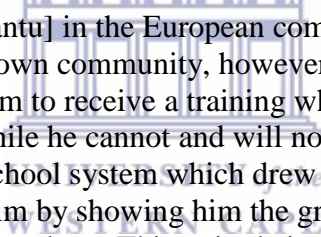
In spite of mission schooling providing a relatively good standard of education for Blacks, the colonial period saw the creation and maintenance of many dualisms. As noted by Plumwood, dualism is the logic of colonisation, which in Western philosophy creates a "devalued and sharply demarcated sphere of otherness" (1993: 41). Some of the obvious dualisms that were constructed and maintained during the early educational offerings in South Africa were master/slave, Black/White, civilised/primitive, and rationality/animality.

The underlying Christian ethos has affected education in South Africa ever since it was introduced via the mission schooling system. The controversial system of Christian National Education (CNE) as implemented by the Afrikaner National Party government from the 1940s had a strong influence on the apartheid education policies that came afterward. The apartheid education system, like the town planning system, had far-reaching influence, and their effects are still observable in South Africa today. Christian values of freedom and land ownership place humans (especially White men) firmly on top of the natural order. These 'civilising' tenets were used by Westerners to permanently change South African society, and continue to perpetuate violence (both symbolic and literal) against people of colour.

Landscape, the inert backdrop against which life gets played out, is controlled by civilised Man, who is free to secure it against attack. This biblical guidance was understandably seen to be under attack by Marxists, who proclaimed that it was a crime against the state to hold private rights over land. During the Cold War, when apartheid was in full control, liberation movements such as the ANC and the Communist Party were maligned and labelled as evil communists, who were to be defeated by the protectors of Christian values. The post-apartheid government officially adopted a secular stand, as enshrined in the South African Constitution. Section 15 entrenches freedom of religion, belief and opinion (Republic of South Africa, 1996) yet there is a clear continuation of the Christian ethos. This is not only a South African phenomenon, and the conflation of secularity and Christianity has been observed since the end of the Cold War. This "myth of secularism" (Braidotti et al., 2014: 6) is based on the underlying connection between humanist values and Judeo-Christian values such as respect for the law, individual worth, autonomy, freedom, and rationality. These values were also most prized and promoted during the period of brutal colonial expansion. It should be noted that racism and colonisation of old is still alive and well in the world today, albeit in the form of neo-imperialism and prejudices towards many kinds of others. The

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danger of these prejudices is that they are obscured by popular myths, such as the South African myth of the 'Rainbow Nation' – a harmonious grouping of diverse peoples living in peace. This harmony has, of late, been questioned amid poverty and high levels of inequality which persists along racial lines. The dualist boundary between rich and poor, White and Black is propagated under the effect of advanced capitalism.

Apartheid education further dehumanised Black South African and relegated them to the status of sub-human. During the 1950s, the people of District Six were generally oblivious to the destruction that was being planned for them. Some of the most repressive apartheid laws were being conceived. The Bantu Education Act No. 47 of 1953 officially segregated education in South Africa, and led to the closure of the mission schools. Relatively cosmopolitan urban areas such as District Six would, by apartheid logic, need to be radically socially altered to prevent the mixing of race groups. 'Separate development' was a term coined by H.F. Verwoerd, one of the main architects of apartheid, and required Blacks to be moved (mostly forcibly) to the homelands. According to Verwoerd, the homelands were separate countries, and their creation allowed the apartheid government to claim that there was no Black majority in South Africa. However, the dualistic tactic of backgrounding (denial) was used, and the Bantu Education Act helped in this regard. The Act created a separate Black educational system which in effect produced poorly educated manual labour. The Act was penned by Verwoerd, who, when he was Minister of Native affairs, said in a speech on 7 June 1954:

> There is no place for [the Bantu] in the European community above the level of certain forms of labour. Within his own community, however, all doors are open. For that reason it is of no avail for him to receive a training which has as its aim absorption in the European community while he cannot and will not be absorbed there. Up till now he has been subjected to a school system which drew him away from his own community and … misled him by showing him the green pastures of the European but still did not allow him to graze there. This attitude is not only uneconomic because money is spent on education which has no specific aim, but it is even dishonest to continue with it (Politicsweb, 2016).

The use of the animal imagery by Verwoerd is telling - Blacks grazing on forbidden European land relegated them to the status of animals, and established the hierarchy of European man over land. This was in keeping with the Christian National Education ethos of the time. Access of Blacks to the mission schooling system was viewed as 'dishonest' by Verwoerd as it gave the indigenous population a false semblance of humanity. It was also dangerous for the apartheid government to provide a similar quality of education to Whites and Blacks. This was remedied by disadvantaging the Black populace with a poorer quality of education via the Bantu Education Act and other racist legislation. The White/Black, civilised/uncivilised binary was further entrenched. Using Plumwood (1993), the dualist mechanisms of backgrounding (denial), instrumentalism (objectification) and radical exclusion (hyperseparation) can be observed in the abovementioned dualisms. The apparent benevolence of the apartheid state (in providing Blacks with an education) denies the reliance of the White populace on Black bodies and land. In addition, the differences between the apparent needs of Blacks and Whites are magnified (hyperseparation) so as to legitimise the need for two separate education systems. In Verwoerd drawing a direct linkage between Blacks and animals, one can observe the characteristic of instrumentalism, where the Black population is objectified and reduced to the status of less than human. This is a classic example of differences being organised on a "hierarchical scale of decreasing worth"

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(Braidotti, 2013a: 143) with the humanist subject (Man) defining himself by what he is excluded from. This self-representation justified a violent relationship between Man/Anthropos and the sexualised, racialised and naturalised others. The separate education offerings were designed by the apartheid government, against the backdrop of a need of the White populace for Black labour. This boundary between educational offerings was drawn and the phenomenon of separate development exhibits the dualistic characteristic of incorporation (or relational definition). This is because the lower (Black) member of the dualistic pair is defined in relation to the upper member (White).

When the Natives Land Act was promulgated and implemented in 1913, the catastrophic mass forced migration of race groups started. Sol Plaatje's scathing criticism of the Natives Land Act in particular and South African racism in general in his melancholic *Native Life in South Africa* identified the parallels between natives and animals. For example, in discussing the unfair taxes that Black South Africans had to pay, he had this to say:

> In addition to these native duties and taxes, it is also part of 'the black man's burden' to pay all duties levied by the favoured race. With the increasing difficulty of finding openings to earn the money for paying these multifarious taxes, the dumb pack-ox, being inarticulate in the Councils of State, has no means of making known to its 'keeper' that the burden is straining its back to breaking point (Plaatje, 1914: 19).

As we have seen, the mission schooling that Plaatje obtained was to be disallowed for other indigenous people under apartheid, some four decades later. In addition to this, the homelands and group areas that were designated for Blacks were insufficient in size and the quality of land was unsuitable for farming (see section 5.2.2).

6.5.2. Black silence, environmental silence

The surveying system in South Africa, from its physical infrastructure, to its legislation, and the people who maintain it are acknowledged globally to be exemplary. However, this is one side of the story. As argued in Chapter Five, the global geomatics academy focused on technical and scientific aspects (like accuracy) in their scholarship, which resulted in social and environmental issues being of secondary concern. These two silences (towards social and environmental issues) are discussed below.

Whilst the most violent forced removals of the residents of District Six were taking place in the 1970s and 1980s, academic publications on geomatics education were relatively silent on the plight of Black South Africans, as well as issues of the environment. The first of the two silences is perhaps not as surprising as it may seem. The lack of any mention of the abnormal nature of South African society by White academics could be viewed pragmatically. One could simply blame them for turning a blind to the plight of the Black populace and the atrocities of their government. However, there was much state-sanctioned violence to defend the regime, and there was a very real threat of violence against those who spoke out against the government. The violence being meted out on the innocent people of District Six at the time (and many other urban areas in South African cities) was indicative of what the government was capable of. However, the sympathetic White voices were in the minority, and there was an environment which supported their 'privileged irresponsibility'. The result is that the geomatics scholarship of the time appears ahistorical. In rare cases authors situate their practice as part of a troubled, divided society, with entrenched boundaries. Some had no

choice – Eekhout (1978) was in the employ of the Blacks-only University of Fort Hare, so was intimately aware of the problems facing the Black student populace. His awareness of the ramifications of the 1976 student uprisings paints a bleak picture.

During the 1970s, District Six was almost entirely demolished. Talking to ex-residents, their children, or people who are connected to District Six in some way, one gets a sense of the immense affective power of District Six. The popular memory of District Six was not destroyed by the social engineering of apartheid, and there is still a deep sense of belonging to District Six amongst the dispossessed. District Six is iconic, and "has become a place of symbolic meaning, a memorial to all South Africans dispossessed by apartheid" (Swanson & Harries, 2001: 63). The huge national and international appeal of District Six is affectively tapped into via my District Six story. It relates the iconic place to the everyday lives of my students. Their place of study is on the actual physical space of District Six, and the technology of GIS provides a connection via the mapping of the space over time. For some students, their involvement in my story is a moving experience as they would have heard stories about District Six from others, perhaps their family.

In focusing on technical aspects of geomatics and ignoring social ones, White academics ostensibly focused on the scientific project. In discussing the design of a university course in cartography, Scogings outlined what he thought were the most important aspects of cartography in the education of surveyors. He dismissed the need for artistic or creative aspects to be included. Being highly respected in surveying academia at the time, his words carried weight and were reflective of the prevalent attitude within the geomatics academy:

> A numerate surveyor is not happy with the implication that cartography is an "art" in the artistic or "fine arts" sense but will accept "art" used in the sense of a skill developed as the result of knowledge and practice (Scogings, 1981: 25).

Scogings goes on to claim that a satisfactory course in cartography would contain a theoretical and practical component. The theory would need to cover computational issues, the map as graphic image, and the technology required to construct the map. The practical aspects would link to these main theoretical themes. Nowhere is ethics mentioned. This attitude is still seen today, and is reflected in some of the interviews with geomatics academics (to be explicated in Section 6.6). Academics have been conditioned into thinking that cartography education must exclusively cover technical aspects of the discipline. Their attitudes towards the artistic aspects (nice to have but not essential, etc.) is reflective of the process of subjectification that they went through in their education.

In a later paper, Scogings euphemistically describes the human and technological tensions observable in South Africa at the time. Choosing to ignore the criminal repression of the Black populace that was happening around him, he portrays Western knowledge as superior:

> These tensions spring from history and the side by side existence of rapidly advancing high level Western technology with the lower technology characteristic of a developing country. The gulf between the West and Africa is an ever widening one, which in human terms, we cannot afford to ignore (Scogings, 1982: 1).

This exhibits the dualistic characteristic of incorporation (relational definition) that fed the civilised/uncivilised and modern/primitive dualisms.

This focus on technical excellence by Whites, rather paradoxically from the perspective of the Black population, further entrenched Black inferiorisation. As Steve Biko noted in 1970 about the Black perception of White scientific scholarship:

> Celebrated achievements by whites in the field of science – which he understands only hazily – serve to make him rather convinced of the futility of resistance and to throw away any hopes that change may ever come. All in all the black man has become a shell, a shadow of man, completely defeated, drowning in his own misery, a slave, an ox bearing the yoke of oppression with sheepish timidity (Biko, 2004: 31).

The dualistic tactic of relational definition is seen and criticised here with clarity by Biko[48]. This focusing on technical excellence was one of the contingencies that led to the subjectification of both sides of the Black/White dualism. In addition to the representation of White knowledge as superior, indigenous knowledge was systematically erased due to the imposition of Western modes of being on Black bodies. For example, by dispossessing people from their ancestral land, long-standing relationships between people and the specific flora and fauna that occurred there were erased.

The effectiveness of the apartheid state lay in its power to regulate all aspects of the life of the citizenry through both 'petty apartheid' and 'grand apartheid'; from where people of different races could walk, enter buildings, go to the beach, to who people could associate with (the Immorality Act took care of inter-racial relationships), to where people were allowed to study. I remember being ashamed of my 'Indian' accent at university in the 1990s, so chose to not speak up, particularly in the presence of Whites. All the lecturers and others who were in similar positions of authority during my undergraduate and postgraduate studies in the 1990s were White. As an authority group, what they focused on (and what they chose to be silent on) would leave an indelible mark on the way I (and others like me) would perceive the discipline of geomatics. Today, the South African academics that are in the employ of geomatics departments would, in the majority, have gone through some or all of their education during the apartheid period. This in turn affects what they choose to focus on in their pedagogical practice or research.

The second of the two silences mentioned above – that towards the environment – requires a more subtle understanding. As a starting point, it should be noted that geomatics education is inherently non-anthropocentric. This is because much of geomatics theory is based on scientific principles that are grounded in the natural, mathematical and physical sciences. The dominant human (Anthropos) does not feature in many of the problems that geomatics practitioners and students are required to solve. Calculating co-ordinates of points, monitoring movements of the earth's surface, or producing a map of a piece of virgin land all do not seem to be human-centred activities. Furthermore, surveyors spend much time outdoors, involved in activities that bring them closer to the natural environment than many other professions. The issue is that the more insidious and linked problem, namely *humanism*, is masked by a profession that portrays itself, rather romantically, as being at one with nature. One of the reasons that I chose to study land surveying was a video that I watched during my final year in high school. The video was played by the Department of Surveying and Mapping at an open day at the University of Natal. I was seduced by the combination of

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[48] His quote at the beginning of this chapter points to the associated process of subjectification.

working with technology, making good money as an engineer, and the promise of a lifestyle of 'Land Rovers and sunsets'. The desires that were activated in me are typical desires of subjects living under the socio-economic conditions of advanced capitalism. I was soon an undergraduate student of land surveying.

Academic E, when asked about the characteristics that make a successful geomatics practitioner, had this to say:

> *They must have motivation and they must have a mathematical ability and they must have some appreciation for the environment, they must enjoy the outdoors. Of course they must enjoy working in the outdoors but they must also enjoy protecting the environment.*

(Interview with Academic E)

Here we see the archetypal surveyor being described: self-motivated, with adequate skills in the scientific (more specifically, mathematical) method, and an enjoyment of being out in nature. These traits are strongly resonant with the subject of humanism, who is rational, autonomous, self-directed and has the freedom to choose a path in life. The enjoyment of nature conforms to the nature-as-backdrop notion promoted by dominant Christian morality.

Although surveyors might, at an individual level, practice what they feel might be akin to environmental ethics[49], their actions within a collective might be contrary to it. The deeply humanist nature of geomatics education, as paradoxical as that may seem, is a marker of the dominance of the Western humanist Man. Hence, the challenge in developing a posthumanist orientation to geomatics is to look further than developing non-anthropocentric perspectives. Braidotti (2011a: 355) notes that "classical humanism, with its rationalistic and anthropocentric assumptions, is of hindrance" to affirmative transformation. Yet there are possibilities of affirmation in the face of mourning the loss of the natural order. Braidotti's strategy is one of zoe-centred egalitarianism, which advocates a flattening of the species hierarchy. This, as mentioned in Chapters Two and Five, is a very difficult task, as our anthropomorphic lived realities are different to those of other members of the 'natural' world. In addition to this, environmental and animal rights activists run the risk of extending humanism to the natural others by anthropomorphising animals. Although having good intentions, this position re-establishes Man as the centre of all things, thus opening the door to commercialisation and commodification.

Zoe- or bio-centred egalitarianism (Braidotti, 2006) agrees with the principle of non-profit and communally held property rights. There are efforts in South Africa to strike a balance between communal and traditional land ownership on the one hand, and private property rights on the other. For example, the Communal Land Rights Act (CLaRA) was a piece of legislation enacted in 2004 that was intended to offer redress to mainly Black, rural people whose land tenure was legally insecure as a result of past racially discriminatory laws. CLaRA was struck down by the Constitutional Court in 2010 because it would have placed decision making around land tenure in the hands of traditional councils (which used to be the apartheid-era tribal authorities in the homelands). This centralisation of power was contested. Yet the distribution of wealth (and ownership of land) is still highly concentrated and very much along the old axes of power. Furthermore, the promulgation of legislation that assigns

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[49] Braidotti (2006: 121) makes the following note about environmental ethics: "ethics begins with a responsible and accountable interaction with one's 'natural' habitat".

communal land rights to parts of the country creates separation between those parts and the rest. The effect of the dominance of the free market on the communal tenure areas has, thus far, kept large-scale investment away. The logics of the market and the imperatives of economic growth guides government policy. The government "recognises that land remains an unusable or "dead" asset until land tenure is instituted and formalised" (Williams-Wynn, 2015: 2). This viewpoint is understandable, considering the generational impact of the denial of formal tenure to Black South Africans under colonialism and apartheid. What is seen, however, is the logic of advanced capitalism being inscribed onto indigenous knowledge systems and practices. Restitution sees the government imperative of granting the rural poor the ability to enter the market economy via formalisation of communal land tenure. Communal tenure is in tension with the Western conception of private land rights, which allocates individuals rights over discrete parcels of land. The effectiveness of officially recognising communal tenure rights within the formal cadastral system remains to be seen. There is currently draft legislation (the Communal Land Tenure Bill, 2017) which seeks to formalise communal land tenure, as the previously ill-fated CLaRA did.

In post-colonial and developing countries like South Africa or Brazil, what is referred to as modernisation or economic growth through land use, simply serves to reproduce the colonial model and does not effectively change the structure of land ownership. The hegemonic system effectively becomes the "usurper of ecosystems and local cultures" (Sato, Silva & Jaber, 2014: 105). Furthermore, South Africa is a rapidly urbanising country, and such development serves to make the landscape inhospitable for local fauna and flora.

6.6. Modern geomatics education and disjointed ethics

Around the beginning of the 1990s, GIS started cohering into a distinct, yet heterogeneous profession. GIS was introduced into the curricula of universities in South Africa in the mid-1980s. This was late, compared to other universities overseas (especially in Europe and the United States). This could be attributed to the trade sanctions imposed on South Africa during the apartheid years (Hodza, Coetzee & van der Merwe, 2016), making it difficult for universities to acquire the specialised hardware and software required. J.B. Harley started challenging cartographers to think about ethics in the late 1980s, while other critical thinkers in cartography started drawing links between mapping, war and propaganda (Dibiase et al., 2009). The rapid development of new technologies ensures that we are in a state of constant jet lag – we are always behind the times and trying to keep up (Braidotti, 2006). This is brought to the fore in the ethical challenges that geospatial disciplines encounter with new developments in the field, and in the adoption of the technologies by other fields. For example, location-based services are able to track humans and non-humans with astounding levels of accuracy, around the clock. The panoptic gaze of contemporary forms of control (like corporate companies) is increasing, and geomatics technologies are crucial enablers. In addition to this, Artificial Intelligence (AI) systems interpellate/interpolate us into conforming to the algorithmic logic at their core. Academia too is an agent in this assemblage of control, and the commodification of research via corporatisation of the academy means that the amounts of data grows exponentially, but access to it is prohibitive via costs, copyrights or patents. In addition to this, the intimate involvement of geomatics technologies (e.g. GPS and Automated Unmanned Vehicles) in the business of war is clear. Ethical guidance is needed.

6.6.1. Ethics development

Crampton suggested a four-stage linear sequence through which a discipline passes when it comes to ethical awareness:

a. ignoring ethics (or rather being unaware of ethical issues),
b. considering ethics from an internal perspective only,
c. considering ethics from both an internal and an external perspective, and
d. establishing a dialectical relationship, which modifies both internal and external perspectives (Crampton, 1995: 85).

This was written in the mid-1990s, and Crampton placed the ethical awareness of the GIS community in the U.S. at stage (b). I suggest that in South Africa currently, geomatics education is located primarily at stage (b), with evidence of both (a) and (c) in some instances. A posthumanist sensibility allows the simultaneous occupation of multiple time-zones, so the linear nature of Crampton's sequence can be troubled. Stage (b) is defined by preoccupation with technical issues, such as reducing errors, maximising accuracy and establishing standards.

As an indication of stage (a), there is very little published research about ethics in geomatics emerging out of South Africa. This is indicative of the (lack of) importance that is accorded to ethical considerations in geomatics education. In developing a proposed framework for GIS education in South African universities, du Plessis and Van Niekerk (2014) researched the perceptions and needs of the GIS community in South Africa. The participants were asked to rate a set of knowledge areas (KAs) in order of importance for inclusion in GIS curricula. Out of a set of 16 KAs, 'Legal and Ethical Aspects of GISc' scored below average and was placed 13th on the list of importance. It is interesting to note that the most important KAs were those covering technical aspects – the first 5 were: Data Modelling, Geospatial Data, Geographical Science, Analytical Methods, and Cartography and Visualisation. The KAs that covered social aspects, namely Training, Legal Aspects of GISc, and Organisational and Institutional Aspects were ranked 12th, 13th and 15th respectively.

Working in concert with (a), which is ignoring ethics completely, is the tendency to pass the responsibility to others. This was observed in numerous conversations. Academic A identified 'morals and ethics' as important characteristics to inculcate in the production of geomatics practitioners. When asked about how these qualities should be cultivated, they said:

It's firstly how people grow up, it, their culture at home.

(Interview with Academic A)

Academic A then goes on to critique the general state of moral and ethical decline observable in South Africa at present:

In this country [there is a] general culture of not really doing things as they should be done.

(Interview with Academic A)

The perception of Academic A is in contrast to that of Practitioner H, who is employed at the City of Cape Town municipality. Practitioner H explained that there had been a major

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political drive to minimise corruption within the municipality over the last decade. Compliance with regulation governing behaviour is strictly enforced, and employees are at risk of being dismissed if found guilty of wrongdoing. Under these conditions, Practitioner H felt that the ethical awareness of geomatics practitioners in the municipality has gotten better. They describe geomatics graduates who come to work for the municipality as follows:

> *The students, when they come to the City of Cape Town, it's a bit of a wake-up call because they realise now they are sitting in the real world and then someone is looking over their shoulder. They get a strong sense that there must be order in the world and there's certain structures which you are forced to comply with and certain regulations and that these regulations are actually being enforced. So when it comes to simple things like leave and sick-leave and working hours they get strictly monitored and there is a daily time sheet and it gets checked.*

<div align="right">(Interview with Practitioner H)</div>

The interpellation into behaving in specific ways in the context of pre-defined hierarchies is evident. With respect to ethical behaviour, Practitioner H further explains what happens at new staff induction:

> *when they come to me … I explain them the hierarchy and what we're doing and the staff compliment and the functions and I give them a broad overview. I also cover ethics and I tell them what we expect of them. I cover things like private work and ethical conduct and that includes religious comments and sexual harassment, stealing and all these things get mentioned and also cheating on working times. That is a big issue, being punctual, completing projects in time, be accountable for the work you do, do not cheat on survey results.*

<div align="right">(Interview with Practitioner H)</div>

One can see that this conception of professional ethics is associated with the avoidance of bad behaviour, and is moralistic.

As mentioned, the geomatics curriculum largely ignores ethics, and presumes that students have had ethical guidance from parents or guardians. This of course does not say much about the quality of the ethical guidance. When I asked Student K about whether his university education taught him how to operate ethically in the world, he said:

> *I think ethics are a personal attribute. I don't think anybody can teach ethics, it's something that you just have as a person, you know. Yes education, formal education will give you principles that you need to adhere to as a professional but in terms of maintaining those and applying those principles that really becomes up to you as a person, you know. So I don't honestly think that it helps but it makes you aware of what you need to do as a professional*

<div align="right">(Interview with Student K)</div>

Student K went on to say that his personal ethical outlook depended mostly on family upbringing:

> *From my family, I mean my grandfather was a minister at church, so I grew up in church, you know what I mean, so I grew up in a strict household so it's something that*

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has always been within me. Hence I say it's a personal thing, it's not something that I picked up from university … it's something that I've just always had.

(Interview with Student K)

Student L did not have such an experience, and in discussing her upbringing, had this to say:

When we get to university straight from matric, I believe my lecturers are now supposed to be my mentors. But, when we get there, it's not like that. [For example] Mr Motala will focus on GIS. The ethics parts, [he's] not gonna touch it. When I get to the work environment, they assume I've learnt that in school. I lack it. Now the whole chain going down, is broken. No-one teaches me ethics, nowhere. Because, when I'm young, my mum sends me to school. [She] believes that my teachers will teach me ethics. My teachers assume that these kids learn that at home. We learn ethics on our own. I feel that we lack that. Our profession lacks that, our teachers from school lack that, our parents also.

(Interview with Student L)

There is also an avoidance of responsibility, or perhaps oblivion on the part of Student L, who claims that she was never taught ethics. Our current era is marked by a high degree of moralising discourse, aimed at the individual. The resurgence of evangelical Christianity in Africa, for example, means that many Christian students will be exposed to religious doctrine and taught normative Christian morality as a matter of course. This individual moralising fails to deal with complex problems that need to be solved collectively. Hence, modern South African subjects are characterised by being conditioned into humanist thinking. This is achieved firstly by the powerful Christian ethos at the heart of the education system. Secondly, the influence of the church on African Christians is very strong. This does not only apply to Christians only, as the other monotheistic religions (Judaism and Islam) also have, at their core, the humanist belief system promoted by Christianity.

With regards to evidence of stage (b) in Crampton's taxonomy, a search of recent academic geomatics publications shows that the inclusion of ethics into curricula are largely due to the need to conform to the PLATO model, so as to allow graduates to register with the professional body (Barry & Whittal, 2003; du Plessis & van Niekerk, 2014; Hodza, Coetzee & van der Merwe, 2016).

In the interviews, academics exhibited a sense of resignation to the dominance of 'hard' science in the hard/soft science dualism. Academic B, in discussing the curricular reform in the geomatics curriculum at their university:

In our discussions on curriculum we haven't really considered [environmental issues] because we are so concerned with the challenges of our own technical requirements of the discipline, so how do we put all that in? To make space for something else like this, as valuable as it may be, is difficult.

(Interview with Academic B)

The above statement was made in response to a question about how to teach for an awareness of environmental ethics. As alluded to, the 'technical requirements of the discipline' take precedence over other ('soft') issues such as ethics. However, there still remains the difficulty of adequately dealing with the issue of professional ethics, which is a requirement in the PLATO model. When probed about how this difficulty is dealt with, they said:

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We bring external professionals in to teach that content… so hopefully those interactions … hopefully a bit of that rubs off.

<div align="right">(Interview with Academic B)</div>

This exhibits a combination of an avoidance of responsibility on the behalf of the geomatics department in question, and a means for capitalist logic to directly influence the subjectification of students. The latter is achieved by farming out the work of the lecturing of professional ethics to industry, whose primary motive is profit. Although there might be more benevolent intentions on the part of individuals in industry to offer their time for lecturing, an explicit connection between industry and academia is made. One can see how, in this case, the ethical conditioning of students is facilitated by industry. This perpetuates stasis, and the profession stays firmly rooted at stage (b) in Crampton's sequence.

Dibiase et al. (2009) believed that GIS educators should address ethics 'in house' and choose not to outsource ethics to other academic departments, like philosophy. This promotes the inward-looking nature of the geomatics profession. This is paradoxical, considering that GIS emerged out of a convergence of many disciplines, such as computer science, geography, cartography, surveying, engineering, etc. Nonetheless, leaving ethics to geomatics has led to a rather one-sided and technicist view. This view has conflated accuracy with ethics, and established a hierarchy of importance, with the sciences (natural, mathematical and physical) firmly at the top, and other branches of knowledge taking a back seat. In addition to this, the brand of ethics that the geomatics profession advocates is one that can be described as professional ethics, once again staying internal to the profession at stage (b) in Crampton's sequence.

When probed about what we could do as educators to counter the phenomenon of general ethical underpreparedness, Academic A suggests:

This is obviously a national issue and I think, we just have to preach it. I tried to preach it to my students and more in individual conversations than in lectures.

<div align="right">(Interview with Academic A)</div>

Academic A's statements shows a combination of wanting to avoid the difficult task of ethics education, and a resignation to dealing with it in a humanist way. The urge to 'preach' illustrates Academic A's paternalistic view that his ethical viewpoint it superior to the students. Preaching positions them as transcendent, an outsider who knows more. When probed about what 'it' is that needs to be inculcated, there is a return to professional ethics:

Academic A: *Attention to detail, discipline...*
Interviewer: *What does that mean, discipline?*
Academic A: *Discipline means that you force yourself to check in situations where you think you could actually get away without a check. You know you've done a survey, it's fine, do you still want to go back and check it once more? Do you always make sure that everything you're doing is done according to the books? It's a question of professional ethics. I think that, besides certain mathematical skills you need to have an ability to think on your feet. And I think professional ethics is very crucial for the professional surveyor.*

<div align="right">(Interview with Academic A)</div>

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Within the boundary of the geomatics discipline, ethics is humanist, emphasising autonomy and rationality. This is by no means a South African phenomenon, as the sentiments expressed by Academic T1 (from ITC the Netherlands) are similar. When asked about the qualities that need to be inculcated in GIS practitioners, he had this to say:

> *I would say that they would be skilled operators, but operating as an independent GIS person that is actually competent in working individually.*

<div align="right">(Interview with Academic T1)</div>

6.6.2. Distributed ethics

In contrast to the individualistic notion of ethics within the boundary of geomatics, we find that in the 'family of professions', the focus on professional ethics is approached in a distributed manner. Once-close professionals, such as architects, town planners and surveyors nowadays seldom communicate substantively; hence do not influence each other's work as much as they used to in the past[50]. An architect, for example, may not dwell on the environmental implications of clearing indigenous vegetation from a building site; this would, in the mind of the architect, be addressed by the company which would carry out the environmental impact assessment. The land surveyor who would be tasked to stake out the building lines for the construction phase of the project would have a different conception of ethics. Ethical behaviour would involve the accurate placement of beacons and boundaries, so as to avoid future accidents, boundary disputes or litigation. The land surveyor would not have the decision-making power to influence many aspects of a project, so ethics at a more holistic level is ignored. This is related to the problem of passing the ethical responsibility around.

Academic A, when asked about how knowledgeable geomatics practitioners should be of issues pertaining to ethics, such as sustainable development, climate change and the environment, had this to say:

> Academic A: *That I find very difficult question because my first response would of course be, very, it's very important. But if you look at the reality, in all my life, and I've done quite a number of international projects, like I've done this ... project where I was scientific developer, the scientific coordinator for development projects. That was the only time where I ever could actually practice these things...*
> Interviewer: *Why?*
> Academic A: *Because you don't have the opportunity as a technical surveyor - you cannot easily influence decisions which relates to environmental issues and so on.*
> Interviewer: *So again it goes back to the power of the surveyor being just a service provider?*
> Academic A: *That's right, exactly that. If you get into a managerial position or if you can get in design circles, into the group of people who design something, who develop something, then you can say something and then the surveyor is very important but generally you don't have a say in this.*

<div align="right">(Interview with Academic A)</div>

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[50] It should be noted that, despite this estrangement, the linkages between this family of professions is written into law. In the PLATO rules (see Appendix 1), a surveyor may not enter into partnership with anyone other than a town and regional planner, a quantity surveyor, an architect, or a professional engineer.

Surveyors are thus interpellated into a mindset of being a service provider. In rare cases do local academics consider the broader social and environmental implications of GIS education, which implies a move to stage (c) in Crampton's sequence.

Coetzee, Eksteen and Grundling (2013) consider the role of GIS education in furthering South Africa's sustainability goals, as devised by government. They recognised the interconnectedness of the dimensions of economic growth, environmental balance, social inclusion and culture (the four dimensions of sustainable development). The aim of sustainable development is to meet current needs, without compromising the needs of future generations. Notwithstanding the underlying capitalist logic inscribed onto this definition of development (particularly economic growth), this represents a more holistic move for the education of GIS students. There are resonances with a posthumanist brand of ethics, which entails the formation of new alliances in our ongoing process of becoming. Radical pedagogical practice seeks to encourage disidentification from the dominant subject of Man and Anthropos. This disidentification entails various modes of becoming: becoming-woman, becoming-other and becoming-world (Braidotti, 2018a), which may involve non-linear thinking and encourage communication across generations. At ITC in the Netherlands, the core introduction to GIS course starts off with a section entitled 'System Earth' (Tolpekin & Stein, 2013). Instead of being focused on the technology, there is more of a zoe-centred leaning by starting off with the earth. Students are introduced to systems thinking by focusing on environmental systems and their relationship to GIS. It acknowledges the complexity of the earth and takes the viewpoint that GIS can help to describe and model the earth for the purposes of sustainable development.

We find that there is a lag between ethical issues in South African geomatics publications, compared to the scholarship emerging out of the Global North. There is a wider recognition in the writings of the 'first' world that businesses are finding it more difficult to legitimise ethically questionable behaviour (for example toward the environment and indigenous people) on the basis of economics alone. However, it should be noted that this behaviour is more likely to be curtailed in smaller companies. Bigger corporate companies have the backing of powerful governments and are able to get away with destruction on a much larger scale. My Caltex story in Chapter One illustrates this point.

Reading Crampton's sequence diffractively with a posthumanist conception of ethics, one can see a problem in the final stage (d), which requires a dialectical relationship between internal and external perspectives to be established. This entrenches the interior/exterior binary, and assumes that there is a clear-cut boundary between geomatics and other professions. As we have seen, the boundary has been drawn around the profession largely in the name of humanism. I am advocating a different sensibility, informed by a posthumanist ethic at both the analytic and normative levels. This requires a desire to bypass the logic of dialectics which inscribes otherness and implies a universal idea of reason. Braidotti (2013a, 2018b) advocates a third way, based on Spinozist, monistic thought. This third way tracks the multiple ways in which we are becoming knowing subjects, and does not subscribe to "dialectical oppositions and pejorative differences posited by classical humanist 'Man', and the supremacist assertions of 'Anthropos'" (Braidotti, 2018b: 8). Monist thinking relocates difference outside dialectics, and ethics in this case would not be seen as two opposing (exterior and interior) approaches. I would thus propose an alternative schema, one that does not assume an 'interior' and 'exterior' viewpoint, but demonstrates the following movement:

a. ignoring ethics
   b. a humanist conception of ethics, and
   c. a posthumanist conception of ethics.

In my schema, South African geomatics education exhibits a combination of (a) and (b). Moving beyond humanism is difficult, and moving beyond anthropocentrism even more so. A nomadic ethics or even the ethics of care does not impose a top-down view of ethics, but is more responsive to situations as they arise.

6.6.3. Geomatics scholarship and alterity

Karen Barad points out that in knowledge-discourse-power practices, measurement or observation of something necessarily requires something else to be excluded. "Accountability must be thought of in terms of what matters and what is excluded from mattering" (Barad, 2007: 184). In the traditional geomatics learning experience, issues of alterity (involving Blacks, women and the environment) are excluded and the world is articulated (and articulates itself) in specific ways.

There is an element of privileged irresponsibility on the part of White academics, who produced all geomatics scholarship before the late 1990s. Soon after the fall of apartheid, Waters lamented the decline in the ethical standards of surveyors:

> Ethical consideration has always been part of a professional land surveyors [sic] way of life - the business manner in which he behaves towards his clients, partners, and other members of the profession. However, there is a growing concern in the profession for the lack of ethics of recent graduates. Changing values, the general pace of life, demands on time, and business competition may be some of the contributing factors facing the newly qualified graduate. The graduate is thrust into a world where time means money, and ethical considerations may not be at the back of his/her mind (Waters, 1996: 370).

White academics like Waters were complicit in being agents of apartheid education, yet might have also been strongly guided by their individual ethics that disagreed with the system of apartheid. In addition to this, environmental concerns were not as urgent as they are today. Notice the conflation of ethics and business conduct by Waters - this points to professional ethics that is important to the discipline.

Black academics only started appearing in geomatics departments in South Africa after the fall of apartheid. This new phenomenon was bound to introduce a new awareness in geomatics education, but, as witnessed by the ongoing public debate into decolonisation, it did little to overturn the underlying colonial knowledge base.

In a sign of the changing times, recent academic papers from the geomatics academy make reference to ethics (see for example Coetzee, Eksteen & Grundling, 2013; Landman, Akombelwa & Forbes, 2017). The overwhelming evidence of the destructive nature of the period of the Anthropocene, together with moves by governments internationally to mitigate such destruction, places sustainable development at the centre of educational thought. In addition to this, the renewed focus on decolonisation in South Africa and anti-racism globally has fuelled this 'new' thinking.

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A diffractive and cartographic understanding sees the effect of difference, in relation to contextual power relations. There is a paradox in the 'new' focus on ethics in geomatics education. Although moving in the right direction in terms of environmental awareness, one cannot help view these developments with a certain amount of scepticism. This scepticism comes from an awareness of the market logic that has permeated the geomatics profession. The need to be in touch with changes in the environment (physical environment and world of work) comes in part from an aim of universities and academics to produce "a highly adaptable graduate who can survive in this rapidly changing environment" (Rüther, 1996: 4). Hence the stated ethical aim is not an environmental awareness that is necessarily for the sake of the environment – it stems, in part, from what Braidotti calls a negative or reactive form of pan-humanity engendered by shared vulnerability in the time of mass extinctions and a loss of the natural order (see for example Braidotti, 2011a, 2013a). In addition to this fear of our own extinction, the bio-political power of capitalism is able to harness fear in furthering its own aims (the insurance industry is a good example of this). The rapidly changing environment that Rüther speaks about in the quote above is the capitalist, market environment that the modern geomatics practitioner has to negotiate. This environment is focused on explicitly in geomatics education, and it is to the detriment of the 'natural' environment.

Further to the above discussion about the power of global markets, geomatics educational papers often use economic growth or opportunities to validate curricular reform suggestions. When geomatics departments were struggling to keep open in the 1990s and early 2000s, it was pointed out that geomatics products and services contribute significantly to global markets, hence justifying their survival (Barry & Whittal, 2003). This capitalist, market logic is ubiquitous in higher education. Bozalek (2017) points out that market principles such as efficiency, competitiveness and productivity dominate all aspects of the corporatised university.

6.6.4. Ethics in geomatics legislation

The current legislation that is applicable to the geomatics profession is The Geomatics Profession Act No. 19 of 2013, which repealed The Professional and Technical Surveyors' Act No. 40 of 1984. Act 40 of 1984 had a set of rules that were published by the South African Council of Professional and Technical Surveyors (PLATO). With the introduction of the 2013 Act, PLATO has been replaced by the South African Geomatics Council (SAGC). The rules of the 1984 Act have for a long time (since 1984) guided the conduct of surveyors. The rules were replaced recently (in 2017) by a Code of Conduct which replaced the section of the rules of the 1984 Act entitled 'Improper Conduct'. There is a strong indication of the ethical stance of the profession if one analyses the 1984 rules and the 2017 Code of Conduct. Both documents are shown in Appendix 1.

In the 1984 rules, Sections 15, 16 and 17 are the only sections that deal with ethics, albeit by negation. They are respectively entitled Improper Conduct, Inquiries into Alleged Improper Conduct and Procedures at Inquiries. They were ostensibly composed to encourage proper conduct by outlining what constitutes improper conduct. This engenders a reactive orientation toward ethics, one that is fear-based: the land surveyor is driven by an ethic that discourages negligence. This is also deeply resonant with Kantian universal ethics which are intended for rational, autonomous beings. These beings are guided by moral laws that are general, unconditional, and universally applicable (Taylor, 2018). These subjects are the subjects of

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humanism, and require rules that are generally applicable by all. Professions such as land surveying have these sorts of rules written into their codes of conduct.

This can be contrasted to a posthumanist affirmative ethics, in which relational subjects gesture toward virtual futures in a show of *potentia*. A close reading of section 15 reveals the aspects of surveying practice that the Council deems improper. Following Foucault, these aspects of practice become familiar, focused on, and unchallenged, thus inscribing themselves into the psyche of the practicing surveyor. The reader is encouraged to refer to all the 'acts and omissions' of improper conduct that appear in section 15 of the 1984 rules (see Appendix 1). Some highlights of this section include:

A surveyor may not:
- conduct work that they have not been trained for, or work for a company as a surveyor if the company is not a surveying practice, or employ someone who is not qualified, or employ someone who has been suspended in terms of the Act;
- end a job without it being completed as per a contract, or charge more than a reasonable fee for a contract;
- conduct unsolicited advertising or mislead the public in terms of what they are capable of doing;
- enter into partnership with anyone other than a town and regional planner, a quantity surveyor, an architect or an engineer;
- bring the reputation into disrepute.

By paying attention to what has been left out, we also see what the aspects of geomatics practice are that the profession deems to be unimportant, confirming the findings from academia. No mention is made about environmental ethics, sustainability, social justice or land appropriation made possible by land surveying. In the 2017 Code of Conduct, however, an expansion of the 1984 rules can be seen, and, in keeping with the Constitution of South Africa, more ethical issues are dealt with. Chapter 2, the largest section of the document, is very much in keeping with the ethos of the 1984 Act and rules, and focuses on improper conduct. Chapters 1 and 5 explicitly encourage geomatics practitioners to work towards the transformation of the demographics of the workforce. The very short Chapter 4 encourages geomatics practitioners to work towards the welfare of society and the health of the environment.

It is useful to analyse the codes of ethics that have been published by the two main institutes aligned to the geomatics profession in South Africa, namely the South African Geomatics Institute (SAGI) and the Geo-information Society of South Africa (GISSA). SAGI has a 'Code of Conduct', and GISSA has 'the GISSA Code of Ethics'. Both these documents can be found in Appendix 1. They were both published before the 2017 Code of Conduct. It is possible that these institutes identified the lacunae in the 1984 PLATO rules, and dealt with ethics more substantively thereafter.

When compared to the PLATO rules, both SAGI and GISSA have commendable codes of ethics. Besides discouraging members to act improperly (in the sense of the conduct outlined in the PLATO rules), there is much other affirmative guidance. It should be noted that codes of ethics of the institutes are generally not included in geomatics curricula at universities.
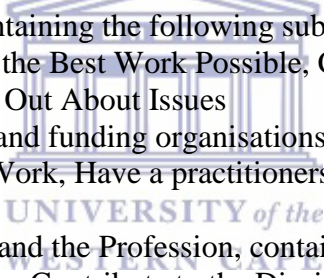
The SAGI document contains sections on the following aspects:

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- Competency;
- Integrity;
- Public Interest;
- Environment;
- Dignity of the Profession;
- Administrative;
- Price Competition

The sections on competency, integrity, dignity of the profession, administrative and price competition have strong resonances with the general ethos of the PLATO rules, and focus on the minimisation of unethical conduct. However, the two (small) sections on public interest and environment encourage members to regard issues related to public health, public safety, public interest, impact on the environment and sustainable development. This is a notable move away from a sensibility that is focused on the subject of humanism, to one that opens the door to the subjects of alterity. It is also more explicitly relational, as it acknowledges that practitioners are located in a society and their actions can have an impact on health, safety and other issues of public interest.

The GISSA document takes ethical considerations a step further. There are sections that elaborate on the following themes:

- Obligations to Society, containing the following sub-sections: Legal responsibilities, Social responsibilities, Do the Best Work Possible, Contribute to the Community to the Extent Possible, Speak Out About Issues
- Obligations to Employers and funding organisations, containing the following sub-sections: Deliver Quality Work, Have a practitioners Relationship, Be Honest in Representations
- Obligations to Colleagues and the Profession, containing the following sub-sections: Respect the Work of Others, Contribute to the Discipline
- Obligations to Individuals, containing the following sub-sections: Respect Privacy, Respect Individuals

When reading this document and the 2017 Code of Conduct together with posthumanist literature, there is a much more affirmative stance represented. Although the centrality of the human is maintained, there is at least a more thoughtful approach towards issues of the environment and ethics in general. It takes a less normative stance and recognises that there could be conflicts encountered in carrying out GIS work. It says "In case of any conflict of interest, the interest of society will be our deciding factor" (The Geo-Information Society of South Africa, n.d.). Although this places the needs of man at the centre, it does emphasise the importance of environmental health. The hierarchy of humanism is maintained: a 'well society' is characterised by GISSA as both a safe social environment, and a healthy natural environment. One can see the underlying Christian ethos in that the natural environment is defined in utilitarian terms.

There is a possibility of an affirmative transformation of the relations that continue to ignore and minimise ethical thought. This would involve seeking out new, qualitatively different relations. From my perspective of being a lecturer, these relations would be based on what we have called a pedagogy of 'response-ability'(Bozalek, Bayat, et al., 2018). A response-able pedagogy, which is based on a relational ontology, would have an ethical stance that is less normative, and more emergent, without slipping into relativism.

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6.7. Concluding thoughts

This chapter has shown that there is a lacuna in the ethics education of geomatics students. Being attuned to silence allows this type of analysis to highlight a blind spot. It is clear that geomatics academics were too consumed by technical issues (like accuracy) to have been overly concerned with ethics as a caring or socially just practice. The ethics furthered by the geomatics profession conflates ethics and accuracy, and accuracy is deemed to be the most important aspect in professional ethical practice.

Scientific, quantitative thinking is not rejected outright – it greatly enhances the experience and understanding of the phenomenon under investigation. Scientific thinking must be deterritiorialised and guided by a posthumanist ethics which has a healthy scepticism towards boundaries in general. Hence there is a balancing act required to proceed. The scientific geomatics method must be guided past the need to derive conclusions that promote dualisms, which is a tactic of colonisation. The virtual intersects with the actual across time in an awareness that displaces the central position of the subject of humanism. Useful questions that helped me in thinking with theory across time were: What are the gestures to the present in the past? And how is our present an actualisation of a host of virtual possibilities from the past?

For the stories that I told, stories from African history were mainly used to grow a postcolonial consciousness. Personal stories allowed me to speak from my location, and opened myself up to connections with students that would hopefully enhance their power of being able to act. Furthermore, stories like District Six that cut across time, gesture toward a justice-to-come (Barad, 2010). The ethic that guides the analysis is the inspiration for seeking out patterns of difference. A pattern of difference that matters in the District Six story is the disruption of the spatial fabric or the physical landscape over a period of time, but also the continuity of other elements such as religious buildings and schools. There is a break in the continuity of the living land. For example, very few large trees survived the destruction of District Six. Being in close proximity to Table Mountain, it is an ironic scar on the mountain which is the very heart of the Cape Floral Kingdom, a unique megadiverse ecological wonder.

The District Six story is conveyed and represented as a set of chrono/logical maps. Relying on the logic of *Chronos*, they are useful in understanding the systematic nature of the hegemonic order. The repetition of the exclusions/forced removals by the racist/capitalist systems show up with regularity. Capitalism changes over time, and is intimately entangled with colonialism, racism, conquest, knowledge creation, religion and prosperity. As in Barad's stories, the hauntings in the stories of Pieter Potter and District Six are not just recollections of a painful past (for some) but are part of difficult existing and future material conditions. Conversely, other (mainly White) people are born into a nurturing environment where they can pursue happiness and self-improvement. Barad points out: "Hauntings are not immaterial, and they are not mere recollections or reverberations of what was. Hauntings are an integral part of existing material conditions" (2017: 74). The apartheid/colonial spatial planning continues to exert hauntological forces of *potestas* on the land and people.

My District Six story makes reference to the wider South African context at the time. The tragedy of the destruction of District Six is rendered at a human scale by relating the CPUT

campus to individual buildings that existed on the same site. This is contrasted with the inhuman nature of the legislation promulgated at a national level. In addition to this, linkages between Blacks and Whites are identified, for example, the story points out that District Six was a residential area that contained all ethnicities living together, before its destruction.

There have been constant shifts of power observed since the inception of the first land surveying degree. These power relations occur between the members of a group of agencies that have a direct influence on the practice of geomatics education, and by extension, the land. Being ontological primitives, the relations between participants produce phenomena (material-discursive intra-actions) that extend across spacetime (Barad, 2011). Reading Barad with Braidotti allows us to relate intra-active relationality with a Spinozist account of bodies. Both ontologies do not take the Cartesian subject/object divide for granted. Furthermore, relations between intra-acting bodies can combine to form more powerful relations, or can serve to decompose them (Deleuze, 1988).

The analysis thus far has largely highlighted the *potestas* contained within the sedimented geomatics curriculum. The geomatics learning experience in South Africa has developed out of a contingent intersection of a host of material and affective forces. I have brought to light some of these forces through my agential cut, which is an ethical act. This granting of agency is done with the intention of activating *potentia* in the classroom. It is facilitated by my pedagogical practice of combining storytelling with counter-mapping. Patterns of difference were illuminated so as to trouble dualisms that reinforce the hegemony of humanism and/or anthropocentrism. The movement from the traditional human-centred geomatics learning experience to a more posthumanist experience is facilitated by storytelling and technology. This movement takes place in between art/science, hard/soft, nature/culture, and Black/White.

PART 3 – POTENTIA

In contrast to *potestas*, power can also be viewed as productive and enabling, where people are empowered to pursue their own ethical imperatives – *potentia*. *Potentia* is covered in this section. In Chapter Seven, the student storytelling intervention is investigated. Stories that were produced by students are foregrounded. There are stories that promote a continuation of hegemonic power relations, and there are also a few stories that escape capture by exhibiting affirmative moves toward a posthumanist subjectivity. In Chapter Eight, the effects of geomatics education and the student storytelling intervention on subjectivity are elaborated upon.

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CHAPTER SEVEN – STUDENT STORIES

7.1. The story so far…

The previous two chapters provide a critical cartography of geomatics education in South Africa. The chapters help to interrogate aspects of geomatics that have an effect on the subjectivity of its practitioners and students. As we have seen, geomatics education habitually reinforces the 'purification' of the human subject through practices that privilege rationality and autonomy. It also denies and limits other ways of being.

From a relational ontological stance, this subjectivity promotion is not one way – the subjects that are created in geomatics influence the creation of the world that they (and others, both human and non-human) are part of. All these participants are in a state of becoming through *doing*. The voice that has emerged in Chapters Five and Six is largely the voice of *potestas*, because the viewpoints of academics and practitioners promote the normativity of the subject of humanism.

In this chapter, I analyse all the stories that were produced by students, and then zoom in to two stories in particular. I attempt to do justice to the voices of the majority (by identifying broad themes across all stories), as well as the transgressive voices that may have emerged. Voices of critical cartographers (like Harley) and students who question the status quo are voices that I have paid attention to, as they allow for the emergence of difference, contradiction and complexity. In this chapter, I continue in this vein, and zoom in to the particulars of the digital storytelling intervention that students and I have gone through. Part of the investigation is also meta-methodological – I am researching my teaching methodology.

I have taken an activist stance in my pedagogy. As a build-up to this chapter, I have showcased some stories which I have used in my teaching. Hence the characters in the stories of Pieter Potter, District Six and Caltex have been granted agency through my pedagogical practice. In several courses within the curriculum, the students, myself, GIS, and the characters intra-act. The stories are told by me in three of my undergraduate courses, namely Map Projections (taken by third year surveying students and second year GIS students), Geographic Information Systems 3 (an introductory GIS course, also taken by third year surveying students and second year GIS students) and Spatial Analysis (an advanced spatial analysis course taken by third year GIS students). The characters (human and non-human) have been chosen carefully to draw transversal links across difference, and represent the marginalised others of modernity. These stories provide exemplars of the combination of storytelling, counter-mapping and movement across boundaries. They are used to grow an awareness of alternative points of view, and promote dialogue. Following Braidotti, my ethical thought involves an inquiry into relationships with alterity (Braidotti, 2006). The characters are also important navigational tools and markers of situatedness that have assisted us to negotiate complexity during many interesting discussions. I have found that telling these specific stories allowed me to speak from my location, and opened myself up to connections with students. This pedagogical method is aimed at enhancing their power of being able to act by activating Spinozist joyful passions. Joyful passions should not be confused with feelings of joy or happiness. Joyful passions, according to Spinoza, can result in an increase in our power of acting. They arise out of relational encounters between bodies that agree with each other (Deleuze, 1988). For example, whilst intra-acting with the story of District Six which is

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a sad story, some students may have been empowered to speak up in class, or try something new with the GIS software, or discuss the story with others which lead to further empowerment.

As a practice, seeking connections across difference is supplemented by another level of storytelling – by using student digital stories from previous cohorts. As a deterritorialisation of the teaching voice, student stories are played in class, ostensibly to build on technical knowledge. It is much more than that, of course, and is driven by a posthumanist ethic that seeks to empower students in a decolonising move. I am seeking new knowledge through the practice of a socially just pedagogy. Reading this practice (using my stories supplemented with student stories) with Braidotti shows adherence to all of Braidotti's 6 rules of a critical posthumanist theory and practice[51]. The stories I have chosen together with the subsequent discussions that they elicit in class do justice to my ethical stance through using history (Rules 1 and 3) across multiple time zones in a non-linear fashion (Rules 4 and 5). I transgress disciplinary boundaries by combining historical and archaeological knowledge with geomatics knowledge (Rule 2) in a move that is aimed at disrupting the teacher/student binary (Rule 6).

The story so far highlights one aspect of my pedagogical practice, namely my telling of stories. The other involves a more substantial shift of power relations. In response to the critique elicited by my stories, I seek out affirmative horizons of hope through boundary crossing of power relations. I convert the *potestas* contained in the geomatics curriculum into *potentia* by handing some of the power of pedagogy over to my students. This is done by allowing students to produce their own stories.

In this chapter, I outline the multiple and related processes that I developed and implemented during the storytelling intervention. My focus is on the process of the intervention as a performance, and the subsequent digital stories that were produced. I report on students' engagement with the creative potential of stories, and explore the effect that this would have had on their subjectivities. In addition to conforming to Braidotti's rules, I also show how the storytelling intervention has strong resonances with non-representational theory. Through a diffractive analysis, I show that the intervention is non-representational and is an example of a socially just pedagogy which is attuned to care as a practice.

7.2. A response-able pedagogy

In South Africa, feminist relational ontologies such as posthumanism or new materialism have not yet been used in engineering education. I have reported on the introduction of storytelling in engineering education (Motala & Musungu, 2013) and briefly reported on its theorisation with posthumanism (Motala, 2017). In previous research (Bozalek, Bayat, et al., 2018) we set out to diffract Tronto's ethic of care with posthumanist ethics. This helped to explore what we termed 'a pedagogy of response-ability' which is aimed at social justice and

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[51] As outlined in Section 2.2.4, Braidotti's (2013a: 163) rules are:
Rule 1: Cartography accuracy with ethical accountability
Rule 2: Transdisciplinarity
Rule 3: Combining critique with figurations
Rule 4: Non-linearity
Rule 5: The power of memory and imagination
Rule 6: De-familiarisation

flourishing in South African higher education. In this chapter, I continue with the theorisation that we started, and also ground my engineering education work more rigorously. This analysis benefits the geomatics community by showing how a geomatics experience guided by a posthumanist ethic produces differences that matter. In the GIS diploma, for example, students would not have actively engaged with experimentation that brought together technical knowledge and creative writing. Within the flattened posthumanist ontology, creativity should not be seen as an inherent property of individuals, but rather as an assemblage (Bozalek, 2018). Hence my ethical stance guides the process aimed at reconstituting this assemblage.

Tronto's ethic of care is read together with posthumanist theory and applied to my pedagogical practice. I show that elements of my pedagogy resonate with the qualities of Tronto's ethic of care. I focus particularly on the qualities of attentiveness, responsibility and trust. Haraway and Tronto see ethics as a sympoietic activity and not as rules-based principles. Ethics is made together with and emergent, not transcendental. A caring pedagogy is one that is premised on a mutual relationship between student and teacher, where all parties render each other capable. This conforms to Tronto's ethic of care, Haraway's speculative fabulations and Barad's agential realism – they are all ontologies that conceive of entities coming into being through relations.

Bringing Braidotti into the superposition, one can identify further resonances. Braidotti's nomadic ethics emphasises the need for a relational methodology that is embodied and embedded in a context. She points out that within education, critical posthumanism can assist in creating local communities of learning. It can also help to produce socially relevant knowledge that is guided by an ethic of social justice and respect for alterity, whilst rejecting false universalisms (Braidotti, 2013a). Tronto (1995: 144) notes that "the care ethic requires that we constantly return to the real world of daily-lived lives in order to generate our philosophical and political positions". Furthermore, care is contextual and subject to power relations. Democratic care allows for people to disagree with each other, but through engagement and a demonstration of care for democracy itself, trust is created. Following from this, it is important to keep a pedagogical space open to other points of view, whilst being grounded in context. This is a 'caring with' that is open to and respectful of alterity. According to Gough (2004), I am practicing a 'cyborg pedagogy' by allowing students to situate curricular knowledge into their everyday lives. In the South African context, an intervention that brings to the fore student subjugated knowledge is a decolonising move. It is also cognisant of the diverse nature of South African society, and a way to encourage a plurality of voices.

Tronto's first element of the ethic of care is attentiveness, which refers to a recognition of the need for care in the first place. Read with Braidotti, some interesting resonances arise. Alterity is exemplified by the structural others of modernity (natives, women, and the environment). If there is an attentiveness to the needs of one or more of these others, then the resulting pedagogy could be caring and decolonising. However, pedagogies guided by the ethic of care have also been critiqued, because there are inherent dangers in its application in teaching and learning. For example Bozalek, Watters and Gachago (2015) caution against the dangers of *paternalism* and *parochialism*. These dangers were identified by Tronto (1993), and stem from the inherently unequal power relations between caregivers and receivers and between those in the classroom. Paternalism is when the teacher has an overdeveloped sense of importance, and students may become infantilised in the relationship. Parochialism is a

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narrow or limited outlook, and can result in the teacher focusing on those close to him/her, or only focusing on narrow disciplinary contexts.

With regards to the quality of responsibility, reading Tronto with Barad, Haraway, Plumwood and Braidotti is useful. Reading Tronto, Haraway and Barad together shows that a pedagogy that is responsible is one that is accountable (Bozalek, Bayat, et al., 2018). After I identify a need in the geomatics learning experience – a need related to the neglect of ethics in the curriculum – I respond with an intervention that is tailored to address and act on that need. Responsibility also entails an awareness of what has been silenced or what has been excluded from mattering (Barad, 2007). There is thus an effort to counter parochialism in this regard, as issues of alterity are considered. The resulting stories are intended to foreground students' subjugated knowledges (countering paternalism because students are given the opportunity to be teachers in their own right), as well as to resist some characteristics of dualism (such as incorporation) by rediscovering a story for the underside (Plumwood, 1993).

Storytelling is a measurement apparatus that allows further properties (that were not examined in the traditional engineering methods of assessment) to become determinate. A diffractive reading reveals that agency is not held in an individual; rather, as a response-able pedagogy which stresses *caring with*, agency is distributed amongst the humans and the technology. Within the story circle (to be described in the next section), stories get worked by the group, taking into consideration the limitations and advantages of the human-software-hardware-data assemblage. The environment that I encouraged in the story circle (and in the storytelling intervention as a whole) is one of openness and respect. This can be seen as conforming to Tronto's ethical quality of *trust*, as it is predicated on relations, plurality, communication and respect.
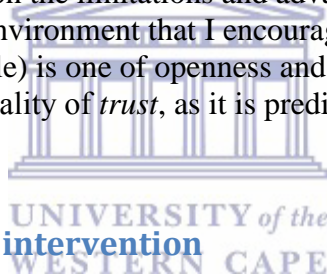
7.3. The digital storytelling intervention

7.3.1. Aims

In this section, I describe and analyse the digital storytelling intervention for the timeframe 2012 - 2015. The aims of this research that are most related to this chapter are:

a. How can the student voice be foregrounded through a socially just pedagogy using digital storytelling?
b. How can posthumanist ethics be used to guide the intervention, thereby encouraging a posthumanist subjectivity and furthering the aims of decolonisation?

With regards to aim (a), my analysis firstly explicates how the intervention has changed over the years to produce a learning experience that has moved away from a focus on the final product to a focus on process. The performative nature of the process was found to value the student voice through an attentive pedagogy. I also show that the student storytelling intervention is an example of a socially just pedagogy through diffracting the work of Tronto, Haraway, Barad and Braidotti.

The storytelling intervention was started in 2012 in the Spatial Analysis course. The stated aims of the course in the official study guide are: students should be able to demonstrate understanding and skills in: GIS analysis of vector data, GIS analysis of raster data, and

spatial statistical analysis. I realised that the aims of the course could be achieved by following the bland, technicist and traditional methods typical in geomatics teaching. On the other hand, I felt that an injection of creativity through experimentation might help to do more than cover the minimum technical requirements of the course. I was also actively seeking out other academics who were pursuing creative alternatives to traditional teaching. At the time, there were numerous other lecturers at CPUT (particularly in the education faculty) experimenting with the use of digital storytelling in their teaching. Through meetings with them, my power to act was enhanced – an example of Spinozist joyful passions. What followed was a process that has produced (and continues to produce) affirmative effects along the way. I had no idea that one virtual future (which would be actualised) would be that the intervention would provide me with inspiration to pursue my PhD studies.

When the intervention was first implemented, I invited the CPUT expert of digital storytelling, Daniela Gachago, to present a workshop to my students on how to produce a digital story. Daniela was heavily influenced by the Center for Digital Storytelling (CDS), which developed a seven step model of digital storytelling[52]. She adapted the seven steps in the development of her own workshop, which she developed specifically for South African students. In her own research (see for example Gachago et al., 2013) she developed a model for critical digital storytelling, which had an influence on the workshop she presented to my students. The workshop was an intense two-hour long session which introduced students to digital storytelling and gave them practical tips, such as how to use digital storytelling software and where to find non-copyright music (see Appendix 2 for the assignment briefs, which contained useful information on the production of digital stories).

7.3.2. Evolution of assessment

The brief for the task was broad with respect to what students could base their stories on. Framing the task, they were asked to do the following:

> *You are to create a video that tells a story. The story must have a spatial component (you must use maps in telling the story), and must contain numerous spatial analysis techniques.*
> *The story could be your story or someone else's story. It could be about a social issue that you are interested in. The script must be written by you.*

Following the advice of post-qualitative and non-representational theorists (for example Lury & Wakeford, 2012; Mazzei, 2014; Vannini, 2015), the openness of the task is geared towards the development of new ways of knowledge creation and ways of investigating the world. This is especially relevant in engineering education, in which qualitative methods of enquiry are subordinate to quantitative methods. In class, I encouraged students to produce a story about something that they were interested in, and suggested relating their stories to social or environmental issues.

This task takes engineering students across multiple boundaries, such as science/art, quantitative/qualitative, and even the representational/non-representational boundary. The latter boundary crossing is achieved by a focus on the doing and a submission to a process, as opposed to being focused on the map as the final product of the analysis.

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[52] See www.storycenter.org

For students, the climax of the storytelling intervention was the production and sharing of their own digital stories. The briefs of the task given to the students in all 4 years (2012-2015) are shown in Appendix 2. In 2012, students were asked to produce a professional mapping and cinematographic product that could be uploaded to the World Wide Web, one that they could be proud of. I was very prescriptive on the types of analysis that the students needed to use in the production of their stories:

> *The spatial analysis and GIS processing contained in the story must, at a minimum, have the following:*
> *- Data capture (e.g. digitizing, co-ordinate importing, or raster image georeferencing)*
> *- Database analysis;*
> *- Overlay analysis;*
> *- Buffer analysis*

It was found that the students only attempted the types of analysis mentioned. I had chosen these specific types of analysis because these were techniques already covered at some previous point in the GISc diploma. I was concerned that the digital storytelling intervention represented such a change in the pedagogy that they would have experienced up to that point, that I decided to ease them into the experience. At the time, I was influenced by the theorizing of Lev Vygotsky and considered narrowing the Zone of Proximal Development (ZPD)[53] with regards to the technical GIS analytical skills attempted. I also gave students the option to produce a PowerPoint presentation, for those who might have been overwhelmed by the production of a video. This hand-holding proved to be unnecessary. The following year (2013), I circumvented students attempting only the abovementioned analytical techniques by making the task more open-ended:

> *The spatial analysis and GIS processing contained in the story must, at a minimum, have the following:*
> *- Data capture (e.g. digitizing, co-ordinate importing, or raster image georeferencing)*
> *- At least 3 types of spatial data analysis*

In 2012, there were 10 students who completed the storytelling task. Of the 10, only 4 produced videos, and 6 produced PowerPoint presentations. The quality of the videos, and the relative ease with which they produced them, convinced me to discard the PowerPoint option the next year. In addition to this, the 4 who attempted the video had learnt a new skill, namely the production of a video, whilst the others reverted to what they knew.

During 2013, I realised through discussions with students that they worked together on their stories. This produced some unanticipated advantages, such as collaboration and increased interpersonal communication. I thus decided in 2014 to give students the opportunity to work on their stories collaboratively:

> *You may work in teams (not > 2 people) for this assignment. If you work in a team, do a story on an issue that both of you agree on.*

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[53] Several theorists find the epistemological stance of Vygotsky problematic. His underlying assumptions about knowledge, reality and the world are challenged by the stance of non-representational theory, which argues that the world is constructed through activities and relations (Thrift, 2008). In mathematics education, De Freitas and Sinclair (2014) critique Vygotsky for not being able to adequately straddle the immaterial and physical worlds.

In 2012 and 2013, I had not yet begun my PhD, so the intervention was not yet explicitly guided by a posthumanist orientation. However, the changes that I did implement (by encouraging students to work in groups, and to be more experimental) are compatible with several core aspects of posthumanist ethics and non-representational methodologies. The changes encouraged working relationally and across difference. There was also a desire to allow students more freedom to experiment with the software and analytical techniques. I had hoped that students' intimacy with the software would increase by allowing them to decide on the analytical methods that suited them. This could be seen as an awareness (perhaps preconscious) of relational materialism, which recognises the co-evolution of humans and things. In this case, the thing is the computer, and in particular the GIS software.

Over the period reported, the assessment went from being focused on the final *product*, to the *process*. This was due, in part, to the incremental changes above, but also because of the way I changed the assessment of the digital stories. See Appendix 3 for the rubrics that I used to assess the student attempts of the tasks.

In 2012, it can be seen that all the marks were allotted depending on the quality of the actual digital story. In 2013, I introduced a questionnaire that was to be completed by students after they had seen other students' videos. I did this so as to provide students with the opportunity to reflect on the process, as well as to get some concrete ideas on how to improve the task during the next iteration. I decreased the weighting given to the story itself, and it counted 70% of the marks allocated to the task. Of the remaining 30%, 20% was dedicated to the plenary discussion that was held after the conference. To make sure that the students completed the questionnaire, I allocated 10% of the marks towards the questionnaire.

In 2015, I implemented most of the changes, as can be seen in the appendix. I introduced a story circle, where students discussed their stories in a plenary session in class. They then had to conceptualise their story and produce a storyboard. This really assisted in helping them to visualise their final product. They were told that if they followed the process and respected the formative evaluation, they would pass the task and automatically obtain 50%. The remainder of their mark would be allocated according to the quality of the digital story itself. This seemed to provide an injection of creativity, where students were not afraid to express themselves as they knew that they had passed the task already. By this fourth iteration, the assessment had changed into a task that was more collaborative and focused on taking the students through a series of performances. What follows is an excerpt of the 2015 assessment task:

2015 Assignment process - steps
1. *Story circle: This will take the form of a discussion, when each person/group will present their story to the class. You will present the basic idea of the story, the storyline, the main character/s, the maps and the analysis that you will produce. Presentation:* **8 October 2015**
2. *Storyboard: You will hand in a storyboard that contains a graphic representation of your story. You must choose 6 (or less) of the most important scenes from your story, and draw it onto the storyboard. Each scene should have a description or some of the script written under it. Hand in the storyboard (hardcopy) on* **15 October 2015***.*
3. *Conference: You will play the video at a mini-conference for the rest of the class to watch. Your video will contain a narrated story (audio) and still maps (images) or moving maps (videos captured from the GIS). After each video, there will be a short discussion. Conference:* **29 October 2015***.*

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The task had evolved from a process that focused on the technicalities of spatial analysis and video production, to one that valued being present with students during the process. This practice demonstrated Tronto's (2013) qualities of attentiveness (by caring about the interests of the students, and allowing students' subjugated knowledges to emerge), responsibility (by actively learning-with in a process that renders each other capable) and trust (by emphasising respect through plurality, communication, solidarity and respect).

7.3.3. Student involvement

In 2014, I had explicitly given the students an opportunity to work in groups, yet none took up the offer. Students chose to take the safer, individualistic option that they had been conditioned into during the course of their studies. In addition to this, the majority of the 2014 cohort chose stories that placed themselves as storytellers at a safe distance away from the story. This represented a re-inscription of the public/private boundary. This is further evidence of the engineering mindset, in which the engineer observes and analyses from a distance.

The 2015 incarnation of the task was meant to elicit more student involvement, as well as to give students more formative feedback so as to intervene in the creation process. The story circle was thus introduced. The story circle was a good first activity, as it required all students to be actively involved in a process that valued the voice of all. Students and I sat in a circle and each person was given the opportunity to present the basic idea of their story. The rest of the class were then invited to offer advice or ideas. The story circle is emphasised in the methodology of the CDS (Lambert, 2013), and is a space where all participants collaboratively help to develop all stories. Gachago et al. (2013) note that emotions often surface during this part of the process, which is based on Step 2 (owning your emotions) in the CDS model (Lambert, 2013: 57). However, there is a problematic individualisation that can be identified in the CDS theorisation. By emphasising the need for the storyteller to own their emotions, the ultimate holder of responsibility and emotion gets placed in the individual. This is humanist and anthropocentric and does not recognise that affect is pre-personal in a relational ontology. I would suggest that the affects which circulate during the story circle do not only reside in individuals – this requires careful attention in the planning and execution of the intervention. Attentiveness, responsibility and trust are central to the process.

By creating a space in which conversations happen across difference, I allowed for the student voice to be foregrounded in the learning experience. In addition to this, I encouraged students to 'think big' in this phase, and also not be consumed by what Braidotti calls the 'reactive political economy', which affects subject formation and knowledge practices. This is due to the dominant negativity in the public imaginary which causes blockages in our desire for affirmative ethics (Braidotti, 2018a).

Guided by affirmative ethics, I allowed students to explore counter-actualisations of virtual alternatives. For example, where students felt bound to tell their stories with documentary-style accuracy, the story circle allowed them to use fiction. Story 43 ('The story of Jony') was largely autobiographical, but the storyteller changed aspects of his biography to tell a story that was a mix of fact and fiction. The story loosely followed the life of the storyteller,

growing up in the rural Eastern Cape and longing to climb a mountain from where he could see all the people of the world. He moved to Cape Town to pursue his studies and arrived in Cape Town during the time of the 2010 World Cup. He met people from all over the world, thus realising his dream. The use of a *nom de plume* and fiction afforded the storyteller a certain amount of artistic freedom which did not leave him feeling as exposed as he would have if he used his own name. In this way, stories use creativity that is not necessarily bound to the actual. This allowed students to think big together in a safe space.

7.4. Thematic analysis of stories

This section focuses on an analysis of stories that were produced by students. I first extract themes from all the student stories that were produced over the four years of the study. This is useful to obtain an understanding of the normative voices that emerged. The normative voice is in keeping with the argument that I have been developing thus far. The deeply-ingrained humanist influence on students' subjectification is observable in the stories that were produced by most students. Students tend to perform their subjectivities in keeping with the current hegemonic logic. Individualism, rationality and hard boundaries emerge out of the stories. However, as my stories, previous student stories, and conversations that led up to this intervention were ethics-led, many students produced stories that foregrounded subjugated knowledge.

Seeking difference, I then turn my attention to the transgressive voice in Section 7.5, and analyse two specific stories that were produced by students. These two stories have been selected as they are illustrative of transgressions and showcase boundary crossings. In this way, my deployment of the figuration of the boundary is strengthened by empirical evidence. It shows stories produced in a geomatics learning experience which emphasise boundary crossing and liminality. These qualities are not foregrounded in a traditional geomatics learning experience, but have been deliberately included in mine. I take both a qualitative and post-qualitative stance in this chapter. I move across boundaries, in the in-between space, between codes and stories.

7.4.1. Overview of all stories

For the four years 2012-2015, 46 stories were produced by students. As time progressed, previous cohorts' selected videos were shown to the class. In this way, students were exposed to stories other than mine. Of the stories that were produced over that period, all students were from South Africa, so it is appropriate to classify them according to the apartheid racial categories, with which the majority of students would have identified.

Appendix 6 contains a table showing detailed information about all the stories that were produced over the four years, and notes that I made during the thematic analysis. It also contains the numbers by which all stories are identified in the analysis.

There were 25 stories produced by Black students (comprising 54% of the stories), 12 by White students (26% of the stories), and 9 by Coloured students (19% of the stories). In 2015, there were 3 stories that were produced by groups – two were produced by groups of two Black students, and one by a group of two Coloured students. 26 stories (57% of the stories) were produced by male students, and the remaining 20 stories (comprising 43%) were produced by female students.

7.4.2. Themes that emerged

In this section, I follow a more traditional qualitative analysis to extract themes from the student digital stories that were produced over the time period. Appendix 7 contains a table of the themes that were extracted. Appendix 9 contains links to the digital stories that were cited (and quoted from) in my analysis.

Although coding is critiqued within the ambit of post-qualitative and non-representational methods, it is also not rejected outright. Coding is useful if utilised with a sense of wonder; in a creative mode that experiments "with order and disorder, in which provisional and partial taxonomies are formed, but are always subject to change and metamorphosis" (MacLure, 2013b: 181). In this regard, I first approached the exercise by coding and re-coding the data. The idea was to investigate the data in ways that eschews a single, hierarchical taxonomy. However, I have found that a taxonomy based on race was most useful for this part of the analysis. Basing some of my analysis on race, however, is problematic as I am propagating the Black/White dualistic construct – this could be seen as an essentialist conceptualisation of race, but it is not intended. In fact, the subsequent analysis of boundary crossings shows how the racial boundary is troubled.

Historical research

Of the 46 stories, 31 had a historical slant. These stories were classified as either having a short/personal history or a longer history. The short/personal stories contained analyses where the storyteller focused on the development of a specific phenomenon that lasted not more than the course of a lifetime. The majority of this type of story was autobiographical (stories 1, 5, 8, 9, 10, 36, 43 and 46) but in some cases, students produced stories tracing events over a few years. These stories were about: lived realities in South African townships (stories 15, 26, 40), environmental disasters (stories 7, 38), the build-up to the 2010 football world cup (story 14) or journeys of others (story 44). In the 'longer' historical stories, the development of phenomena over longer periods was documented, namely: South African politics (stories 12, 13, 28, 31, 33, 34, 35, 39 and 41), the history of a university (story 18), cultural history (story 19, 27) and city development (story 45).

One of the major vectors of influence in the choice of historical stories was my focus on history. Most of my stories had a historical slant to them, so by the time students had to produce their own stories, the combination of GIS and history was foregrounded. In discussions, some students confirmed this. In addition to this, I can speculate that the production of historical stories was strategic on the part of the students – by mimicking my storytelling method, they were hoping to elicit a positive response from me in the assessment.

The use of history in geomatics education is not common. As pointed out in Chapter Six, geomatics scholarship often appears ahistorical. Much of the geomatics curriculum is not contextualised within a time period, a hegemonic discourse or a political imperative. By including historical stories in my teaching, I explicitly made connections between events of the past (in particular settler colonialism) and students' current reality (for example the racialisation of space). The power to do this was handed over to students in the storytelling intervention, and was gleefully accepted by many students, but in the main by Black students. The majority of Black students' stories (20 of 25 or 80%) were historical or had a historical

element to them, whereas White students chose to stay away from historical stories (only 3 of 12 or 25% chose this option). In the main, White students' stories were also decidedly apolitical.

Story 12 ('Soweto uprising') was a documentary-style story about the 1976 Soweto student uprising. The events of 1976 started off as a reaction to the imposition of Afrikaans as the language of instruction in South African schools. This was particularly offensive and disadvantageous for Black students, the majority of whom did not speak Afrikaans. The storyteller, a Black student, connects the language issue to her current lived reality:

> *The generation that we live in today is one of freedom and democracy. This has resulted in various advantages for our generation. One of them being that today we are free in our schools to learn our subjects in any language. English is however used as the recognised language between teachers and students. This has meant that learners and teachers are not obliged to use Afrikaans in the classroom.*
>
> (Extract from Story 12)

This story pays homage to the Black protestors who died in 1976, so that the storyteller could live in a free country. There are other historical stories like this, told from the perspective of Black students that remind the audience of various aspects of apartheid and colonialism. They are stories that connect our shared troubled past to the present.

Disidentification

Some stories required the storytellers to practice disidentification. These typically involved students telling the stories of others, and these others may not have shared cultural similarities with the storyteller. For example, stories 19, 31 and 44 are stories that tell the story of people who have migrated to South Africa. Discussing issues of xenophobia towards African migrants in class would have contributed to the inspiration for these stories. The stories are attempts at disidentification from South African xenophobia, in order to see migration or refugees from a different point of view. What follows are excerpts from two stories, showing students disidentifying from their South African subjectivities to try to understand the plight of refugees.

> *South Africa is a democratic country which is free, where everybody is equal, which preaches to treat everybody with dignity and respect. Where apartheid is history. Where diversity of cultures, religion and race. That's why refugees prefer it…. But, our refugees don't experience all this when they come to South Africa. They are discriminated and even killed. Without consideration of push factors that have brought them to South Africa.*
>
> (Extract from Story 31)

A short excerpt from an interview with a Somali refugee follows, in which the interviewee explains that he had to leave his country in order to save his life. The storyteller goes on to relate the 'push factors' that have forced people from Zimbabwe, Democratic Republic of Congo, Nigeria, Somalia, India, Pakistan, China to take refuge in South Africa. Graphic images of starving children, wounded people, dead bodies of people in conflict zones, and child soldiers are juxtaposed with pictures of African leaders such as Robert Mugabe, and military personnel. She concludes her story with a heartfelt plea, talking directly to the camera:

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Of course yes, if you were from one of those countries, and you get the opportunity to go to South Africa, you were going to jump for it. Hope one day that light will shine upon those countries and they will have peace, they will be free from poverty and have joy. So, my brothers and sisters, let us stop xenophobia and show them love and peace. Let us be the example, let us inspire the world, let us inspire the nation.

(Extract from Story 31)

Story 44 was about a refugee from the Democratic Republic of Congo. It was done by a group of two students, and was based on the story of a person they knew.

He left home without legal documents coming to South Africa. He travelled all this way in an airtight container in a horse-and-trailer. The driver had to stop every two hours so the guy could take a breath. Six kilometres away from the Zimbabwean border gate with South Africa, he had to get out and walk his way into the country.
[Map of the Limpopo River, showing possible crossing points]
More than three people get killed, either by wild animals or die fighting for survival. Out of ten women who cross over, four get raped or killed by strangers or people helping them.
Census shows that there are about 1.7 million illegal immigrants living in South Africa. After a long horrifying journey he finally smiled, when he reached Pretoria, then caught a bus going to Cape Town.
Indeed South Africa is home to all who live in it.

(Extract from Story 44)

Figure 22. Images from Story 44

The stories above show a willingness of (mainly Black) students to try disidentification. Stories 31 and 44 counter the citizen/foreigner dualism in numerous ways. They resist incorporation by telling the stories of the underside. They also resist homogenisation by recognising the complexities of the problems faced by people who are forced to flee their

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country. Furthermore, images like the ones shown above (from Story 44) and those from Story 31 evoke strong emotions in the viewers, as they allow the homogenised group (foreigners) to be individualised. They also shed some light on the diversity of the many people who are classified in one pejorative group: foreigners. By showing these stories to later cohorts of students, I am practicing a pedagogy that exhibits a *caring about* and a *caring for* (Tronto, 2013) the persecuted foreigner.

Harney and Moten remind us that disidentification is needed to survive being Black in the university. It requires one's "subjectivity to be unlawfully overcome by others" (Harney & Moten, 2013: 28) – it is another example of epistemic violence that is enacted upon Black bodies by a system that is geared toward White success. It can also be argued that these examples of disidentification are actually identification with blackness, albeit the blackness of foreigners. It is a plea, a call for recognition of a difficult life that Black bodies are subjected to. It is worthwhile to note the presence of the menacing boundary between South Africa and Zimbabwe in the images in Figure 22. The river and the barbed wire fence are boundaries that have been imposed on Black bodies, but are surmountable. Story 44 is an important story in my teaching practice, as it troubles the efficacy of, and the need for, the national border.

Distance from the story

I encouraged student to tell personal stories, or stories that students had first-hand knowledge about. 68% of Black students' stories (17 of 25) situated themselves 'close' to the subject of the story, compared to 50% of White students (6 of 12) and 33% of Coloured students (3 of 9).

Many Black students took the opportunity to foreground their specific cultural knowledge.
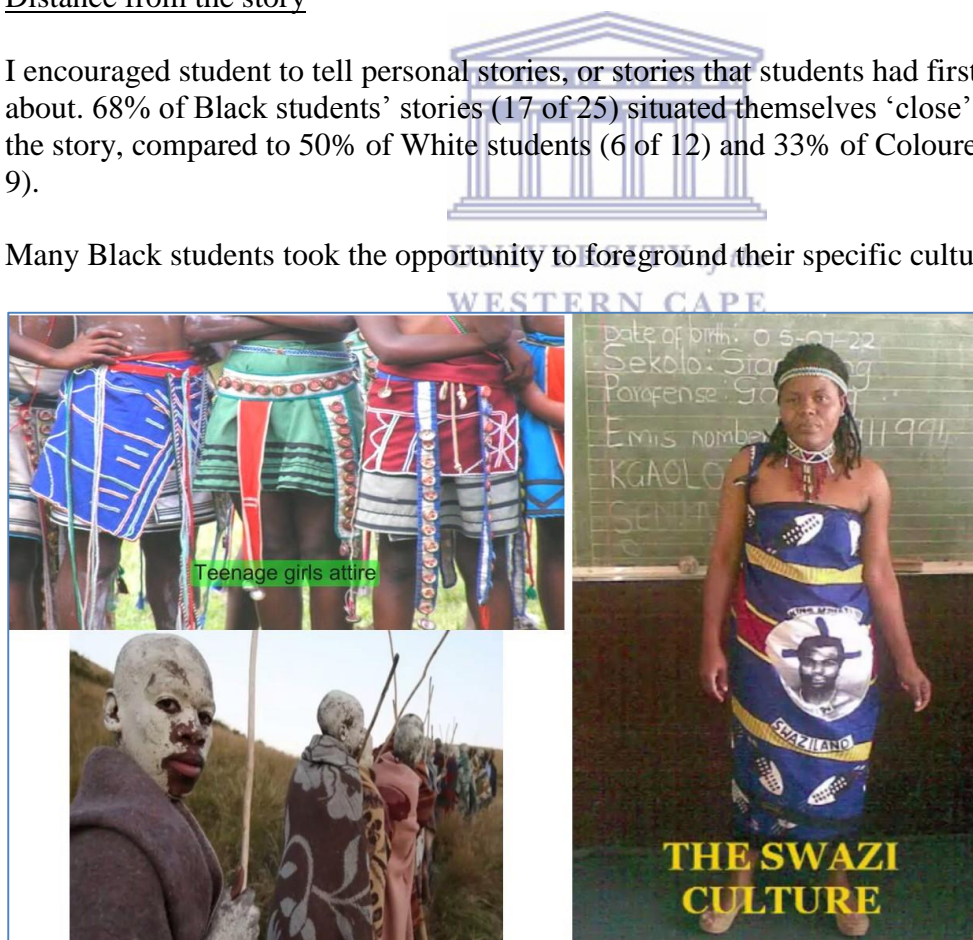
Figure 23. Images from Stories 27, 39 and 43

A pedagogy of response-ability is a caring practice that allows for a becoming-with. In this case, the sharing of subjugated knowledge is a becoming-minoritarian. It allows for some of

the structural others of modernity (specifically Blacks) to have their say. It also gives the larger group a sensibility of a movement away from the dominant subject in a peaceful way. A minoritarian political practice need not take place by violence, but there is a disruption in the hegemonic order. This politics is not an expression of the people, but of a 'people to come' (Colebrook, 2002; Gray van Heerden, 2018). Figure 23 shows some images from stories that foregrounded cultural aspects of the lives of students. It shows female attire from the Xhosa and Swazi cultures, and Xhosa boys who are going through their initiation ceremonies (which marks their passage into manhood).

In/visibility of the Black experience

Related to the distance from the story, is the choice of Black students to make visible their lived experiences. A key characteristic (Plumwood, 1993) of the Black/White dualism is incorporation (relational definition), in which the White lived experience is defined as being primary. Tuck and Yang (2012) also note that indigenous people become an invisibilised group through colonisation. Besides foregrounding cultural knowledge (thereby resisting incorporation by discovering a positive story for the subjugated), Black students also chose to create stories that explicitly related South African politics to the hardships they faced in their daily lives. Of the 25 stories by Black students, 15 stories (comprising 60% of all Black stories) fell into the 'politics/hardship' category. Some students chose to make visible their lived experiences in poorer areas in Cape Town. For example, Story 26 was done by a resident of Khayelitsha, the biggest township in Cape Town:

> *This shows where Khayelitsha is situated on the map. The area stricken by poverty but still, these boys are fighting instead of grooming one another. What exactly are they fighting for?*
>
> (Extract from Story 26)
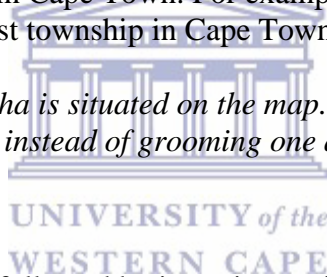
The largely rhetorical question is followed by interviews with gang members, and a graphic, violent video clip of a boy being attacked. A photograph of the boy is paired with the following commentary:

> *This is the fifteen year old in the picture who was part of the gang and experienced a tragic death in the video.*
>
> (Extract from Story 26)

Later on in the course, the storyteller completes a questionnaire and reflects on her learnings:

> *I learned a lot because all our topics were the issues that we are facing and it's a reality though some were scary, it was hard for me to complete my task (gangsterism) and at some point it was traumatising because I have little brothers, same age as those who are gangsters and it's so hard because I always thought what if it was my brother who died because of these gang fights and too many children, innocent boys died because of this.*
>
> (Questionnaire response by creator of Story 26)

This reality is one typically encountered by the urban poor and largely Black residents of South Africa. It is invisible to more economically secure students, and was brought to the fore in an unsettling, raw way. Juxtaposing such stories with other stories that show the lived reality of White and affluent students, opens up a meaningful space for stories of settler

colonialism. Tuck and Yang (2012) note that settlers make indigenous land their own and also disrupt the relationships that indigenous people have with their land.

My pedagogy is an attempt to make visible the invisibilisation imposed on indigenous people. In part, I do this by utilising some of Plumwood's strategies for escaping dualisms. Through stories like story 26, I give previously marginalised people the opportunity to be recognised as a centre of needs and values (thus resisting instrumentalism in the Black/White dualism). I also allow for stories that recognise complexity and diversity of 'other nations' that have been homogenised and marginalised (thus resisting homogenisation). An example of this is Story 39 ('Merging of two cultures').

> *Marrying someone coming from a culture different from your own is not quite the same thing. But the greatest part of this process is the cultural exchange that you pass on to your children.*
>
> (Extract from Story 39)

The storyteller goes on to tell the story of his parents, who came from the Tshivenda and Swazi cultures. He is the proud offspring of this union, and his rather sentimental story pays homage to various aspects of their cultures. Besides resisting homogenisation, it also resists radical exclusion by affirming areas of overlap between cultures (with regards to love, marriage, courting, children and mutual respect) and incorporation (by rediscovering a story for the underside).

Environmental stories

There were 9 stories produced about environmental issues (Stories 4, 7, 16, 22, 23, 32, 37, 38 and 45), and the overwhelming majority of these (7 of 9 stories) where produced by White students. Of the 2 outlier stories that were produced by Black students, one story (Story 16 – 'The unlikely rhino poacher') evaded capture by traditional qualitative methods and is analysed in the next section.

Story 27 ('My Eastern Cape') was produced by a Black student and was a critique of the choice of location of isiXhosa initiation ceremonies, and contained an environmental aspect. I have characterised the theme of the story as being mainly cultural, but it should be noted that in indigenous ontologies, there is no clear dividing line between nature/environment and culture. Indeed, many stories had multiple themes and entanglements to which a traditional qualitative analysis does not do justice. Nonetheless, my aim in this part of the analysis is to show that White students tended to gravitate to environmental issues, and Black students foregrounded cultural stories, as mentioned. There is also a marked difference in the distance to the story between Black and White students – most White students chose to keep their stories at a safe distance, following a documentary approach.

White students' privileged positions do not require them to undertake emotional labour (Gachago et al., 2013) in order to succeed. It was a safe bet for White students to tell stories related to the environment. It should also be noted though, that the intention of many/most White students was honest – the environmental stories are intended to show a deep connection to the environment. The hegemonic system allows the majority (in a Deleuzian sense) to have a safe alternative to stories that spoke to the Black/White dualism more directly. For example, Stories 4, 37 and 42 were stories about travel that was made easier due to the relatively privileged position of the White storytellers. These and all other White

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storytellers do not interrogate the racialisation of space, nor do they attempt to make any connections to South African racism. This can be seen as a shortcoming of the intervention – it did not challenge the status quo because it continued asking Black students to undertake forms of labour that White students needn't have undertaken. This left White students in positions of 'privileged irresponsibility' because they ended up getting out of responsibilities (Bozalek, 2014). A more direct approach could involve practicing a 'pedagogy of discomfort' (Boler, 1999) where all students (including and especially White students) are made to confront issues of social injustice. I suggest that reading a pedagogy of discomfort with posthumanism in engineering education would provide interesting and valuable insights to both posthumanism and engineering education by seeking out an in-between space, beyond boundaries.

7.5. Stories of boundary crossing

Having extracted useful themes that convey a sense of the dominant subjectification contained within the geomatics learning experience, my analysis of student stories is not complete. As themes seek stability and sameness in the data (student stories), a posthumanist analysis pays close attention to data that produces multiplicities and evades coding. Like Jackson and Mazzei (2012), I was drawn to stories that refused to be captured, and were more about difference than about sameness. In Chapter Six, I drew attention to elements of the geomatics education assemblage that reinforces specific silences. In this section, I am interested in two silences that I have identified – Black silence and environmental silence.

I have chosen two stories (I can equally say that the stories chose me) that re-turned with regularity over the course of my PhD journey. They are entitled 'Ndingubani na?'[54] and 'The unlikely rhino poacher'. See Appendix 4 for the transcripts of both stories. These two stories are available on YouTube: see https://youtu.be/560BukipHJU for 'Ndingubani na?' and https://youtu.be/MMgtDYLTfK4 for 'The unlikely rhino poacher'[55].

Both these stories were produced by Black male students, and the stories glowed for me because they refuse to conform to the silencing of the voices of Blacks and the environment. They are emblematic of the boundary creation and crossing that I am interested in. These stories have also found their way into my teaching, and I have played them to all subsequent cohorts since their production. In addition to this, they have garnered much interest from other researchers and teachers. They are interesting and almost always evoke a strongly affective response from viewers.

7.5.1. Story 19 - Ndingubani na?

A very important story in my repertoire of student digital stories is 'Ndingubani na?' which was produced in 2013. The story was created by Zanuxolo, a student who was deeply engaging in class during my lessons. During 2013, I was interested in the great Bantu migration which took place in Africa[56]. I used maps to help to understand the phenomenon and tell the story. I introduced it in my Map Projections class, which was taken by Zanuxolo

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[54] Translation: 'Who am I?'

[55] I suggest that the reader watches both digital stories before continuing.

[56] My interest in African history, combined with my desire to contribute to decolonisation, resulted in me introducing the mapping of the Bantu migration into my pedagogical practice.

and who contributed so valuably to the teaching and learning experience. On other occasions, we discussed the xenophobic violence towards (mainly African and poor) migrants to South Africa. 'Foreigners' who were living in poor urban areas were targeted by poor South Africans. They were accused of taking jobs away from locals, thus contributing to the cycle of poverty. Foreign-owned shops were looted, and some foreigners were assaulted or even murdered. This violence intensified from 2008 onward, and is still ongoing, albeit at a lower level. The foreigner/local boundary is re-drawn.

Reading my practice with Braidotti, Tronto and Plumwood illuminates some important patterns and matters of concern. My pedagogical practice was attentive to a need for decolonisation. This illustrates a 'caring about' (Tronto, 1993) which is attuned to the needs of some of the structural others of modernity (Braidotti, 2006). In this case, the others that were focused on were Bantu people in general, as well as vulnerable African refugees. Furthermore, in discussing the differences within these groups (e.g. how Somali shopkeepers are able to maintain successful businesses when others struggle, and the linguistic differences between various Bantu languages) is utilising Plumwood's (1993) strategy to counter homogenisation.

Unbeknownst to me, Zanuxolo had a keen interest in the history of his clan, and would draw inspiration from class discussions in producing a remarkable story that spoke to issues of xenophobia through the tracing of his ancestry. He had fostered connections with others who shared similar interests over the internet, and some of the information he presented derived from blogs dedicated to Xhosa culture[57].

See Appendix 4 for the written script of the story.

The story starts out with the storyteller introducing himself:

> *My name is Zanoxolo. My surname is Pama and my clan name is Nqana ooMdande ooNakisa ooNomakhungelo oDlala alidliwa the Great Mpondomise.*
>
> (Extract from Story 19)

His clan names are given, which is a relational act - he connects himself to other clan names and the important clan name Mpondomise. He then goes on to situate his home town in the Eastern Cape province, where the majority of Black students at CPUT are from. Speaking from his location, he separates himself from many, while joining himself to others through cultural heritage.

The main part of the story traces the journey of Bantu people in their epic migration south, using maps and images. Zanuxolo narrated the story himself, and utilised music produced by the South African artist Simphiwe Dana. Zanuxolo showed how his ancestors crossed boundaries (physical boundaries then, which would in some cases later become national boundaries) and ended up in eastern South Africa.

Reading the story with Thrift's principles of non-representational theory produces some interesting resonances. Firstly, the story is one of movement. The movement of his ancestors is carried through to his movement from the Eastern Cape to Cape Town. The story is replete

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[57] See http://embomaxhosa.blogspot.co.za/ and
https://amampondomise.wordpress.com/author/amampondomise/

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with words and phrases of travel: 'go', 'search', 'migrated', 'travelled', 'led', 'spread', 'left', 'searching' and 'moved'. His motivation for leaving rural Eastern Cape to a big city is shared by many:

> *Xonxa is my home village, situated approximately 979 km from Cape Town, 804 km from Johannesburg, and 621 km from Durban, where youth mostly go to search for better jobs and better education.*

<div align="right">(Extract from Story 19)</div>

Although it can be seen as autobiographical, I argue that it can also be taken as pre-individual. This is because it is the story of *all* Bantu people, and it joins this minoritarian group together, rather than separating the storyteller from the group. The paradoxical autobiographical/pre-individual nature of the story is brought to the fore using diffraction. Although Zanuxolo can claim the story as his own, it is more than that – it is also a powerful story of the racialised other of alterity. Whilst it is told by one person, the story elicits patterns of sameness or difference for many who watch it.

The Spinozist joyful passions were observable in the case of Zanuxolo's story. In conversations with him, he indicated that an intersecting vector of influence or inspiration came from a lesson that I conducted in a previous class. In that lesson, I had a conversation with students about indigenous Southern African languages, and how they evolved over time. The Bantu migration was touched on, and this served as inspiration for his story. In it, he related the Bantu migration to his own cultural and linguistic group (isiXhosa). Already having an interest in the historical development of his culture, he decided that he could produce a story about it. Furthermore, connections with others (for example via the Xhosa blogs) served to provide the momentum required for a Spinozist acceleration of intensity.

There is evidence of the affective power of this story in the reaction of its viewers. The use of Simphiwe Dana's song in isiXhosa, together with the imagery and spoken words resulted in a moving final production. The story ends with:

> *Indeed, I am Xhosa, I am the son of Fikile, grandson of Laqhomfela, grand grandson of Pama. I am Mpodomise. I am Bantu. I am from the Great Lakes. I am originated from the Central Africa.*
> *Embo! Embo! Apho kutyiwa ngendebe endala ndisatshaya ndingumAfrika.*
> [Translation: *The Great Lake! The Great Lake! Where people live according to old way, I am smoking, I am an African*]

<div align="right">(Extract from Story 19)</div>

The story closes with a Google Earth map showing Zanuxolo's ancestral route, labelled with 'My Beginning' (sic) in Central Africa and 'My Ending' in South Africa (see Figure 24).

Figure 24. Image from Story 19

Through the story, he forges relations with 'foreign' Africans, thus transcending the citizen/foreigner boundary. He ends it by singing praises to the Great Lake, and 'smokes' which implies that he is now going to stop talking. Black students (particularly Xhosa speakers) who watch the story often applaud or express feelings of pride. Other academics are often enthused by the story, as it provides concrete evidence of a proud Black student voice. 'Foreign' African students express appreciation for the attention given to other parts of Africa. Paying attention to affects and sensations is one of Thrift's principles of non-representational theory.

Neville Alexander (2014) warned us that instead of difference being used as a bridge towards understanding the intrinsic value of diversity, it could be used as a springboard for xenophobia and conflict. 'Ndingubani na?' is seen as counter-narrative to this, as the storyteller takes a firmly anti-xenophobic stance. His story traces an affirmative line of flight. It is the literal journey taken by ancient Africans as they accumulated knowledge; found new land; met with / engaged in conflict with 'new' people; adapted to new environments as the environments adapted to them; became (and continue to become) the different tribes of Africa. The citizen/foreigner dualism is eloquently troubled in this story, by resisting radical exclusion – continuity between indigenous South Africans and Bantu people from other parts of Africa is affirmed. Countering incorporation in both the Black/White and citizen/foreigner dualisms, a story for the underside (Black South Africans and foreign Africans) is rediscovered, hence reclaiming positive sources of subjectivity. This story joins African people, but does not erase difference. Countering homogenisation, the complexity and diversity of African society is recognised, thus moving towards a non-hierarchical concept of difference.

Ancestor worship continues to be a reality for many indigenous South Africans, so the linear temporality of then/now is not taken for granted. Using Braidotti, it is a sensibility attuned to *Aion* that is activated through the story. For Barad, past, present, and future are threaded through each other in heterogeneous iterations of spacetimemattering. The story shows respect for the ancestors. One could also see this as an act of care – as Tronto notes, "the activity of caring is largely defined culturally, and will vary among different cultures" (1993:

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103). For people who do not see ancestors as separate to themselves and their lived realities, caring for one's ancestors is caring for oneself and one's clan.

7.5.2. Story 16 - The Unlikely Rhino Poacher

The next story to be analysed is entitled 'The unlikely rhino poacher', which is a story championing the cause of the endangered African rhino. Created by a Black male student, this is a story that troubles numerous boundaries.

The story opens with the following narration:

> *The rhinoceros, a native of Africa and South Asia. These animals have very few natural predators. However recently, they face a much more deadly and unforgiving enemy – the human.*

(Extract from Story 16)

This is followed by a sequence of images of dead and dying rhino that have been victims of poaching, together with statistics of the number of rhinos that were killed. Like 'Ndingubani na?' this story evokes an affective response in the observers. Typical responses of viewers were to shield their eyes or turn away[58]. When asked about how they felt after watching the story, various audiences described it as sad, horrific, violent, sickening or anger-inducing.

The anti-anthropocentric or pro-environmental view of showing care for rhinos is put forward not just for the sake of the rhino. It is also intended to bring into question certain racialised assumptions about concern for the environment. As the storyteller says:

> *You'd not expect a black person to be concerned about rhino poaching ... this is the general stereotype.*

(Interview with storyteller)

This stereotypical Black person that he is describing is one that is uninterested in matters of the environment. This subjectification is paradoxical – Blacks and nature have been brought closer and pulled apart in one move, via the colonial/apartheid system (of which the education system is a significant part). As described in section 6.5, they are brought together by the mechanisms of dualism. The Black/White and civilised/uncivilised dualisms create maximum separation between Whites and others, thus drawing the others closer together. It is the "anthropocentric normal" (Tuck & Yang, 2012: 6) that makes White colonisers more deserving of dominion over animals and land[59]. Simultaneously, Blacks have been separated from nature by means of historical dispossession and removal off ancestral lands.

The storyteller problematises the racialised stereotype of rhino poachers being Black and foreign (particularly Mozambican). He accomplishes this by introducing the audience to White game farmers/rhino poachers:

> *Meet Marnus Steyl, a game farmer from the Free State and an excellent marksman.*

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[58] Before playing this story to audiences, I inform them that the story contains graphic images of dead rhino, and they are given the option to not watch it.

[59] As noted in section 7.4, environmental stories were produced by the majority of White students.

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This man hardly fits the description of your stereotypical rhino poacher. Well, he's not.
He's a game farmer.
He's one of the people who are supposed to be taking care of the rhinos right?
[Gunshot]
Wrong.

<div align="right">(Extract from Story 16)</div>

Further on in the story, he introduces the audience to other White rhino poachers:

The Van Deventer brothers…
They tell a story of how they hunted rhino in the Kruger National Park.

<div align="right">(Extract from Story 16)</div>

After telling their story, he again reminds the audience of preconceptions around rhino poachers:

The Van Deventer brothers entered and exited the Kruger National Park several times
with rhino horn and weapons in the car…never being searched even once.
They don't fit the stereotypical profile of a rhino poacher…
Something to think about next time you think about a poacher!

<div align="right">(Extract from Story 16)</div>

Interviewing the storyteller provided further clarification on the motives behind his choice of story.

There's a general perception that rhino poachers look like this, and there are other
stories that are not being told so much in the media - I'm interested in that sort of
thing, how the media portrays the certain people, how the media … pushes certain
agendas.

<div align="right">(Interview with storyteller)</div>

The illicit trade in animals is huge – it is "the third largest illegal trade in the world today, after drugs and arms, but ahead of women" (Braidotti, 2013a: 8). This requires a well-resourced underworld community, and this story uncovers a part of it. Additionally, the 'stereotypical rhino poacher' that the storyteller refers to (as portrayed by the South African media) is Black, poor and often Mozambican.

With regards to the Black/White dualism and rhino poaching, there is hyperseparation observable in the way that rhino poachers are portrayed by the media. By associating rhino poachers with Black bodies only, differences between both members of the dualistic pair are magnified and similarities are eliminated. The storyteller can be seen to employ Plumwood's (1993) strategy to overcome hyperseparation, which is to affirm continuity between the members. He makes the point that rhino poachers can come from both sides of the dualism.

Besides the queering of the Black/White boundary, there are strong boundaries drawn too – national boundaries are uncontested, and in fact, nationalistic rhetoric is enhanced. The language could be seen as xenophobic in its criticism of China, Vietnam and Thailand.

What would drive people to kill so many rhinos? Well, the horn is very popular in
certain parts of East Asia, because of the misguided belief that it possesses aphrodisiac

<div align="center">169</div>

properties. This of course, and according to scientists, is nothing but a myth. But hey, business is booming; Africa supplies the raw material, as always.

(Extract from Story 16)

The lines above take a clear oppositional stance, and discredit the belief of those cultures with regards to the consumption of rhino horn. Furthermore, he rails against neo-colonial practices of extracting resources (in this case rhino horn) for the purposes of feeding the appetites of the external nations. These practices are called external colonialism or exogenous/exploitation colonisation by Tuck and Yang (2012).

In contrast to "Ndingubani na?" the storyteller takes a dim view of many forms of alterity, whilst sympathising with others. He positions himself as a Black person (the racialised other) on the side of the rhino (the naturalised other), against rhino poachers, who are symbolised by White men (the hegemonic subject), who are aided by the exploitative Eastern foreigner.

Read with Braidotti, this story can be seen as an accounting of an alternative subject position by making transversal connections, especially between marginalised others. Furthermore, it is a simultaneous critique of the primacy of humanist Man and Anthropos. While it doesn't trouble the species hierarchy, it can be seen as a gesture towards zoe-centred egalitarianism. Working with *Aion*, this story is a step towards a re-connection between indigenous people and the natural environment. The connection was iteratively lost during generations of colonial violence, dispossession and erasure.

7.6. Concluding thoughts

7.6.1. Benefits of the intervention
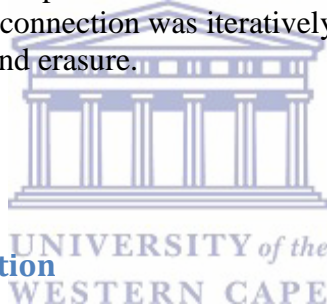
Besides the benefits unearthed in the analysis above, there were numerous other benefits that were realised because of the storytelling intervention. An experimental pedagogical intervention driven by posthumanist ethics was implemented with precise aims in mind, as well as an openness to see what emerged.

With regards to the aims spelt out in Section 1.4, the student voice was foregrounded (addressing aim 2(b)) through their stories. My ethical stance allowed for the voice of the other to be privileged, which represented a subversion of the humanist subject. I privileged this voice by re-playing selected stories (such as 'Ndingubani na?') to later cohorts, whilst silencing the voice of hegemonic stories. The privileged stories, besides being re-presented to students, have been presented to other interested groups (such as higher education researchers and teachers). These are stories that have made a qualitative leap, a transposition across disciplinary boundaries. The subjective treatment of the student stories spoke to aim 2(c) (related to furthering the aims of decolonisation) in particular.

Note that it is often the case that there is no distinct boundary between hegemonic stories and stories of alterity, with many stories exhibiting traits of both. It is sometimes difficult to separate hegemony from a minoritarian stance, since complexity is harnessed easily by cognitive capitalism. At the same time, critical posthumanism requires the tracing of complex entanglements to lay bare dualistic constructs which entrench hegemony. Stories can exhibit traces of becoming-minoritarian, whilst at the same time promote hegemonic interpellation. Hence, some stories take students' subjectification on a deterritorialising line of flight, whilst

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at the same time entrench some dualisms. This can be seen in 'The unlikely rhino poacher', in which the storyteller problematises the inherent value judgements that come with certain categories (especially Black, White and foreigner). This is a plea to shed preconceived value judgments around race. At the same time, the storyteller is complicit in homogenisation (with regards to the citizen/foreigner dualism) in casting value judgements on citizens of some Eastern countries.

Both stories 19 and 16 exhibit resistance to hegemonic interpellation. The embedded Black bodies of the storytellers refuse to subscribe to specific forms of othering that are widely observable in current society. Both stories are exemplars of the emergence of subjugated knowledges through an activation of *potentia*. Furthermore, both stories exhibit resistance to hegemonic interpellation. 'Ndingubani na?' refuses to subscribe to the citizen/foreigner dualism. 'The unlikely rhino poacher' rejects preconceived racialised notions with respect to the illicit trade in animal parts, criminality and nationality.

Students were exposed to an event that made them link geomatics knowledge to their everyday lived experiences and, more generally, the world they inhabit (and are a part of). The experience put them in a space that interrogated difference. The following two responses are illustrative of this:

> *Everyone's story was so different and I realised how different we all are. It also showed me what issues are close to peoples heart. Everyone had some sort of social issue in their presentation.*
>
> (2013 questionnaire response)

> *My general knowledge on how I see the world has changed. Everything on earth is spatial related to the other. The tasks about story telling made me learn about relating our day to day lives to spatial analysis.*
>
> (2013 questionnaire response)

Digital stories, like GIS software, are not purely symbolic digital artefacts – they have materiality. It is clear that the digital stories, through various forums, have material force. For students, they have affectively taken centre stage across cohorts, and they inspire action. Leonardi (2010) clarifies that the materiality of digital artefacts does not come from their tangibility. One way of assessing the materiality of an object or tool is by its *affordance*, that is, what it affords a user to do. Read diffractively, this definition brings a relational understanding to digital artefacts and tools. It postulates that a tool is material because it provides possibilities that afford or constrain action. Taken a step further, one can see that artefacts such as digital stories provide the affects or intensities necessary to accelerate (or decelerate) action in students. This Spinozist reading of the materiality of the stories comes with an in-built ethics – one which looks to enhance *potentia*, make connections across difference and focus on issues of social and environmental justice. Furthermore, the digital stories do more than act as simple transmitters of knowledge because they allow for connections across new domains to be sought.

Following posthumanist ethics requires one to be in a dynamic mode. Being in a constant state of change, of becoming, means that I was in constant dialogue with students. It required attentiveness and responsibility to issues of alterity. Furthermore, faith in the *process* required an environment that inculcated plurality, communication, respect and trust. These elements of care (Tronto, 2013) resonate with non-representational methodologies (Vannini, 2015) or

'inventive' methods (Lury & Wakeford, 2012). It should be noted that students are largely resistant to the open-ended nature of the task at first, but once guided through it, they see the benefits ultimately. The following comment from a student during the plenary discussion after the intervention illustrates this:

I hated the idea. But I enjoyed [the process]. At the end I enjoyed it.

(2015 plenary discussion comment)

7.6.2. Critiques of the intervention

Analysed contextually, several critiques of my pedagogy arise. Firstly, despite the intention to disrupt barriers to success in higher education, the intervention could be seen to have perpetuated some inequalities, particularly those related to class and race. Poor (mainly Black) students were disadvantaged because of differential access to computer facilities (e.g. access to their own laptops) and this showed in the quality of the final products. This was one of the reasons that the focus of the assessment shifted from the final digital product, to the process. Subscribing to a process ontology, however, does not mean that the quality of the digital product will always be compromised. In fact, as more exemplars of digital stories emerge with each iteration of the intervention, I have observed that students aim to better the quality of the videos produced. Improvements in software, my improved ability to articulate and guide the intervention, and a growing repository of stories all aid at enriching the educational assemblage. However, these do not address the conditions of inequality in South African society, which are ever present in the university classroom space.

Secondly, it allowed White students to remain in their comfort zones, and did not disrupt or interrogate their privilege enough. Most White students stayed away from stories that involved apartheid, racial injustice, inequality and privilege. Related to this, Tronto (1993) notes that with respect to race, class and gender, the least well-off in society are disproportionally those who do the work of caring, and the 'superior' members use their position of strength to pass off caring work. This privileged irresponsibility (Bozalek, 2014) has not adequately been challenged in my pedagogy thus far. White students in general did not choose to do emotional labour, whilst many Black students were challenged and dug deep to produce stories that were emotionally difficult. It should also be noted that students carry the burden of 'troubled knowledge' differently – White students could feel guilt or resentment for being vilified for the actions of their parents, and Black students could feel anger or resentment for the lack of transformation (Zembylas, 2012). If these intense emotions are properly managed, it could lead to critical inquiry.

Thirdly, my pedagogy could be criticised for not being anti-anthropocentric enough. Our current way of thinking devalues natural rhythms and privileges technological rhythms. A geomatics pedagogy, through having a geo-centred and nature-facing orientation, lends itself to an anti-anthropocentric pedagogy. Such a pedagogy would represent an attempt to re-connect with our long-lost natural rhythms. Whilst there is evidence of stories with environmental themes, there was not enough attention given to the troubling of the nature/culture dualism in my pedagogical practice. Stories about nature and relations are zoe-focused, and I will work towards activation of zoe through stories in future iterations of the intervention.

Fourthly, the intervention does little to consciously question or challenge the representational worldview of geomatics. A significant part of the experience is representational (namely the production of maps and other digital artefacts). Whilst the focus on the process is emphasised, the representational aspect of geomatics is not interrogated. This critique notwithstanding, there is much in my pedagogy and this analysis that adheres to the principles of non-representational theory. In particular, I hope to convey a sense of movement, vitalism and becoming in this analysis. The storytelling intervention too, is a "war on frozen states" (Thrift, 2008: 5) as it is constantly changing and non-linear. For example, the stories (mine and student digital stories) that I choose, and the order that they are presented in, are all dependent on relations that develop in class.

Fifthly, because my research is attuned to silence, I am aware that my pedagogical practice also can propagate some silences. For example, there is a clear silence on the plight of women. My agential cut has resulted in me focusing on two of the marginalised others of modernity, namely the native and the environment. With respect to women, my silence is paradoxical, considering that much of my theory has feminist roots. In this regard, my silence translates into a lack of stories that had an overtly feminist stance, championing the cause of the marginalised female.

CHAPTER EIGHT – THE SUBJECT OF GEOMATICS

> … the realization of the prophecy of an old Basuto became increasingly believable to us. It was to this effect, namely; 'That the Imperial Government, after conquering the Boers, handed back to them their old Republics, and a nice little present in the shape of the Cape Colony and Natal – the two English Colonies. That the Boers are now ousting the Englishmen from the public service, and when they have finished with them, they will make a law declaring it a crime for a native to live in South Africa, unless he is a servant in the employ of a Boer, and that from this it will be just one step to complete slavery' (Plaatje, 1914: 58).

8.1. Subjectification of geomatics practitioners

Critical posthumanism does not assume the knowing subject is Man (the Eurocentric humanist subject) or Anthropos. These two characters are reserved for the subject of humanism. Subjectivity of geomatics students and practitioners emerges as part of an assemblage, and has traditionally been dominated by humanism. The posthuman subject, on the other hand, is complex, non-linear, non-unitary, relational, embodied and embedded. This subject is connected to a web of human and non-human agents via dynamic power relations.

In this thesis, I have analysed various phenomena which serve to interpellate geomatics students and practitioners toward a humanist sensibility, and others which are more attuned to posthumanism. In this chapter, I outline the various instances of *potestas* which constrain geomatics students' subjectification, as well as the instances of *potentia* that open up possibilities.

A definitive account of subject formation is a difficult, if not impossible task. The focus of what constitutes subjectivity, and the factors that affect it, have changed over time, and vary across different disciplines. In Western cultures, subjects were once described in terms of their values and identities; this has been extended to incorporate aspects like emotion, affect and intensities. Even the so-called market economy, which is a key influencer, is driven by sentiment (Mansfield, 2000).

The hegemonic combination of Man and Anthropos can be observed in society at various sites, such as the immense power held by Western corporate companies, the immense destruction of the natural environment in the time of the Anthropocene, and the pervasiveness of Hollywood and CNN. In geomatics education, similar interpellations can be observed in the focus on accuracy (at the expense of art), the suppression of ethics in the curriculum, and the promotion of Western knowledge as the ideal. As a lecturer, I am complicit in the re/production of the subject of geomatics, and a posthumanist orientation asks me to try something different to resist the capitalist order. Within the increasingly corporatised university, subjectivity "is the site where the resources for the reproduction of neoliberal ordering is secured" (Postma, 2016: 312). Yet alongside these interpellations, we are also seeing resistance, as attested to by critical scholarship and pedagogies aimed at social justice (see for example Bozalek, Braidotti, et al., 2018).

Despite the overwhelming dominance of the subject of humanism in the subjectification of students, subjectivity is more than the dominant forms of subjectification. New categories of subjects are constantly evolving and being re-formed. Some local variants combine

seemingly contradictory elements with ease. For example, there are subjects such as the religious (Christian), post-colonial Black subject, who vehemently promotes the need for decolonisation on the one hand, and is a staunch Christian capitalist on the other. In addition to this, some subjects who practice American-influenced evangelical Christianity do not have any problem with syncretic linkages to indigenous knowledge systems such as ancestor worship. These sorts of complexities are brought to the fore in the student stories. Capture by the dominant hegemonic subject position is observable in tandem with lines of flight or deterritorialisations across boundaries.

8.2. Subjectification through *potestas* and *potentia*

8.2.1. Capitalism and morality

Morality, as imposed by religion and brute force, were the main factors in the composition of the subject in pre-modern times. In modernity, these power structures were replaced by a new impersonal power, one built into institutions of social control, such as universities, schools, hospitals and prisons. Following Foucault, I argue that the current geomatics conception of the world has evolved into a system that conditions geomatics practitioners to think about themselves and the world in specific ways. In this thesis, my cartographies analyse the "microphysics of power" (Braidotti, 2011a: 271) invested in university geomatics departments. These departments, being part of the larger higher education system and being intimately connected to industry, assist in the conditioning of subjects.

For Foucault, the 'medical gaze' referred in part to the dehumanising treatment that medicine performs – it separates the patient's body from their mind. This mind/body dualism makes it possible for the body to be subject to new power relations. The development of the medical gaze allowed the patient to be seen as the disease itself, and medical practitioners perform analytical techniques on the body of the patient so as to improve their clinical knowledge (Kelly, 2013). Linked to this was the meta-narrative of scientific superiority and science's ability to solve problems. The geomatics practitioner, like the medical professional, is implicated in this view. Firmly entrenched in scientific and engineering discourses, the modern geomatics practitioner is seen as a problem-solver. One of the reasons that engineers are highly regarded in corporate and other modern companies is their ability to manipulate modern tools and technologies to solve problems.

In university geomatics departments, students are trained to belong to a group that has a proud heritage. They should thus conform to certain norms. Geomatics practitioners control, police and present themselves in the 'correct' way – as people who are rational, scientific and predictable. This 'correct' behaviour is arrived at under the influence of a myriad of powerful influences, such as the *potestas* contained in geomatics knowledge: the imperatives of the profession, government and statutory bodies, the modern media, and the workings of the market economy. Each of these influences are not monolithic, and do not necessarily behave coherently. Thus the internal fragmentation of the modern subject is something that must be accounted for, and is something that a posthumanist methodology is suited to because it can handle complexity. Self-regulation is a characteristic of the humanist subject. Students are encouraged to self-regulate in order to obtain marks to pass their assessments. This economistic, individualistic logic helps the university, as a centre of power, to foster self-regulation in students. Disciplinary control is thus maintained.

The capitalist system reproduces itself through constituting and conditioning subjects that become its instruments and promoters. It utilises the affective power of capital and technology. In my teaching, I see that the allure of money is irresistible to most students. My Caltex story harnesses the seduction of global capital (see Chapter One). The power that money affords is a key driver in the choice of most students to study at university. University education nowadays follows the overly economistic conception of development, which can be contrasted with development for expanding personal freedom (Badat, 2015), or the realisation of potential ways of affecting or being affected (Massumi, 2015). The knowledge/power nexus takes an individualistic slant under the influence of advanced capitalism. There is a paradoxical consumerist obsession with the new which coexists with a conservative social rejection of radical transformation. This, as Braidotti notes, has a disastrous effect on subjectivity: "it reasserts individualism as the norm while reducing it to consumerism" (2011a: 275). Barad too, expresses her suspicion of the capitalist fascination with the new, and emphasises that temporal indeterminacy is integral to our existences. She points out that "we're always already haunted by the past and the future – that neither the past nor the future is closed" (Juelskjær & Schwennesen, 2012: 13). Within the university, the arborescent logic contained in the privileging of 'new' technology, hierarchical curricular knowledge, prescribed textbooks, high-stakes tests and rules of progression all feed into the individualistic subjectification of students.

Students coming from low income backgrounds see higher education and subsequent employment as the means to escape the trap of poverty. Students coming from middle to upper class families also see employment as a means to maintain or improve their income. Success at university (as well as access to university) is linked to social class (Motala & Vally, 2014). A proxy for social class in South African society is still race, and we see Black students being disadvantaged in the environment of the university (Bozalek & Boughey, 2012). In addition to this, the Eurocentrism still prevalent in the culture of the university marginalises those not marked as White. Academic underpreparedness as a result of sub-par schooling disadvantages Black students in general (Department of Higher Education and Training, 2013; Spaull, 2015). This is exacerbated by financial constraints, which prevent them from accessing resources and networks that would aid their university studies. In Story 19 ('Ndingubani na?'), the storyteller brings to the fore the absence of adequate education and economic opportunities faced by Black, rural youth:

> *Xonxa is my home village, situated approximately 979 km from Cape Town, 804 km from Johannesburg, and 621 km from Durban, where youth mostly go to search for better jobs and better education*

(Extract from Story 19)

Economic migrants within South Africa are linked to economic migrants from the rest of the continent in this anti-xenophobic story. As noted by Braidotti (2006), nationalism serves to foster new forms of xenophobia (and the re-inscription of the settler/native dualism) in countries that see an influx of refugees, such as South Africa or European countries.

The practices of science and related disciplines (such as engineering) face challenges in the current multi-layered, complex and contradictory society. In these rapidly changing times, there is a high degree of technological mediation influenced by the goals of the market economy, combined with a resurgence of religious extremism across the world. These changes cannot adequately be represented by traditional philosophy, and contemporary culture retreats into refrains that emphasise morality at a personal level (Braidotti, 2006).

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This religious morality neglects communal or relational ethics. Rooted in the metaphysics of individualism, it backfires when practitioners start working together in interdisciplinary groups.

8.2.2. Specialisation and professional relationality

Specialisation of knowledge into different disciplines has had a concomitant effect on the way that subjectification takes place. Nowadays, we find that the geomatics profession is not very good at forming substantive relations (other than relations based on mutual economic gain) with other professions. Geomatics practitioners pride themselves on the exclusivity of their profession. Individualism, fuelled by market logic has resulted in the geomatics profession drawing a hard boundary around its practice. Even within the profession, we find hierarchies at work. For example, the job of placing cadastral beacons is reserved for professional land surveyors only (who would have completed a professional degree at a traditional university). A surveying technician (who would have completed a diploma at a university of technology) is only allowed to place beacons under the supervision of a professional land surveyor.

In the 'family of professions' the focus on ethics is approached in a distributed manner (see Chapter Six), and there is not as much substantive communication between professionals such as surveyors, civil engineers, architects and town planners as there was in the past. For example, in a construction project, each of these professionals might take care of their narrow ethical responsibilities (guided by professional ethics and focusing on legal and administrative compliance), but a more holistic view is lacking. The surveyor, for example, will not think too deeply about the environmental impact of a housing development as they might be of the opinion that that is the responsibility of other allied professionals. It is not adequate to take the molecular view of looking at the details only. The conflation of ethics and accuracy by surveyors is often observed (this was explored in section 6.6), both in the geomatics learning experience and in industry. There may be cases where all processes are legally and administratively complied with, yet there might be serious ethical questions around the total project. My Caltex story (in Chapter One) is a case in point, and the question I pose ('*Can you help me to explain how a group of nice people can form a company that murders people?'*) is important to problematise professional ethics. As an employee in a large company, a specialist worker can lose overall sight of the aims of the company. Within academia too, a specialist researcher sees the world exclusively through her theoretical or methodological lens. Even traditional oppositional strategies to deepening domination, such as feminism and socialism, have been criticised by Haraway for their rigidity and for their inability to reconcile contradictory standpoints:

> The political struggle is to see from both perspectives at once because each reveals both dominations and possibilities unimaginable from the other vantage point. Single vision produces worse illusions than double vision or many-headed monsters (Haraway, 1991: 154).

Specialisation, however, does not absolve the geomatics practitioner or educator of ethical carelessness. As with other specialist areas of knowledge, geomatics is intimately entangled with societal values (which change over time) such as income generation, profit-making, land appropriation and political interests. Referring to GIS, Crampton points out that "there is little or no substantial discussion of ethics" (Crampton, 1995: 84). This lacuna in ethics education

has been uncovered in Chapters Five and Six. In addition to this, the practice of GIS is complex: it is situated in many different contexts (which could have contradictory interests), and can exhibit ethically inconsistent behaviour. For example, a GIS operator working for a multinational oil company would be expected to subscribe to a very different set of ethics to one employed by the World Wide Fund for Nature.

The narrow view of professional ethics described above can be contrasted to views of ethics which are based on relational ontologies. Thus, viewing ethics relationally would require an acknowledgement of entanglements, and collaboration for responsible professional practice. The subjectivity that is promoted by the geomatics profession exhibits many traits of Enlightenment, humanist logic. Thus I follow the lead of current critical thinkers (Barad, 2007; Braidotti, 2013a) who aim their critique at the Enlightenment which posited the subject as free, autonomous and rational. Subjectivity is *not* linked to transcendental reason, but emerges out of an assemblage that is based on the immanence of relations. Reading the ethic of care (Tronto, 2013) together with non-representational theory and posthumanist theory is useful as it allows for the emergence of a caring and ethical pedagogical *practice*. I acknowledge that a shortcoming of my storytelling intervention is that I do not foster collaboration between my students and other related professionals. However, the intervention does foster connections between students and encourages connections across disciplinary boundaries.

8.2.3. Maps and subjects

Maps and cartographers have agency and influence the process of subjectification of geomatics practitioners. The agency referred to here is relational – it is more than individual and carries in it the will of the hegemonic order. As agents of the state apparatus, the *potestas* contained in maps can promote the subjugation of subjects. When Harley's (1989) seminal article *Deconstructing the map* was published, it drew much attention from the cartographic community. One of his vociferous critics, Anne Godlewska, took exception in the way that Harley portrayed cartographers – as being obsessed with accuracy, and unaware of the implicit values behind maps. She claims that "[a]s for the values enshrined in maps, cartographers are perforce aware of the masters they serve and their interests" (Godlewska, 1989: 97). Whilst cartographers might literally know their masters (their direct employers), I would argue that a more nuanced and relational understanding is necessary. Harley's insight could be extended to refer to a far greater hegemony – that of the global capitalist market. As Braidotti notes, present capitalist hegemony is centreless, and a "scattered, weblike system is now operational, which defies and defeats any pretence at avant-garde leadership by any group" (Braidotti, 2006: 8). Godlewska further pits her own impression of cartographers against that of Harley, and found that "[i]n contrast to Harley's experience of cartographers, I have found that most have a subtle and critical sense of the nature of their work and do not perceive cartography as an objective form of knowledge" (Godlewska, 1989: 97). Not taking sides in this binary conception of cartographers, my experiences are somewhere between their two points of view. There are some geomatics practitioners and academics who have this subtle understanding, whereas there are just as many (and perhaps more in my experience) who do not.

Students are certainly inclined to uncritically accept maps and mapping software as being incontestable, and it should be the responsibility of the teacher to alert them to these taken-for-granted assumptions. When considering blind faith in maps, the underlying assumptions

about the nature of the world that emanate from cartographic representation are implicated. Viewing the world as consisting of geometric constructs (e.g. points, lines and polygons) means that uncertainty is handled inadequately. There are many phenomena (like soil type, climatic conditions or consumer preferences) that do not have clear physical boundaries and are not well represented by maps. Furthermore, conceptual generalisation is needed in handling uncertain data during map production. This may result in students making binary statements (e.g. this area is shown as grassland, therefore there are no trees here) when interpreting maps. This feeds into the scientific, rational conception of the cartographer who views boundaries in very specific ways. About boundaries, Barad notes:

> It is through specific agential intra-actions that the boundaries and properties of the components of phenomena become determinate and that particular concepts (that is, particular material articulations of the world) become meaningful (2007: 139).

In my teaching, I explicitly sow the seeds of doubt when confronted with blind faith in maps. In this regard, it is important to expose students to examples of propaganda maps which are used in a way that creatively distorts facts for political aims (see for example Monmonier, 1996). Harley noted that maps helped to create the myths of empire, and were utilised to maintain the territorial status quo. In addition to this, the figure of the surveyor was complicit in furthering the aims of colonisation:

> Surveyors marched alongside soldiers, initially mapping for reconnaissance, then for general information, and eventually as a tool of pacification, civilization, and exploitation in the defined colonies (Harley, 2009: 132).

It is into this non-innocent pedigree that student surveyors are being conditioned. Being able to come to terms with, and disidentify from, certain aspects of our shared past is important in the process of becoming.
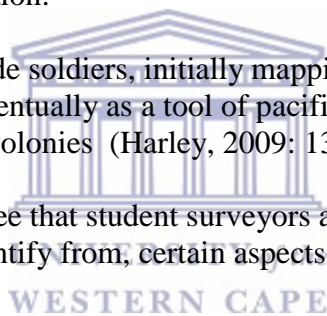
8.2.4. Surveyors as hauntological figures

My analysis so far has shown that the subject of geomatics education is intensely humanist, and more subtly anthropocentric. The figure of the surveyor arose out of a contingent array of historical processes. In the early colonial years, the need to mark, own and control access to land saw Pieter Potter produce the maps that he is famous for. The story of Van Riebeeck's hedge helps to trace some important entanglements related to colonialism, war, apartheid planning, cartography and control. I cast a light on some important binaries so as to queer them at the same time. Consider the boundary hedge. The animate/inanimate and absent/present boundaries are not as clear cut as the boundary between settler and native. The hedge, although absent, was not erased in over 350 years of settlement at the Cape. It still keeps out the native in a hauntological entanglement with the land. The highlighting of the presence/absence of the hedge in my pedagogy is a cutting together/apart (Barad, 2014) and a useful pedagogical/analytical device. The spectre of the surveyor is always lurking in the shadows of boundaries that were created to keep the inappropriate/d others at bay.

Patriarchy, rationality and racism were important driving forces in the actions of the first surveyors, as were scientific and anthropological curiosity. Colonisation fuelled progress in cartography, which in turn helped to further the aims of the colonisers. The surveyor, with map in hand, worked with the priest, the soldier and the businessman to further aims of

empire. In later years (from the late 1700s onward), during the trigonometrical survey of South Africa, many unnamed and disposable Black bodies would have carried the heavy instrumentation that would have been needed for accurate measurements. The scientific feats of the three pioneering astronomer-surveyors (Abbe Nicholas de la Caille, Thomas Maclear and David Gill) have been faithfully recorded for generations of surveying students (see for example Hurly, 2004; Lloyd, 2004). The trigonometrical survey helped to create a network of control points (points with known co-ordinates) that were distributed all over South Africa. These points were called trigonometrical beacons and were set up in the most visible places on the landscape, usually the tops of hills and mountains. To this day, trigonometrical beacons that dot the South African landscape are used by surveyors. They are a prized part of the celebrated South African surveying system, and are a testament to the hard work of the pioneering surveyors. They are also markers of innumerable Black bodies that toiled under the weight of heavy equipment and materials. In addition to this, they are markers of the domination of man over nature.

8.2.5. Counter-mapping, boundaries and affirmation

The logic of hard boundaries is part of the surveyor mind-set that is inculcated through their education and practice. The formalisation of surveying education in South Africa was in large part due to accuracy errors in the location of cadastral boundaries. The surveying worldview is seemingly one of boundaries and hard edges, difficult to reconcile liminality. However, leaving my argument there would be one-sided, and would not give due credit to geomatics practitioners and students, who are after all embedded in contemporary society. As Braidotti notes, "the new techno-cultural context writes hybridity into our social and symbolic sphere and as such it challenges all notions of purity" (Braidotti, 2006: 99). So some boundaries (e.g. virtual/physical) are easily transcended by geomatics students who are mostly young and technologically able.

My task in deploying the figuration of the boundary is to trouble well-established dualisms (such as Black/White), as well as newer boundaries that have started emerging. The settler/native dualism takes on a new twist in the context of economic migration within Africa. South Africa, Ivory Coast, Ghana, Nigeria and Burkina Faso are similar because they have massive migrant populations from other African countries. In a reversal of the dualism, the native is the hegemonic or dominant half, with the settlers seen as people who take the jobs and opportunities from the natives. Some stories[60] reverse the dualism by resisting radical exclusion (by affirming the continuity between Africans), incorporation (by rediscovering positive stories for African migrants) and homogenisation (there is a recognition of the diversity of cultures and material realities within the fuzzy boundary of Africa).

Apartheid town planning is a particularly nefarious example of boundary creation. The location of the apartheid boundaries had definite material consequences to everything (organic and inorganic), depending on where it which side of a boundary it fell. If a person was afflicted by blackness during apartheid, they would have had to live in an area which was under-developed and badly maintained. Environmental factors were often not considered in the establishment of these areas, which could lead to a steady decline in their overall environmental health. Underdevelopment led to urban decay, societal problems and

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[60] E.g. Story 19 ('Ndingubani na?'), Story 31('Reasons why refugees come to South Africa') and Story 44 ('The journey').

environmental degradation. Eco-destruction continues today – there is a hauntological connection to apartheid boundaries across time. Furthermore, the silenced voices of the others of the past such as Sol Plaatje are given prominence in my teaching. In the quote at the beginning of this chapter, Plaatje worries about the imminent slavery of his people at the time of the Natives Land Act. At the time, he gestured to the future – the logics of capitalism and the void was pointing to a virtual future that worried him greatly. His concern was entirely warranted, as the relations of subjugation stemming from access to land continue today, and are experienced first-hand by all South Africans. These relations are matters of concern that are raised in my pedagogy. Apart from stories like Story 26 ('Gangsterism in Khayelitsha') which focus on the harsh realities of township life, there are other stories which affirmatively transform this hardship. Story 40 ('Welcome to Khayelitsha') starts off with the history of the development of Khayelitsha.

> *The township was created in the 1980s under the then-prime minister, P.W. Botha. For many years it was a desperate place with few facilities and little infrastructure to house the influx of people into the area.*

<div align="right">(Extract from Story 40)</div>

Despite its troubled beginnings, the storyteller goes on to point out some places of interest (related to tourism) and successes emerging from Khayelitsha. For example, he names some successful businesses and a high-performing school located in the township. The triumphant emergence out of hardship is seen in other student stories. In relation to the affirmative transformation of negative events, Braidotti says: "Ethics consists … in reworking these events in the direction of positive relations" (2011a: 293).

The diverse lived realities of students are discussed in classes that always elicit affective responses. Dictated by market forces, students invariably live in Cape Town suburbs that they can afford. Leading questions produce sometimes uncomfortable, but important discussions. For example:

Look at this choropleth map[61] of populations by suburb in Cape Town.

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[61] A choropleth map is a thematic map in which areas are shaded, coloured or patterned according to a corresponding dataset. It is a common technique for representing census data.
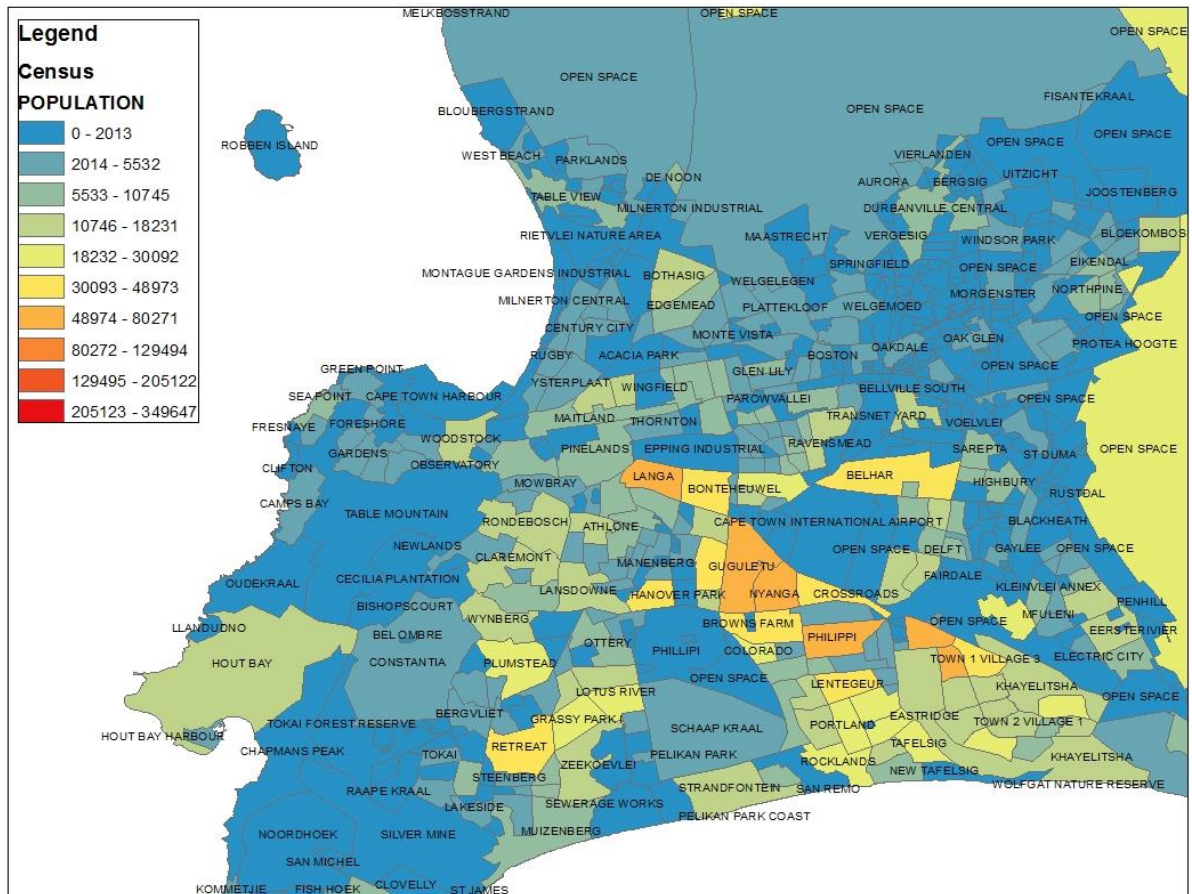
Figure 25. Choropleth map of Cape Town showing population by suburb

Can you identify the highly populated areas? Do any of you live in one of these areas? What is life like there? Which are the less densely populated areas, and who lives there? What are some of the issues that you face? Why is life so different in these two suburbs?

Now let's look at a choropleth map showing average income by suburb in Cape Town.
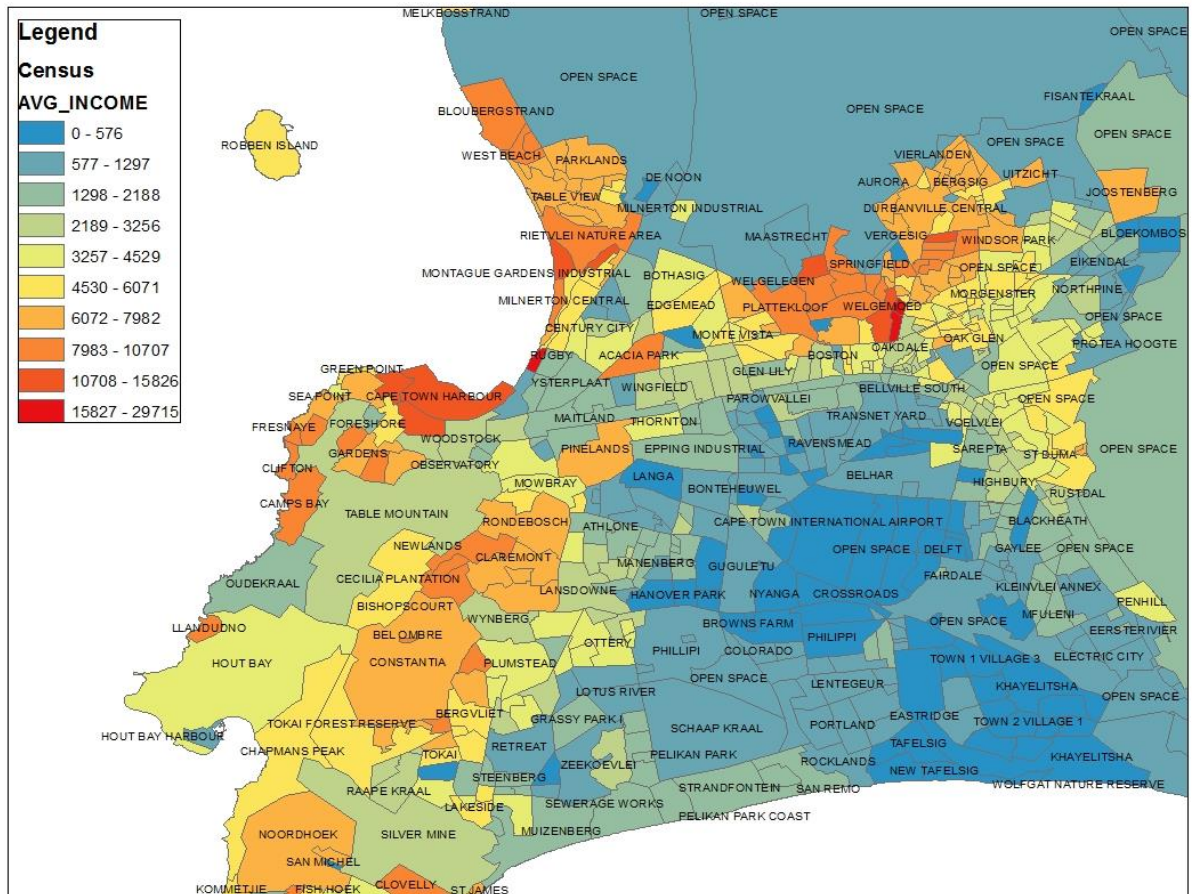
Figure 26. Choropleth map of Cape Town showing average income by suburb

Where do rich people live? Where do poor people live? Where do you live? Is there any relationship between the previous map and this one? If you could live anywhere in Cape Town, where would it be? Why?

These are questions that highlight the relationship between subjectivity and place. The relationship between figure and ground (Hughes & Lury, 2013) is important. More specifically, non-representational theory investigates how bodies and subjects are actualised through their relationship with the world (Anderson & Harrison, 2010). In this view, the world is not an inert backdrop of things, but is part of our fabric, as we are part of its fabric.

Considering the arguments I have presented about mapping as a hegemonic practice, it is easy to adopt a position of resignation about mapping as a tool of colonisation or an instrument of the State. Indeed, university cartography education prepares many students to be in the employ of government organisations. They thus go on to be agents of hegemony without seeing alternative or counter-hegemonic points of view. Many academics, as shown in Chapter Six, conform tacitly to the status quo. My teaching practice intends to disrupt such hegemonic notions, by injecting *potentia* via a micro-instance of activism into the learning experience. This is a deterritorialisation of cartographic practice in which affirmation follows critique. It is a reassembly of a seemingly strict discipline along ethical lines of flight. Judith Butler, in discussing Braidotti's affirmative, transformative ethics, sees the possibility of resistance to toxic hegemony, which is able to reassemble quickly and maintain itself:

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reassembly embodied in such toxic forms must be duplicated in the resistance to such forms. Therefore, the problem is not that the natural world is in the process of being reassembled – disassembly and reassembly are part of every life process. (Butler, 2014: 23)

The reassembly mentioned by Butler can be deployed towards cartography, and can be observed in the practice of counter-mapping. My pedagogical approach utilises a combination of counter-mapping, combined with storytelling. Colonial maps not only contained the colonised subjects, but actually created them (Garuba, 2002). In the same way, modern subjects are actively constituted by State mapping. My pedagogy subverts this subjectification from within the discipline of cartography. I attempt to shift subjectivity in a direction away from traditional humanism-based ethics towards a posthumanist ethical practice. I do not resist the maps themselves; rather, I offer resistance *through* maps by joining subjugated knowledges to (counter-) mapping.

8.2.6. Stories for *potentia*

The stories that I have used in this thesis serve multiple purposes. They showcase my pedagogical approach, they are used to uncover and trouble dualisms, they are used as devices to forge connections across difference, and they critique certain power structures while at the same time begin to affirmatively transform the critique. The last point is achieved by, for example, critiquing the colonial power structures of the seventeenth century, while at the same time giving recognition to the subjugated voices of that period. It helps to reconstitute subjects (including myself, my students and the characters in the stories directly) by tapping into *potentia*.

Another example of affirmative transformation of critique can be observed in my Caltex story. I felt that I could not operate ethically within the corporate environment, and decided to leave. This provided the opportunity for me to join the academy, within which I could use my experiences at Caltex to start conversations with students about ethics. In the story, I portray myself in a contradictory way. I am both hero and villain, and both these roles are not as clear-cut as it may seem. To some students, I am corporate success / victorious user of GIS / money maker / provider for my family; I then become corporate deserter / ambition-loser / guilty of self-harm. To others, I am greedy capitalist / seduced by the power of money; I then become principled educator / ethics follower. These two views are of course binary, and some students could oscillate between them or a combination of them. The story is paradoxical because it engages with the seduction of consumerism, but it also contributes to a pedagogy of ethics. Consumerist desires work through the allure of technology. Geomatics knowledge is an important contributor to the development of technology. However, the agent of consumerism can be affirmatively transformed into an agent of nomadic ethics. I do this by telling the story of why I left Caltex. It is a deterritorialisation, away from existing power relations and a recomposition of new ones. My intention in my Caltex story is to trouble the boundaries between good/evil and corporate employee/academic. It is also intended to showcase an example of becoming. By showing my development along an actual trajectory in space and time, I alert students to the many virtualities or potentialities along the way. These actualisations that could have been, these 'not yets' continue to re-present themselves in the stories that I tell and the subsequent discussions they activate. The crucial aspect about these virtual pasts, presents and futures is that they come into focus because of my ethical stance.

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This ethic is an ethic of care, a posthumanist ethic of relations and of in-between spaces. It is a reappropriation of the production of subjectivity (both individual and collective) by creating a space that allows for transversality (Braidotti, 2006). It emerges because of my agential cut, which allows specific characters of alterity to step out of the shadows.

Student stories allow for the active forging of new alliances across difference. When student subjugated knowledge is paired with counter-mapping, GIS technology and digital storytelling, entrenched dualisms are troubled. In particular, the two interrelated dualisms, Black/White and primitive/modern are brought into focus. As I have shown in Chapter Six, the knowledge of Black people in South Africa was systematically suppressed. In addition to this, indigenous knowledge was made to seem primitive, barbaric or superstitious (see the Biko quote at the beginning of Chapter Six). As Foucault notes: "Subjugated knowledges are thus those blocs of historical knowledge which were present but disguised within the body of functionalist and systematising theory" (1980: 82). Old hegemonic linkages, namely those linking Blacks and Whites to animals in specific ways – where Blacks were seen as animals (see section 6.5.1), and Whites protected animals – were troubled by Story 16 ('The unlikely rhino poacher'). New linkages are formed in this story – the Black storyteller sheds light on the plight of the rhino and champions an environmental awareness.

Other stories of students that foreground subjugated knowledges (for example, cultural stories or stories about the hardships of township life) are encouraged by my pedagogical approach. This follows Plumwood's strategies for overcoming dualisms. Incorporation is countered by allowing students to discover and tell the stories of the underside. Homogenisation is countered by allowing the complexity of Black society to be foregrounded. Furthermore, radical exclusion is countered by showing that there is overlap in the way that the stories of all students can be represented using GIS. For many observers, the combination of subjugated knowledges and storytelling in this particular way is a deeply affective experience. Stories like 'Ndingubani na?' (Story 19) and 'The journey' (Story 44) are a new experience for most audiences. These particular stories are told by Black South Africans, and forge connections with African refugees. They are told with skill and elicit emotional responses. Foucault also points out that it is through these types of stories, "these local popular knowledges, these disqualified knowledges, that criticism performs its work" (1980: 82). The introduction of these knowledges in the curriculum introduces a qualitative shift in the geomatics learning experience, and the concomitant process of subjectification. It gives legitimacy to students' knowledge, and acknowledges that all students can contribute to the geomatics knowledge base. The use of these student stories in my teaching signals to students (Black students in particular) that they are producers of knowledge, not just consumers.

As an exercise in counter-mapping, the storytelling intervention injects some *potentia* into the sedimented geomatics curriculum. It helps subjugated knowledges to emerge in some instances, but it can also equally contribute to the promotion of hegemony. The emergence of subjugated knowledges and hegemonic knowledge appears side-by-side in student stories.

8.2.7. My changing subjectivity

I am aware of the *potestas* contained in my choice of stories (the stories that I choose to tell or student stories that I choose to play as exemplars). The interpellative effect is seen in the thematic analysis of the student stories. Many chose to link history with counter-mapping, or tell personal stories, or tell stories that related to the land or the environment, as I did. Over

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time, as my awareness of various issues of alterity grew, so did my choice of stories. My growing awareness of the need to practice a socially just pedagogy premised on an ethic of care has also resulted in me being attentive by listening more. This has had a concomitant change in the choice of student stories. I have seen an increase in the diversity and complexity of student stories. Over time, a posthumanist ethic emerges out of the pedagogical assemblage. The absence of stories about the plight of women or disabled people points to my silence on these accounts. In future, my stories must break these silences so students can too.

The boundary between Black and White is being blurred in this society which is becoming increasingly complex. New alliances form, which break free from previous patterns, but also repeat the past. For me, the same logic applies. During my PhD process, finding a new community inspired by posthumanism was a leap across difference for me. I interacted with interested and interesting people, places and things. According to the theorisation of Spivak, my subjectification is influenced by being at the centre and periphery simultaneously, and I cannot not inhabit both spaces. It became glaringly clear during the student protests of 2015-2017 that I wield hegemonic power by being a teacher and employee of CPUT. Yet my involvement in the posthumanist community has helped me to trouble old relations of power by recognising them, critiquing them and then attempting to transform them by making students contribute to the storytelling. Students don't just contribute through making digital stories, but by taking part in a process too.

A posthumanist ethic, which is resonant with the ethic of care, helps to trigger an activist stance. Through the process of immersion into posthumanist theory and practice, I am also being interpellated. Appreciating how stories, technology, human subjects, politics and the land co-constitute each other is an interpellation into a posthumanist subjectivity. It is a process which is constituted by many 'diffractive moments' (van der Tuin, 2018). There have been numerous moments that had far-reaching consequences for my pedagogy and research. These were moments in which transversal connections were made across boundaries. Some examples of these diffractive moments were: the experience at/across the gate at NGI during the #Feesmustfall protests (see Chapter One) made me realise that I am immanent to the system I am critiquing; when I first played 'Ndingubani na?' to a group of academics, their responses made me realise that the story was one that affirmed the positivity of difference; and the moment that I realised the importance of *process* during the student storytelling intervention. My appreciation of the world with a posthumanist orientation is a shift in my ontological stance in the face of the becoming of the world.

8.3. Concluding thoughts

The analysis presented in this thesis traces entanglements that have influence on the subjectification of geomatics students and practitioners, including myself. I have adopted a diffractive and genealogical approach, which acknowledges that the process of subjectification cannot be explained by simple cause-and-effect logic, yet there are strong intersecting vectors of influence that emerge over the period analysed. The analysis reveals patterns of difference and sameness – these patterns either serve to promote the hegemonic subject of humanism, or alert students to an oppositional or posthumanist consciousness.

Subjectivity is iteratively performed and is subject to a constellation of forces exerted by power. The power relations are numerous, and are a subset of a larger, indeterminate number

of power relations. The agential cut in this research identifies those relations ethically. Traditional geomatics pedagogical practice and knowledge production are strongly influenced by humanist ideals. Important blocs of knowledge (such as the ubiquitous interpolation) are given primacy in the geomatics learning experience. The repetition of these knowledge practices train geomatics practitioners to be excellent technicians and competent in the scientific method. Issues of alterity are largely silenced, and this effectively silences students' subjugated knowledges. Ethics are thus compromised.

Moving beyond anthropocentrism, while at the same time upholding a posthumanist practice and theory of political, ethical and onto-epistemic subjectivity formation, is challenging. The difficulty is in how to connect anti-anthropocentric perspectives with a radical practice of subjectivity. This radical practice is aimed at awakening consciousness of, and at best, undoing of the humanistic power structures that support the supposedly neutral system of geomatics knowledge production. This is a difficult task as the supposedly non-anthropocentric nature of geomatics knowledge seems to adhere to posthumanist principles, yet tacitly supports the humanist subject at its core. A postanthropocentric consciousness is difficult, if not impossible to attain, and Braidotti's nomadic subjectivity "implies an open-ended trans-species flow of becoming through interaction with multiple others and with many ethical and (micro)political choices to make on the way" (Pisters, 2014: 68). This open-endedness was emphasised by Guattari (2000) too in the development of his ecosophy. For Guattari, environmental activism was geared toward the resistance of capitalism through the enunciation of new assemblages. This focus on the new eschews programmatic or prescribed forms of pedagogy, no matter how progressive they may seem (Greenhalgh-Spencer, 2014). My storytelling intervention opens up the possibilities of enunciations of new assemblages through unexpected alliances and hopes to re-orient students towards new awareness.

Instead of focusing on the ill-preparedness of students, the storytelling approach does not allow the disadvantaged pasts of students to define them. Posthumanism subscribes to a process ontology and stresses the primacy of experience in subjectivity formation. It acknowledges that students who have been defined as other (and all the negative connotations that go along with it) have valuable knowledge to contribute.

CHAPTER NINE – CONCLUSIONS

> The fundamental political desire is for an individual and collective reappropriation of the production of subjectivity, along the lines of 'ontological heterogenesis', chaosmic desegregation of the different categories. We need actively to desire to reinvent subjectivity as a set of mutant values and to draw our pleasure from that, not from the static contemplation of the perpetuation of the regime of the Same. Chaosmos is the universe of reference for becomings in the sense of the unfolding of virtualities, or mutant values (Braidotti, 2006: 123)

9.1. Introduction: what was produced?

In this chapter, I review the ways in which I have addressed the research questions in this thesis. The two main research questions are:

1. How is a specific type of humanist subjectivity encouraged and perpetuated by the geomatics learning experience?
2. How can a micro-instance of pedagogical activism in the form of a digital storytelling intervention be used as an affirmative critical posthumanist educational device in geomatics education?

See section 1.4 for a complete list of the questions and sub-questions. Questions 1 and 2 were largely addressed in Part 2 ('Potestas') and 3 ('Potentia') of this thesis respectively. In addition to the abovementioned questions, the overarching question that I consider is: what was produced by this encounter between posthumanism, geomatics and storytelling?

Through a cartographic and diffractive analysis of geomatics in general, and South African geomatics education in particular, several important learnings emerge. I have shown that there are several elements in the curriculum that have assumed a central place in the geomatics learning experience. In cartography, the deep faith in representationalism emerges from the Cartesian worldview that separates subjects and objects, world and representation. This view is contested within the ambit of non-representational theory, and Thrift's (2008) principles are useful in showing how the storytelling approach is non-representational. Furthermore, critical cartographers (Harley in particular) point out that maps are not representations of the world 'out there', rather, they help to construct the world. 'The model Apartheid city' (Figure 9) is an example of an old map that still constructs the lived reality of most urban dwellers in South Africa.

Cartographers' over-reliance on 'scientific' or 'objective' knowledge blinds them to ethical issues. Within the ambit of geomatics, professional ethics is dominant and is associated with individuality, reliability, professional behaviour, legality and most importantly, accuracy. Dualisms are found throughout the geomatics knowledge base – they are used to keep the subject of humanism in a hegemonic position. There is an overtly binary conception of cartography, which has over time come to be associated more with 'science' than 'art'. In addition to dualisms, there is an interpellative power to the ubiquitous logic of interpolation. Within the traditional geomatics knowledge base, interpolation simplifies the world – it uses several privileged metrics to create models that describe or predict. Interpolation is implicated in algorithmic methods of control that directly influence the constitution of subjectivity. Geomatics graduates are socialised into identifying with a hierarchical

community of practice. This imposes *potestas* upon bodies through the practice of geomatics. I have used Plumwood (1993) to identify the occurrence of dualisms in the geomatics knowledge base and in stories. I have analysed how these dualisms are justified or reinforced. I have also investigated how, through stories, the dualisms can be dismantled or countered.

The activation of *potentia* encourages the emergence of a new, posthumanist sensibility through an ethic which I have taken responsibility for. Barad points out:

> Ethics is about mattering, about taking account of the entangled materializations of which we are a part, including new configurations, new subjectivities, new possibilities - even the smallest cuts matter (Barad, 2007: 384).

It is important to note that ethics is also emergent in a pedagogical practice that emphasises attentiveness, responsibility and trust. Specific stories are brought to the fore by myself or students, and an appropriate, caring ethics emerges. This shows the active and dynamic nature of ethics – unlike morality, it is not based on transcendental reason. Nor is it, as Braidotti explains,

> the unfolding of an essence in a teleologically ordained process leading to the establishment of a supervising agency - be it the ego, the self or the bourgeois liberal definition of the individual. Nomadic becomings are rather the affirmation of the unalterably positive structure of difference (Braidotti, 2006: 145).

The intervention works by exemplifying the philosophy of difference. It works to resist the restrictive power of humanism, but does not reject the *potestas* in the curriculum outright – this is diffraction in action. Students are differentially marked by the learning experiences imposed on them, and this particular experience leaves a different type of mark on their bodies.

My analysis follows Braidotti's advice and critiques "the intertia, the repressive tolerance, and the deeply seated conservatism of the institutions that are officially in charge of knowledge production" (Braidotti, 2011a: 270). The conservatism of geomatics departments has been revealed in the processes of subjectification that are re-iterated with regularity. The geomatics curriculum is bounded and controlled by a number of powerful agencies which are strongly influenced by advanced capitalism. The subject of humanism lurks in the shadows of the curriculum, and keeps the geomatics learning experience within its pre-defined, scientist boundaries. Strongly influenced by cognitive capitalism, yet ostensibly able to be benevolent (especially towards the natural environment), the modern geomatics practitioner is bred within the boundaries of the university.

9.2. Shifting boundaries

A relational agential realist analysis (a diffractive analysis in Barad's ontology) looks at phenomena, not things, as objective referents, and shows that the apparatus produces not just data and things, but values and meaning too. If geomatics education is the phenomenon, and my stories are viewed as the apparatus, then one can see how a different set of meanings and matterings arise. This is an opening up of geomatics education practice, which is meant to foster different forms of engagement, as encouraged by Barad (Juelskjær & Schwennesen, 2012). An acknowledgement of the narrowing of the focus of engineering qualifications has

resulted in calls for a broadening of the epistemological and methodological boundaries (Beddoes, Schimpf & Pawley, 2014). This implicit boundary-widening process is contained in the philosophy of posthumanism.

Central to my diagnosis of the present is my figuration of the boundary. What is included (and what is therefore excluded) in the curriculum is a boundary-drawing practice (Barad, 2014) and one that I have paid careful attention to. In particular, this thesis has been attuned to the silence that has been imposed upon several others, namely the racialised other and the naturalised other. A historical lack of interrogation of social and environmental issues in the geomatics learning experience has contributed to an inertia of action, a deep-seated unwillingness and inability to conceive of action on these fronts. The surveying worldview is one of boundaries and hard edges, and it is difficult to reconcile liminality. The human surveyor, the land, the surveying technology and the practice of surveying and mapping are co-constitutive and co-evolutionary. There is a strongly individualistic influence which conditions students to present themselves as people who are rational, scientific and predictable. In addition to this, Western humanist morality is rooted in the metaphysics of individualism, and this poses serious ethical problems in the world which requires people to work collaboratively in groups.

The boundary features in all the stories I tell. Boundaries are seen by surveyors as mostly static and permanent. However, boundaries are also inspiration for anti-dualist remedies, as they can be porous or fluid. As seen in the example of Van Riebeeck's hedge, boundaries can move across space and time. Troubling the interpolated boundaries of traditional maps, my boundary aims to expose the enclosure of old modes of thought (especially dualistic thought). Through agential cuts, new and fluid boundaries are actualised by collective experimentation.

Boundaries are markers of situatedness. In this regard, many of my stories are set in Cape Town. They are aimed at producing socially relevant knowledge and affirm the positivity of difference at the same time (Braidotti, 2013a). Boundaries, like the figurations of Haraway, have inherited non-innocent pasts that need to be read diffractively (Sehgal, 2014) for an affirmative transformation to take place. Yet crossing the sorts of boundaries mentioned in this thesis is not easy. In this regard, creative figurations are harnessed as tools to transcend boundaries, or draw links between boundaries.

The analysis of student stories in Chapter Seven shows the transcendence or critique of several boundaries. The dualistic boundaries between Black/White, rich/poor and native/foreigner are critiqued and transformed. The boundaries between past/present/future are troubled by stories that showcase student subjugated knowledges (particularly cultural indigenous knowledge), as well as stories about apartheid or colonial boundaries.

In a deliberately playful yet resistant stance, I have chosen to disrespect the boundary between art and science. I have engaged in what Haraway calls art/science activism (Haraway, 2016), using the navigational potential of storytelling to chart a path towards an ethical becoming. This is combined with the analytical potential of diffraction, in which connections are sought out to inspire the navigation.

9.3. Remembering as re-membering

My pedagogical practice recognises the power of memory and the imagination (Braidotti, 2013a). It remembers African history and encourages movement across boundaries. Subjects who identified with one half a dualistic pair are encouraged to disidentify and reimagine their membership in (or outside of) the dualism – this re-membering is activated through *potentia* contained in the storytelling intervention. Like Barad, this thesis raises questions of history and memory (which usually have particular conceptions of time and being) and is about

> the possibilities of justice-to-come, the tracing of entanglements of violent histories of colonialism (with its practices of erasure and avoidance) as an integral part of an embodied practice of re-membering – which is not about going back to what was, but rather about the material reconfiguring of spacetimemattering in ways that attempt to do justice to account for the devastation wrought as well as to produce openings, new possible histories by which time-beings might find ways to endure (Barad, 2017: 62– 63).

My District Six story utilises the power of genealogy to relate students embedded locations to the socio-political system. So too does the Pieter Potter story. These stories trace the entanglements of land, politics and race. They join storytellers and audiences by difference. Students inhabit the university campus and the city differently, yet are all connected to it by virtue of shared timespace. Although I was not in District Six during the time of forced removals, it is my story too. I lived in an Indian-only group area called Kenville in Durban during the 1970s and 1980s, and many of my family were subject to violent dispossession. Growing up in Kenville shaped my subjectivity – as a child, I feared Whites because they were associated with the police who arrested or killed some of my family. The boundary drawn around Kenville was the same as the boundary drawn around many group areas in South Africa at the time, including District Six. In remembering District Six, I remember my family's and friends' stories.

Stories that are inspired and guided by geomatics bring a different, often new, dimension to the stories. For example, by viewing District Six on maps over different periods of time allows one to draw connections between people, places and things. When lecturing at CPUT Cape Town campus, I asked students to imagine that they were transported back in time. I further ask them to imagine what would have been happening around them. The Engineering Building that I lectured in was located at the place where the first demolitions took place in 1968. There is a fracturing in the temporal continuity in this learning experience. Historical mapping and spatio-temporal GIS analysis brings the past into the present in a tangible, material sense. Students whose families were affected by the forced removals of District Six are direct products of District Six, and are re-connected to their past. This and other stories (especially from South African history) facilitate hauntological encounters (Barad, 2010, 2017) across difference.

After telling my stories that draw heavily on collective African memory, students were given opportunities to tell their stories. It is an embodied and relational practice, as one of the first events is the story circle. Part of the appeal of my storytelling intervention is affective. When I tell my stories, there are often moments of intense emotion which emerges from combining technology, counter-mapping, history, art, local place and performance. In this process of affecting and being affected (Massumi, 2015), mapping is reimagined as a practice that is not exclusively representational, as is conventionally thought.

Many stories that were produced made complex connections, spoke about multiple belongings and exhibited critical reflection. Some disrupted conventional notions of subjectivity. This analysis does not ascribe to simple cause-and-effect explanations. The agential cut I employ acknowledges that there is a multiplicity of forces acting on the student subjects, my storytelling being one. The analysis carefully describes the apparatus that was employed and the phenomena that were produced.

Practicing critical theory allows one to shine a light on silenced spaces in the geomatics curriculum. Granting agency to the voices of the other (making space for Steve Biko and Sol Plaatje), a more nuanced analysis is enabled to emerge. It situates my analysis in between hegemony and the dispossessed, allowing me to trouble dualisms. The eloquent voices of Biko and Plaatje trouble the boundary between civilised coloniser/primitive native. The analysis also situates itself across the art-science boundary to critique the neglect of ethics in engineering education, and to affirmatively include ethics via stories. In a similar way, giving students a voice to tell their stories shines a light on gaps in the geomatics curriculum. By rediscovering a story for the underside (Plumwood, 1993) through the foregrounding of students' subjugated knowledges, entrenched dualisms are resisted.

9.4. Posthumanism and geomatics

The encounters between geomatics and posthumanism were facilitated through my pedagogy and this research study. Their entanglements have been traced and the knowledge thus generated has illuminated some interesting and alternative ways of being/becoming. In addition to this, some interesting provocations and questions arise.

This research creates transversal links between the 'hard' and 'soft' sciences by means of a diffractive and cartographic analysis. By deliberately blurring boundaries, particularly those separating dualistic pairs, both posthumanism and geomatics communities stand to benefit. They benefit because of a more relevant and deeper understanding of the world in which advanced capitalism thrives, backed up by empirical evidence of the theorisation of geomatics through posthumanism. Capitalism thrives through harnessing the power of interdisciplinarity and complexity whilst at the same time dumbing down the populace in its service. I ask what knowledge geomatics and posthumanism can add to each other. The knowledge is produced by an entangled apparatus, so attributing the knowledge to either geomatics or posthumanism erases complexity. Hence, sometimes the knowledge emerges, perhaps in a diffractive moment (van der Tuin, 2018), out of the in-between space, at/across the boundary between posthumanism and geomatics.

Thinking with theory during pedagogical practice helps to open up possibilities through creativity. It allows subjects to be in an in-between intensive space that welcomes change. The in-between space is at the site of numerous boundaries, for example past/present/future, Black/White, citizen/foreigner, student/teacher and nature/culture. As Braidotti says: "This includes high levels of intensity and a state of flux or oscillation between the "no longer" and the "not yet"" (Braidotti, 2011a: 119). I hand over the creative power to students by creating an affective moment of *potentia* that embraces alterity. It is creative and activates the power of memory and the imagination. It uncovers virtual pasts, and imagines virtual presents and futures. I imagine what could have been, and actualise the facilitation of African knowledge creation. The knowledge is relational – it is embedded in the local, yet connected to the global by a web of human and non-human agents. It is expressed via stories and maps,

produced with a generation of students in the Global South, and guided by a posthumanist ethic of care. The combination of counter-mapping and storytelling troubles the way maps were deployed in the past (that is, to further the aims of the State). In addition to this, situating the story from the perspective of the colonised land transforms power relations, as the story would have previously told from the human perspective of the coloniser.

Geomatics concepts have rich potential to bridge the gap between the hard and soft sciences. Geomatics students and academics focus on the epistemology of admittedly difficult concepts, but, in order to truly meet the social sciences halfway, they need to understand the ontological and ethical implications of their knowledge. There is a common view that the geomatics curriculum is tightly crammed with content (as confirmed by interviews), leaving no place to introduce the 'soft' sciences, thus creating a lacuna in the ethico-onto-epistemology of geomatics education. Figurations like the boundary are useful as a translational device – they are well-known in geomatics, yet can also be deployed to activate thinking about socio-political or environmental issues. Also, the intricacies of interpolation can be used to show how interpolation is a simplification or approximation of the more complex process of interpellation. Humanist interpellation is dominant, yet there is room for a posthumanist sensibility.

Seeing boundaries as porous, fuzzy or transient is not easy for surveyors who pride themselves on producing accurate representations of the land. A static map (like a cadastral diagram) is sedimented, a snapshot in time, possible to update but not fluid. A cadastral diagram is a representation of a piece of land, intimately entangled with rights over the land, in an anthropocentric vice grip. Once the surveyor bashes the beacons (usually in the form of iron pegs) into the ground, invisible lines are drawn, creating a boundary. Invisible walls extend skyward, subdividing the land, now being owned. Lines of flight are not easy on this map. It is a striated space, a Deleuzoguattarian tracing. The map, the land, the owner, past, present, and future are entwined. The cadastral record can be traced back to when that piece of land was annexed by humans. It is sequential, hierarchical, tree logic.

> All of tree logic is a logic of tracing and reproduction … Its goal is to describe a de facto state, to maintain balance in intersubjective relations, or to explore an unconscious that is already there from the start, lurking in the dark recesses of memory and language. It consists of tracing, on the basis of an overcoding structure or supporting axis, something that comes ready-made (Deleuze & Guattari, 1987: 12).

Deleuze and Guattari's conception of mapping comes from Deligny's performative maps. These maps were co-produced by himself, his colleagues and autistic patients who all lived together in the Cévennes Mountains in France from the 1960s. Tracing sheets were put on maps of the territory, upon which the movements of autistic children were traced. These maps, consisting of lines, conveyed a sense of movement and rhythm (Gray van Heerden, 2017). Deleuze, in critiquing psychoanalytical methods, points out that a "cartographic conception is very distinct from the archaeological conception of psychoanalysis" (Deleuze, 1998: 63). While the latter foregrounds memory, it also sees space as a backdrop against which the action happens and also serves to foreground and establish identities. Cartogaphy, on the other hand, does not seek out some original reality, but rather to evaluate displacements (of subjectivities, assemblages, land or other things). Personal identities or objects are not important, but becomings are. Equally important is the place within which movement occurs (what Deleuze calls *milieu*). This conception of mapping is more aligned with Thrift's (2008) tenets of non-representational theory than traditional geomatics. Non-

representational theory is about movement, it is anti-biographical, concerned with practice, and is experimental. Indeed, many non-representational theorists draw heavily on the work of Deleuze and Guattari (Vannini, 2015).

It should be noted that Deleuze's ideas about cartography were always changing, and there are subtle differences between his writings, although maps and tracings primarily appear in his work on psychoanalysis or linguistics. In *A Thousand Plateaus*, the tracing is likened to arborescent, tree logic, whilst the map is akin to the rhizome. In *Essays Critical and Clinical*, he contrasts the cartographic with the archeological. The archaeological approach, like the tracing, seeks out and confirms a dominant reality. In both however, the map is experimental, non-hierarchical and in opposition to long-term sedimentation. Deleuze and Guattari do not fall into the trap of creating a dualism between maps and tracings: "Have we not, however, reverted to a simple dualism by contrasting maps to tracings, as good and bad sides? Is it not of the essence of the map to be traceable?" (Deleuze & Guattari, 1987: 13).

Besides being a representation, an ordering of our knowledge of a territory, a map can also be used to order the territory itself. Maps are deeply implicated in acts of political advocacy, annexation, spatial ordering and ideology propagation, and are not neutral. The scientific and engineering view of mapping is that spatial information is neutral, objective and impersonal. However, "maps are not independent of the observer: maps are context-dependent, often available only to the initiated, unlikely to be value-free and should be viewed with caution" (Dorling & Fairbairn, 1997: 4). I would argue that even the 'initiated', namely students and some teachers of mapping sciences, are unaware of maps being ideologically-laden communication and ordering devices. This is in part due to the geomatics curriculum, which interpellates and orders the student and lecturer, just as maps do. Harley warns that "cartography is seldom what cartographers say it is" (Harley, 1989: 1). If one compounds this with the multiplicity of voices that talk to the geomatics student through texts and learning experiences, a rational, scientific 'truth' emerges. There are layers of control in the higher education assemblage which sediments both lecturers and students into becoming uncritical geomatics subjects.

Posthumanist approaches to research are very different to those of geomatics. The methodological assemblage that I have employed in this thesis was always intended to be dual – it is both analytical and navigational. Furthermore, my experimental, open ended, subversive pedagogy and research is partly built on the hope that Lury and Wakeford articulate: that the investigation will "enable *the happening* of the social world – its ongoingness, relationality, contingency and sensuousness" (2012: 2). This approach would require a paradigm shift on the part of many geomatics researchers, who are firmly entrenched in positivism. I would suggest that a good starting point is to invite recognition on the part of geomatics practitioners that their knowledge practices do more than simply describe the world 'out there'. In this regard, the insights of Harley are crucial.

Having read posthumanism with geomatics, a provocation about our relationship to land arises. How can we relate differently to the land that we are surveying with such accuracy? There is a real difficulty in going beyond anthropocentrism in this project while upholding a posthumanist practice and theory of political, ethical and onto-epistemic subjectivity formation. The difficulty is not in developing non-anthropocentric perspectives, because much of geomatics theory is based on scientific principles that are grounded in the natural, mathematical and physical sciences. The issue is how to connect geo-centred perspectives with a radical practice of subjectivity. There is thus a tension between two nested practices

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happening simultaneously but at different scales: one focusing on subjectivity and the rejection of self-centred individualism, and another focusing on creating an enlarged sense of community based on environmental interconnection with 'earth' others (Braidotti, 2013a). This radical practice is aimed at awakening consciousness of, and at best, undoing of the humanistic power structures that support the supposedly neutral system of geomatics knowledge production. My research is an intervention aimed at orienting students towards a new awareness. This by no means addresses the problem fully, but gestures towards a posthumanist earth-centred orientation.

9.5. My agential cut can be sharper

While this is not an attempt at a fundamental redesign of the architecture of the curriculum, the intervention allowed for a part of the curriculum to be dictated by students' own affects, intensities and flows. It represents a micro-instance of critique, flow and activism within the sedimented curriculum. It pays attention to what Braidotti calls "micropolitical instances of activism, avoiding overarching generalizations" (2011a: 269). The storytelling intervention is a creative, modest intervention which looks to activate a critical sensibility in my students, guided by a posthumanist brand of sustainable ethics. The dominant conception of ethics in geomatics education is professional ethics, and I feel that more room should be made in the curriculum towards other ontologies (and hence ethical stances). In recent re-curriculation initiatives at CPUT, there are courses being developed within engineering curricula that explicitly address issues of engineering and mankind's impact on the environment[62]. This is a step in the right direction, but is still anthropocentric as the centrality of man is not contested.

Teaching and learning is cyclical, rhythmic, iterative and affective. Modern engineering education is attuned to several rhythms: to the temporality of technology (often dictated by the logics of the market economy), to timetables, to discrete curricula and to assessments. As mentioned in Chapter Seven, a critique of the storytelling intervention is that I tap into technological rhythms at the expense of natural rhythms. Geomatics as a practice, through having a geo-centred and nature-facing orientation, lends itself to an attempt to re-connect with our long-lost natural rhythms. Furthermore, Haraway advises us to continue in a process of becoming-with, "as long as the rhythm of accepting and giving is sustained" (Haraway, 2016: 10). Educational practice that taps into natural rhythms with a sense of giving would be profoundly anti-anthropocentric, and further investigation into interventions to further this aim is important.

As noted, the Black/White dynamic has, in some ways, not adequately been challenged in my pedagogy. Black students were disproportionally challenged to undertake emotional labour, leaving White students in a position of 'privileged irresponsibility'. A pedagogy of discomfort could be an interesting future direction to take. The pedagogy would be aimed at disrupting entrenched racialised power relations, yet upholding a democratic and caring educational practice.

In this research, I have acknowledged that, whilst my agential cut focuses on two of the structural others, namely people of colour and the natural environment (especially the land), my gender blindness is evident. In addition to this, there are other forms of blindness, for example towards differently-abled people. These are especially applicable in geomatics,

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[62] For example 'Engineer in Society' is a course in the Civil Engineering curriculum aimed at, amongst other things, introducing engineering students to the role they play in the care for the environment.

which has traditionally been associated with able-bodied males. In future, my agential cut must further analyse my ethics and strive to foster an enlarged sense of interconnection. In this regard, further research could be conducted on the development of a pedagogical ethic for engineering education.

9.6. The end?

There is no end to this story of the present, as the ongoingness (Lury & Wakeford, 2012) of the world cannot be bounded. Despite the strict split between the hard and soft sciences, boundaries can be crossed. An injection of *potentia* into the structured geomatics curriculum allows a meeting halfway of art and science. This is assisted in part because of the visual nature of geomatics. Geomatics lends itself to an appreciation of visual art, because geomatics is a visual discipline: maps are meant to be seen, and surveyors use eyesight as a crucial tool in making sense of the world.

Strategically, a posthumanist analysis requires an affirmative yet oppositional stance. It privileges the revolutionary voice, and promotes a becoming-minoritarian. My embodied and embedded location in all its complexity provides the ground for my own political and ethical accountability. I must inhabit complex, contradictory and simultaneous spaces: I am a father, a husband, a storyteller, a land surveyor, an agent of *potestas*. Additionally, I am diasporic, marginalised, shaped by apartheid and minoritarian. I also see the capitalism all around me, take part in its practices, and critique it simultaneously.

A diffractive analysis shows that a pedagogy of responsibility (in Tronto's terms) or accountability (from Barad and Haraway) (Bozalek, Bayat, et al., 2018) means that I see myself as implicated in the system I am resisting. The process of research allows me to interrogate my becomings, and think of them in terms of flows and intensities. How has the *potestas* changed to allow some *potentia* in? The storytelling intervention allows for a part of the curriculum to be dictated by students' own affects, intensities and flows. It is a micro-instance of critique, flow and activism within the sedimented, striated curriculum.

The relationship between surveyors and boundaries is co-constitutive. Surveyors create boundaries, and boundaries create surveyors. It is bred into us. Surveyors are taught to create, respect and maintain boundaries, and only in exceptional circumstances are they required to be broken down. In contemporary society, boundaries are being drawn, erased, reimagined, re-appropriated, re-membered, reiterated and disrespected. During a collective re-appropriation (see the Braidotti quote at the beginning of this chapter) of a pedagogical experience that affects subjectivity, some boundary breakdowns/creations are more easily imagined than others.

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APPENDICES

Appendix 1 – Rules and codes of conduct

SOUTH AFRICAN COUNCIL
FOR PROFESSIONAL AND TECHNICAL SURVEYORS

PUBLICATION OF RULES
In terms of
THE PROFESSIONAL & TECHNICAL SURVEYORS' ACT 1984 (ACT 40 OF 1984)
As amended

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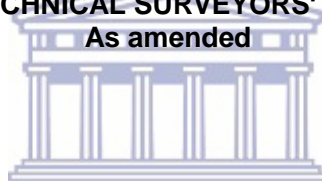
CHAPTER I

1. Definitions

'Chief Surveyor-General '

> means the Chief Surveyor-General appointed in terms of section 2
> of the Land Survey Act, 1997 (Act 8 of 1997);

'institute'

> means an institute referred to in section 3(2)(a), (b), (c), (d), (e), (i) and (i)A of the Act;

'supervise' or 'supervision'

> has the meaning assigned thereto in the Land Survey Act, 1997(Act 8 of 1997) and in respect of any
> kind of work reserved under section 7(2) of the Act shall further mean, the personal
> presence of the professional land surveyor, professional surveyor or surveyor when objects to
> be surveyed are inspected by him/her and pointed out to the survey technician or survey
> technician in training and sufficient reconnaissance by him/her to ensure that the required
> standard of accuracy for the survey is obtained.

'president'

> means the president of the South African Council for Professional and Technical Surveyors or the
> person who is acting in his/her stead in terms of section 6(3) or (4) of the Act;

'the Act'

> means the Professional and Technical Surveyors' Act, 1984 (Act 40
> of 1984);

'the Sectional Titles Act'

> means the Sectional Titles Act, 1986 (Act 95 of 1986);

'the Land Survey Act'

> means the Land Survey Act, 1997 (Act 8 of 1997);

> and any other word or expression to which a meaning has been assigned in the Act shall, when
> used in these rules, have the meaning thus assigned thereto.

CHAPTER II
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2. Meetings of the council

1. At each ordinary meeting of the council called in terms of section 3(8)(a) of the Act and at each subsequent ordinary meeting of the council, the council shall fix the date and the place of the next ordinary meeting.

2. A notice convening a meeting shall specify the place, date, hour and business of the meeting and shall be posted to members not later than 30 days before the date of the meeting: Provided that, in the case of a special meeting, the president may give members such notice thereof as he or she may deem sufficient.

3. Any member desirous of proposing an amendment to these rules, or of bringing any other matter before the council, shall forward, at least six weeks before the date for which a meeting is to be convened, a written notice of motion thereof to the president, who shall ensure that such motion is included in the notice convening such meeting.

4. Except with the unanimous consent of members present, no business other than specified in the notice convening the meeting shall be discussed or transacted at such meeting.

5. The agenda for any meeting shall be prepared by the registrar in consultation with the president, and shall contain, as a general rule, the following-
(a) minutes of the previous ordinary meeting and of any special meeting held in the interim;
(b) matters arising out of such minutes:
(c) president's report;
(d) financial statement:
(e) report of the registrar;
(f) appointment of office-bearers;
(g) determination of registration and annual fees to be paid by a professional land surveyor, a professional surveyor, a professional surveyor in training, a surveyor, a survey technician and a survey technician in training;
(h) determination of honoraria and salaries;
(i) disciplinary matters;
(j) reports deferred from previous meetings;
(k) reports of committees;
(l) notices of motion transferred from previous meeting;
(m) new notices of motion; and
(n) other business.

6. Any member of the council having a personal interest in a matter to be discussed at a meeting shall disclose such interest and shall recluse himself/herself.

7. The proceedings of any meeting shall be preserved in the form of minutes, which shall be confirmed by the members of the council and authenticated by the signature of the president as soon as possible after such confirmation.

8. The minutes of a meeting shall include a record of
(a) the members present;
(b) such motions, and amendments thereof, as may have been adopted;
(c) any rulings of the president as to the interpretation of these rules; and
(d) at the request of any member, the names of the members voting for and against a motion or any amendment thereof, unless the voting is by ballot.

9. Each member of the council and his or her alternate shall be supplied with a copy of the minutes as soon as they have been authenticated.

10. All meetings shall be open to persons registered in terms of the Act, but except with the consent of the council, they shall not take part in any discussion: Provided that the council may at any time decide to go into committee to discuss any matter whereupon non-members of the council shall withdraw from the meeting.

11. Voting on any matter shall in general be by a show of hands, and if any one member so requests the voting shall be by ballot.

12. Notices of motion may be given to review any ruling of the president and when so resolved by the council shall constitute an instruction to the registrar to refer the matter to the council's legal advisers for an opinion.

13. Any standing order of the council may be suspended if a motion to that effect be carried by a majority of votes.

CHAPTER III
MEETINGS OF THE COMMITTEES
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3. **Education Advisory Committee**

(1) At the first meeting of the education advisory committee called in terms of section 16(1)(a) of the

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Act, the committee shall determine the procedure to be adopted at its meetings, and submit a copy of the agreed procedure to the council.

(2) The chairperson of the education advisory committee, or if he or she is not available, the president, shall give every member at least two weeks notice in writing, of subsequent meetings of the committee.

(3) The provisions of rule 2(4), (6), (7), (8), (9) and (11) shall apply mutatis mutandis.

(4) A copy of the minutes shall be submitted to both the president and the registrar as soon as they have been authenticated.

4. **Committee of Inquiry**

(1) A committee to which the council has assigned the power to enquire into any case of alleged improper conduct in terms of the provisions of Section 10 of the Act and to impose a punishment in respect thereof in accordance with the provisions of Section 29 of the Act shall consist of a chairperson appointed by the council and not less than three and not more than five members.

(2) When an inquiry is instituted against a person who is or was registered in terms of the Act the members of such a committee shall be
(a) professional land surveyors when the person who is being charged is or was a professional land surveyor; or
(b) surveyors when the person who is being charged is or was a surveyor, a survey technician or a survey technician in training; or
(c) professional surveyors when the person who is being charged is or was a professional surveyor or a professional surveyor in training:
Provided that, by a two thirds majority decision of the council, a committee may be appointed which differs in constitution from the requirements as set out above.

(3) The proceedings of any meeting of the committee appointed in terms of this rule shall be preserved in the form of minutes, which after confirmation by the members of the committee and authenticated by the chairperson, shall be submitted to the council.

5. **Procedures for Committees**

A committee established in terms of section 10 of the Act, excluding a committee as contemplated in rule 4, shall regulate its procedure at meetings in accordance with the provisions as laid down by the president.

CHAPTER IV
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6. Remuneration and Allowances of Members of the Council and Committees

(1) The members of the council and of a committee of the council, excluding members of the education advisory committee, shall be paid from the funds of the council subsistence and travelling allowances.

(2) The members of the education advisory committee shall be paid such allowances for subsistence and travelling as contemplated in section 18 of the Act.

CHAPTER V

7A. Registration of professional land surveyors and professional land surveyors in training

(1)
a) Subject to the provisions of paragraph (b), the training in practical work to be undergone by a candidate for registration as a professional land surveyor, shall be the carrying out of practical work under the supervision of a professional land surveyor who has been practising as such for at least five years after registration as a professional land surveyor in terms of section 20(2) of the Act

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b) The period of training referred to in paragraph (a), which shall be continuous, and the nature of which shall be approved and controlled by the council, shall be not less than 270 working days:
Provided that-
(i) if a candidate has undergone training in non-cadastral survey work not necessarily under the supervision of a professional land surveyor, or during the course of practice has undertaken practical work, which in the opinion of the council is equivalent to the work referred to in paragraph (a), he or she may be granted exemption from such portion of the period of training prescribed in this paragraph as the council may determine;
(ii) the period of training occupied in any category of practical work shall be in accordance with the requirements as laid down from time to time by the council;
(iii)the council may condone a break in the continuous period of training if, reasonable grounds for such a break exist after a written request in this regard has been made by the candidate;
(iv) the period of training in cadastral surveys shall not be less than 135 working days after completion of the academic training of the candidate: Provided that he or she applies for registration as a professional land surveyor in training within two months of such completion date, failing which, the period of training will be deemed to commence as from the actual date of application for registration.

c) (i)Proof of employment during the period of training by candidate shall be submitted by him or her to the council in the form of a certificate substantially as set out hereunder

CERTIFICATE OF TRAINING

I, ... a professional land surveyor practising in the Republic of South Africa, /
a professional surveyor / a surveyor / an engineer *, practising in .... do hereby
certify that .... has successfully carried out practical work under my supervision
for the following periods and in the following categories:
Period   Category:
                                Cadastral Surveys
                                Topographic Surveys
                                Engineering Surveys
                                Control Surveys
                                Hydrographic Surveys
                                Other
particulars of which in regard to the time and nature of the work, are annexed.

Dated at   on the day of ……………………. Signed ....

Professional Land Surveyor, Professional Surveyor, Surveyor, Engineers, etc.*
                    *Delete whichever is not applicable.

(ii) The certificate prescribed in this rule shall be supported by an annexure in the form of a schedule, signed by the professional land surveyor or other person and the candidate, in which detailed particulars of all practical work are entered.
(iii)The council may dispense with the certificate prescribed in this sub-rule, if it is satisfied that the professional land surveyor or other person with whom the candidate was employed, unreasonably refuses, or for some reason is not in position to grant the certificate: Provided that proof can be given that the candidate was actually employed and satisfactorily carried out the practical work under the supervision of such professional land surveyor or other person for the periods during which he or she claims to have been so employed.
(iv) Exemption in terms of sub-rule (1)(b)(i) shall not be granted unless proof of training or practice to the satisfaction of the council can be given.
The council may require the candidate to undergo such further training as it deems fit.

(2)
(a) A candidate who fails to pass the examination in the laws concerning surveying and related matters, or who fails to carry out an acceptable trial survey or practical test which in whole or in part may consist of an oral examination set by the council, shall be afforded a chance to present himself or herself for re-examination after a period of not less than two months after the date of the unsuccessful attempt at the law examination and/or the trial survey.
(b) Should the candidate fail to attain a standard acceptable to the council after the second attempt, he or she shall not be allowed to present himself or herself for such further law examinations or trial survey or practical test until further training has been undergone as determined by the council.

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(3) For the purpose of this rule
"cadastral surveys" means surveys referred to in section 27(1)(a)(i) and (ii) of the Act;
"practical work" means such survey operations, the nature of which shall be approved by the council and includes cadastral surveys.

(4)The professional oath or affirmation that a candidate is required to make in terms of section 20(1)(f) of the Act, shall be in form A obtainable from the Registrar.

(5)Any person who has passed an examination for which the council has granted recognition in terms of section 20(1)(b) of the Act and who desires to qualify for registration as a professional land surveyor shall apply for registration as a professional land surveyor in training using form Bobtainable from the Registrar.

(6)When a professional land surveyor in training complies with the requirements mentioned in section 20(1) of the Act he or she may apply to the council for registration as a professional land surveyor using form C obtainable from the Registrar, and the council shall register such a person in the appropriate register.

7B. Registration of professional surveyors and professional surveyors in training

(1) (a) Any person who has passed an examination for which the council has granted recognition in terms of section 20(1)(b) of the Act or complied with the requirements set out in section 20(2A) of the Act and who desires to qualify for registration as a professional surveyor in a division of the register provided for in section 7(4)(b) of the Act, shall submit such proof of experience and qualifications as the council may determine.

(b) Subject to the provisions of section 20(2A) of the Act, the training in practical work to be undergone by a candidate for registration as a professional surveyor, shall be the carrying out of practical work under the supervision of a professional surveyor registered in the same category who has been practising as such for at least five years after registration as a professional surveyor in terms of section 20(1) or section 20(2A) of the Act, or such other qualified person approved by the council.

(c) The period of training referred to in paragraph (b), which shall be continuous, and the nature of which shall be approved and controlled by the council shall be for such period after completion of the academic training of the candidate as the council may determine but shall not exceed 320 working days.
Provided that the candidate applies for registration as a professional surveyor in training within two months of such completion date, failing which, the period of training will be deemed to commence as from the actual date of application for registration:

Provided further that –
(i) the period of training occupied in any category of practical work shall be in accordance with the requirements as laid down from time to time by the council;
(ii) the council may condone a break in the continuous period of training if reasonable grounds for such a break exist after a written request in this regard has been made by the candidate.

(d) (i) Proof of employment during the period of training by a candidate shall be submitted to the council in the form of a certificate substantially as set out in rule 7A(1)(c)(i).
(ii) The certificate prescribed in this rule shall be supported by an annexure in the form of a schedule, signed by the professional surveyor or other person and the candidate, in which detailed particulars of all practical work are entered.
(iii) The council may require the candidate to undergo such further training as it may deem fit.

(2)(a) A candidate who fails to pass the examination in law as may be determined or who fails to carry out an acceptable trial survey or practical test which in whole or in part may consist of an oral examination set by the council, shall be afforded a chance to present himself or herself for re examination after a period of not less than two months after the date of the unsuccessful attempt at the law examination and/or the trial survey.

(b) Should the candidate fail to attain a standard acceptable to the council after the second attempt, he or she shall not be allowed to present himself/herself for such further law examination or trial survey or practical test until further training has been undergone as determined by the council.

(3) The professional oath or affirmation that a candidate is required to make in terms of section 20(1)(f) of the Act, shall be in form A obtainable from the Registrar.

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(4) Any person who has passed an examination for which the council has granted recognition in terms of section 20(1)(b) of the Act and who desires to qualify for registration as a professional surveyor shall apply for registration as a professional surveyor in training using form D obtainable from the Registrar.

(5) When a professional surveyor in training complies with the requirements mentioned in section 20(1) of the Act, he or she may apply to the council for registration as a professional surveyor using form E obtainable from the Registrar and the council shall register such a person in the appropriate register.

CHAPTER VI
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8. Registration of surveyors, survey technicians and survey technicians in training

(1) The council shall, on application of any person who has-
(a) (i) after passing an examination for which the council has granted recognition in terms of section 22(1)(a)(i) of the Act completed training in the form of practical experience for a period of at least three (3) years in such practical work which in the opinion of council is of sufficient variety and of a satisfactory nature and standard; or
(ii)complied with the requirements set out in section 22(3)(a)(i) or 22 (3)(b)(i) of the Act; and
(b) carried out such trial survey or practical test which in whole or in part may consist of an oral examination set by the council; and
(c) has passed such examination in law as determined by the council; and
(d) made an oath or affirmation in form A obtainable from the Registrar; and
(e) submitted the form F obtainable from the Registrar.
register such person as a surveyor in the appropriate register.

(2) The council shall, on application of any person who has –
(a) (i) passed an examination for which the council has granted recognition in terms of section 22(1)(b)(i)f the Act and has completed such training as the council shall determine; or
(ii) complied with the requirements set out in section 22(3)(a)(ii) or 22(3)(b)(ii) of the Act; and
(b) carried out such trial survey or practical test which in whole or in part may consist of an oral examination set by the council; and
(c) made an oath or affirmation in form A obtainable from the Registrar; and
(d) submitted the application form G obtainable from the Registrar;
register such person as a survey technician in the appropriate register.

(3) The council shall, on application on form H obtainable from the Registrar, of any person who is registered as a survey technician and who complies with the requirements of sub rules (1)(a)(i), (b), (c) and (d) register such a person as a surveyor in the appropriate register.

(4)(a) Any person who does not qualify for registration as a surveyor or a survey technician, and who wishes to pass an examination for which the council has granted recognition as contemplated in section 22(1)(b)(i) of the Act and who desires to qualify for registration s a survey technician shall apply for registration as a survey technician in training using form I obtainable from the Registrar.
(b) Subject to the provisions of paragraph (c) the training in practical work to be undergone by a candidate for registration as a survey technician, shall be the carrying out of practical work under the supervision of a professional land surveyor, a professional surveyor, a surveyor, a survey technician or another person whom the council considers suitable: Provided that if it is under a technician who qualified in terms of section22(1)(b) of the Act then such technician must have had at least three years experience after passing an examination for which the council has granted recognition in terms of section 22(1)(b)(i) of the Act.
(c)The period of training shall be determined by the council in each individual case unless the candidate has obtained a diploma from a recognised technikon or college in the Republic of South Africa and such technikon or college has certified that the applicant has received suitable training: Provided that, in respect of a diploma issued before 1 January 1985 a professional land surveyor; professional surveyor, or surveyor registered in terms of the Act or such other person whom the council considers suitable may issue such certificate if the applicant has received suitable training under his supervision.
(d)Proof of employment and such further condition of training shall be in the form specified in rule 7A(1)(c) mutatis mutandis.
(e)(i) The council shall set the candidate a trial survey or practical test which in whole or in part may consist of an oral examination.

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(ii) Should the candidate fail to attain a standard acceptable to the council he or she shall be afforded a chance to present himself or herself for re-examination after a period of not less than two months after the date of the unsuccessful attempt of the trial survey.
(iii)Should the candidate fail to attain a standard acceptable to the council after the second attempt, he or she shall not be allowed to present himself or herself for such further examination until further training has been undergone as determined by the council.

(5) When a survey technician in training complies with the requirements mentioned in section 22(1)(b) of the Act, the council shall on application in form J obtainable from the Registrar cancel the registration of such person as a survey technician in training and register him as a survey technician in terms of section 22(2) of the Act.

CHAPTER VII
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9. Establishment of Register

(1) In terms of section 7(4) of the Act a register shall be kept and maintained relating to persons whose applications for registration under sections 20(2), (2B) and (4), 21, 22 and 23 of the Act have been accepted by the council.
(2) Such particulars as referred to in section 26 of the Act regarding any person referred to in sub rule
(1) upon payment of such registration and annual fees determined by the council in terms of section 7(1)(9) of the Act, shall be entered in the register.
(3) The date of the first registration of any person in terms of the Act shall be the date the registrar receives the documents prescribed in terms of these rules, together with the registration and annual fees.

10. Keeping of Register

(1) The registrar shall keep the register correctly and in accordance with the provisions of the Act and shall remove there from the name of any registered person who has died or whose registration has been cancelled, or who has been disqualified for registration or whose registration has lapsed in terms of the Act.
(2) No particulars in regard to any qualification shall be entered in the register unless the registrar is satisfied that the person claiming to possess such qualification is entitled thereto.
(3) Any entry in the register which is proved to the satisfaction of the council to have been made in error or through fraudulent misrepresentation or under circumstances not tenable in law, shall under authority of the council, be deleted or amended in the register.
(4) Whenever any entry in respect of any person has been deleted under the authority of the council, the registrar shall, within seven days of such deletion notify the person concerned thereof, in writing transmitted by registered post to his/her registered address.
(5) Any certificate of registration issued in accordance with the provision of the Act shall be deemed to be cancelled from the date upon which the registration is cancelled by the council in terms of sections 24(2) or (4) and 29(1)(d) or (e) of the Act or has lapsed in terms of section 24(3) of the Act.
(6) The register shall be kept in the office of the council and the registrar shall from time to time, upon the authority of the council, cause copies of the register to be printed, published and issued upon payment of such fees as the council may determine from time to time.

11. Divisions of the Register

(1) The council shall determine from time to time the various divisions for registration in which the names of professional land surveyors, professional surveyors, professional surveyors in training, surveyors, survey technicians and survey technicians in training shall be in the register.

12. Applications

(1) Any person who applies for registration in terms of the Act, shall submit application forms obtainable from the Registrar, as follows:
For a person who desires to register as -
(a) a professional land surveyor in training who qualifies for registration in terms of rule 7A(5), on form B;
(b) a professional land surveyor and who qualifies for registration in terms of rule 7A(6), on form C;
(c) a professional surveyor in training who qualifies for registration in terms of rule 7B(4) on form D;
(d) a professional surveyor who qualifies for registration in terms of rule 7B(5) on form E;
(e) a surveyor, and who qualifies for registration in terms of rule 8(1) on form F;

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(f) a surveyor, registered as a survey technician, and who qualifies for registration in terms of rule 8(3) on form H;

(g) a survey technician, and who qualifies for registration in terms of rule 8(2) on form G;

(h) a survey technician, registered as a survey technician in training, and who qualifies for registration in terms of rule 8(5), on form J; and

(i) a survey technician in training, and who qualifies for registration in terms of rule 8(4) on form 1.

(2) An application in terms of sub rule (1) shall be accompanied by the registration and annual fees as determined by the council from time to time in terms of section 7(1)(g) of the Act.

(3) Apart from the application forms required by sub rule (1) and the fees submitted in terms of sub rule (2) a person shall submit to the registrar such proof of qualification, certificates of practical experience or other documents which would indicate proof of his or her acceptance for registration;

Provided that where any such certificate or document has been lost or destroyed, he or she may provide written confirmation by competent authority to the effect that such certificate or document was issued to him or her: Provided further that the register kept by the Central Council of Land Surveyors established in terms of the Land Surveyors' Registration Act, 1950 (Act 14 of 1950), immediately prior to the commencement of the Act, shall be deemed as sufficient proof of the suitability of any such land surveyor applying for registration as a professional land surveyor in terms of the Act.

(4) After satisfying himself or herself that the applicant is entitled to be registered, the registrar shall enter his or her name and such other particulars as referred to in section 26 of the Act, in the register and issue to him or her a certificate of registration using form K.

(6) advertising services of a survey nature rendered by him or her in a manner which lauds his or her own work or in a manner which is not true and factual or in a manner that is derogatory to the dignity of the profession; or in a manner which misrepresents his or her qualifications;

(7) permitting his or her name to be used in connection with the direct advertisement of any survey equipment or, in his or her capacity as a registered person, with any other commodity other than when his or her name appears in an informative article;

(8) using or allowing to be used any letterhead, account form, receipt form or other document, on which is printed qualifications which, in the opinion of the council, are inconsistent with his or her training and experience;

(9) canvassing or touting for clients or for any survey work, including without affecting the generality of the rule, the following:

(a) the soliciting for custom or work directly or indirectly from any person; or

(b) the making of unsolicited visits or telephone calls or the sending of unsolicited letters or printed material to any person except to an existing professional connection with a view to establishing a professional relationship with such person; or

(c) in any other manner touting for work of a kind commonly performed by registered professional land surveyors, professional surveyors or surveyors; or

(d) permitting, encouraging or conniving with another person to do any of the foregoing on his or her behalf.

(10) entering, in his or her capacity as a professional land surveyor, professional surveyor or surveyor, into partnership with a person other than a town and regional planner, a quantity surveyor, an architect, and a professional engineer, registered respectively in terms of the Town and Regional Planners Act, 1984 (Act 19 of 1984), the Quantity Surveyors Act, 1970 (Act 36 of 1970), the Architects Act, 1970 (Act 35 of 1970), and the Professional Engineers Act, 1968 (Act 81 of 1968): or such other suitably qualified person approved by the council;

(11) failure, within 60 days after having been instructed in writing by the council to do so, to dissolve any partnership or other association of which he or she is a member in his or her capacity as a registered person;

(12) receiving or seeking to recover, directly or indirectly from any source, any fee or other reward for survey services in excess of that which would constitute a reasonable fee or reward for such services, with due regard to all prevailing circumstances, unless such fee or reward has been agreed in writing with the client who is fully acquainted with prevailing guidelines, scales or levels of charges generally applied within the profession;

(13) in respect of any survey, employing a person

(a) whose name has been removed from the register in terms of the Act or whose right to practice has been suspended or cancelled in terms of section 12 of the Land Survey Act; or

(b) who has been suspended from practicing in terms of the Act or section 12 of the Land Survey Act during the period of such suspension;

(14) allowing an unregistered person to assist him or her by making measurements in the field without exercising proper control;

(15) permitting an assistant to perform

(a) cadastral survey field operations without exercising supervision in accordance with the provisions of the Land Survey Act, 1997 (Act 8 of 1997); or

(b) any other survey field operations without exercising supervision in accordance with the provisions of rule 1; For the purpose of this sub-rule "assistant" has the meaning assigned thereto in section 1 of the Land Survey Act, 1997 (Act 8 of 1997);

(16) quoting or tendering or offering to tender for any survey work unless prior thereto tenders or quotes have been invited by, or on behalf of the person requiring such work to be done:

Provided that any quote or tender shall be a bona fide quote or tender and shall not be made for the purpose, or as a means, of canvassing or touting for any other survey work;

(17) superseding another registered person on any survey work which he or she knows, or ought to have known or suspected, had been entrusted to such other registered person without first ascertaining from him or her, in writing or by any other means satisfactory to the council, that the services had been terminated;

(18) (a) becoming a member of a company practicing as a professional land surveyor, a professional surveyor or surveyor if the other members or shareholders are not natural persons registered as professional land surveyors, professional surveyors, surveyors or other natural persons approved by the council in writing; or

(b) failing to comply with any of the provisions of Section 27A of the Act, or failing to comply with any of the aforementioned provisions of rule 14B;

(19) unjustifiably casting reflection by word or implication upon the propriety, reputation or skill of any registered person;

(20) committing any act calculated to bring into contempt or disrepute his or her profession or calling or the council or any of its officers;

(21) conducting himself or herself dishonourably in connection with any work performed by him or her, or under his or her supervision;

(22) granting a certificate in his or her capacity as a registered person unless he or she has satisfied himself or herself that the facts are fully and correctly stated therein;

(23) using the advantage of a salaried position to compete unfairly with other registered persons;

(24) unreasonably delaying the execution and completion of work entrusted to him or her by a client; or

(25) failing to carry out anything required of a registered person in terms of these rules;

Provided that nothing in the foregoing sub rules shall preclude a professional land surveyor, a professional surveyor, surveyor, a company registered pursuant to the provisions of Section 27A of the Act, or a survey technician permitted to practice in terms of Section 22(4)(b)(ii) of the Act, from

(a) placing his or her signature and the name of his or her firm on any document or model prepared by him or her or by his or her firm

(b) displaying a name plate or panel of plain character bearing his or her name or the name of the firm and status, outside his or her office and at the entrances to the building in which the office is located;

(c) issuing a business card or printed information giving details about his or her practice to prospective clients;

(d) advising clients of any change of address or staff of his or her firm or of the dissolution of any partnership;

(e) superseding another registered person, at the request of a client or of the local institute, on any survey work entrusted to such person by the said client, which has been unreasonably delayed and after such person has failed to reply within three weeks to a written request by the said institute to complete the said work;

(f) permitting his or her name, status, the name of his or her firm, the address and telephone number to be listed in a membership list of an organisation of which he or she is a member;

(g) furnishing the following information on a letterhead or other document

(aa) the name under which the firm operates, which name shall consist of proper names or such other name as approved by council, and may include the names of present registered persons in the firm and the names of present partners with whom partnerships may be formed: Provided further that a previous name of the firm may be used and that the name of a past partner may be retained in the name of the firm;

(bb) a description of the service which can be rendered, such as land surveying, town planning, township planning, topographical and engineering surveying, mine surveying, sectional title surveying, photogrammetrical surveying, and property valuation: Provided further that his or her or an associates qualifications and experiences shall not be misrepresented:

(cc) a list of names of the partners in the firm and the names of registered assistants:

Provided further that where such partners or assistants operate from another office
of the firm, the address and telephone number of such office may be given on the letterhead;

(h) placing his or her name or the name of his or her firm in any advertisement which he or she has inserted on behalf of his or her client in the legal or tender columns of a newspaper;

(i) publishing in respect of any practice or organisation offering survey services, the following kinds of advertisements

(aa) notices of commencement of practice and notices of change of address or partnership or company

(bb) advertisement for staff

(cc) a detailed entry in any directory;

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(dd)an announcement in the press that the practice is responsible for the survey work in connection with any structure illustrated in the same issue

(j) distributing brochures or pamphlets describing his or her experience and capabilities;

(k) sending to the media articles, or being interviewed, about his or her work or about surveying topics of general interest, and allowing the work to be displayed in exhibitions;

(l) appearing in a documentary film relating to survey and in the course of which mention is made, in so far as it is reasonably necessary for the purpose of the said film, of the words professional land surveyor, professional surveyor or surveyor, of the name of the person concerned or of the name of his or her firm;

(m) exhibiting his or her name on the site of a survey in the format of the notice boards as approved by the council;

(n) commissioning or employing a public relations consultant or similarly designated person to carry out all or any such aspects of his or her public relations policy as may be permitted within the context of these rules:

Provided further that nothing in the foregoing sub-rules shall preclude a professional land surveyor, professional surveyor or surveyor from entering into partnership with a professional land surveyor, professional surveyor or with a surveyor.

CHAPTER IX
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16. Inquiries into alleged improper conduct

(1) In the case of alleged improper conduct on the part of any person who is or was a person registered in terms of the Act being reported to the council or to any institute the matter shall be referred to the president who shall address the body or person making the complaint or allegation in writing, calling upon it or him or her to furnish an affidavit detailing in concise terms the specific acts complained of or alleged.

(2) On receipt of the affidavit the president shall forward a copy thereof to the person against whom the complaint, charge or allegation is lodged, calling upon him or her to- submit to the president within 21 days a written explanation verified by affidavit in answer to the complaint, but warning him or her that any explanation given by him or her may be used in evidence should an inquiry take place.

(3) On receipt of such explanation, or if no explanation is received from the person concerned, a subcommittee consisting of three practicing professional land surveyors, professional surveyors or surveyors as the case may be and assisted by a practicing attorney or advocate, shall be appointed by the president (failing whom, the vice-president) and such sub-committee shall consider the complaint, charge or allegation and the explanation (if any) and if, in the opinion of the majority of the subcommittee the statements furnished do not disclose prima facie evidence of improper conduct, they shall inform the president (failing whom, the vice-president) accordingly and he or she shall forthwith advise both the complainant and the person concerned of that fact in writing.

(4)(a) Should the majority of the members of the sub-committee consider that the statements furnished disclose prima facie evidence of improper conduct, they shall inform the president (failing whom, the vice-president) accordingly and simultaneously make written recommendations to him or her in regard to

(i) the nature of the charges to be brought against the accused person; and

(ii) whether, in the opinion of the sub-committee, the alleged conduct of the accused person, if proved, is of sufficient importance to the profession to warrant that charges of improper conduct be brought against that person by the council.

(b) Upon receipt thereof, the president and vice-president (acting as a subcommittee of council, the president to have a second or casting vote) shall consider the information and recommendation referred to in sub rule 4(a) and shall decide whether prosecution of the charges shall be brought in the name of the council or in the name of the complainant. At the same time the same sub-committee shall submit to the council for approval the names of the members of a committee of inquiry.

(5) The members of the council shall indicate in writing to the president their acceptance or other proposals regarding the constitution of the committee within 21 days of the date of the notification mentioned in sub rule (4).

(6) Save as provided in rule 4(2), when the president is satisfied that the majority of the members agree to the constitution of the committee of inquiry, he or she shall notify the members of such committee stating where and when the inquiry will be held. At the same time he or she shall notify the complainant in writing of the nature of the council's decision and of the composition of the committee of inquiry and the complainant, if his or her complaint is to be prosecuted in his or her name, shall have the right, if he or she so wishes, to withdraw the charges and to resile from the prosecution thereof by notice in writing addressed and delivered to the president within 10 days of the delivery of the aforesaid notice from the president to the complainant. If the complainant fails to deliver such notice to the president within the aforesaid period of

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ten (10) days, such failure shall constitute proof that the complainant requires the charges to be prosecuted in his or her own name by the council.

(7) After the president has satisfied himself or herself that the complainant wishes to proceed with the prosecution of the charges or if it has been decided that the council shall prosecute such charges in its own name, the president shall issue a summons in the form J obtainable from the Registrar, addressed to the person concerned, (hereinafter referred to as "the accused") stating where and when the enquiry will be held.

(8) The president shall, together with the summons, furnish the accused with a copy of these rules and of such affidavits and other documents as he or she deems fit. In addition the president shall furnish the accused with a schedule of all other documents in his or her possession which may be used as exhibits at the inquiry, and the accused shall be entitled, prior to the inquiry, to examine the said exhibits and, if he or she so desires, to make copies thereof.

(9) The summons shall be served on the accused in the manner stipulated by section 30(2) of the Act and shall allow the accused a reasonable period of time to prepare his or her defence to the charges against him or her and/or to respond in any way which he or she may deem appropriate to the charges set forth in the summons.

(10) Whenever the complainant or the accused requests the president, in writing, that any person or persons be summoned to give evidence on his or her behalf, or whenever the accused requires the presence of the complainant or any person giving evidence on behalf of the complainant for purposes of cross-examination, the president shall, if he or she considers that such person or persons, or any other person or persons are necessary witnesses, summon such person or persons to appear before the committee to give evidence. The fees payable to witnesses shall be according to the tariff in criminal cases in magistrates' courts and shall be payable by the council.

17. Procedures at inquiries

At an inquiry convened in terms of these rules the following procedure shall be followed-
(1) When the accused appears -
(a) the chairperson shall read the summons addressed to the accused and shall table proof of proper service thereof;
(b) the chairperson shall then read to the committee the complaint and shall table any documents or other evidence submitted in support thereof. No statement made by any person shall be tabled unless it is in the form of a properly sworn or affirmed affidavit the accused shall then be asked whether he or she accepts such evidence or if he or she desires to cross-examine the person or persons whose affidavit or affidavits have been tabled. If the statement to that effect, but if he or she desires to cross-examine any person whose affidavit has been tabled, the said affidavit shall not be admitted in evidence unless the deponent appears before the committee and submits himself or herself to cross-examination by or on behalf of the accused:
Provided that where any part of the evidence tabled is a properly certified copy of a record of a court of law, such copy shall be accepted as prima facie proof of the proceedings of such court;
(c) when all the evidence on behalf of the council or the complainant, as the case may be, has been led or placed before the inquiry, the accused shall be invited to lead evidence in answer to or rebuttal of the complaint; and
(d) at the conclusion of the evidence led by or on behalf of the accused, the accused shall be entitled to address the committee of inquiry, either personally or by his/her counsel or attorney. Thereupon the representative of the council or the complainant, as the case may be, shall be entitled to address the committee of inquiry, either personally or by his or her counsel attorney.
(2) When the accused fails without good cause or refuses to appear-
(a) the chairperson shall read the summons addressed to the accused and shall table proof of proper service thereof;
(b) evidence shall then be given or led by or on behalf of the council or the complainant, as the case may be.
(3) Any person giving evidence at an enquiry shall first be examined by or on behalf of the party by whom he or she is called, and may then be cross-examined by or on behalf of the other party. Thereafter he or she may be re-examined by or on behalf of the party by whom he or she is called. Such person may then, with the permission of the chairperson, be questioned by members of the committee.
(4) All oral evidence at an inquiry shall be on oath or affirmation, and if any witness or deponent declines to submit to cross-examination, the committee may refuse to admit his or her evidence to any document or statement.
(5) When all the available evidence has been led by or on behalf or both the council to the complainant (as the case may be) and the accused, and after the committee has been addressed by the accused and the representative of the council or the complainant as provided in sub-rule 17(1)(e) above, the committee shall deliberate thereon in committee.

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(6) The accused may be represented at an inquiry in terms of these rules by counsel or an attorney or both.

(7) In the event of the accused or any other person obstructing the proceedings at any inquiry, the committee may, in its discretion, adjourn or postpone the inquiry or order the accused or such other person to be removed, and may continue the inquiry in his or her absence.

(8) If the accused is found not guilty of the complaint the council shall be notified forthwith and after review the accused shall be advised accordingly, and his or her name and the nature of the complaint upon which he or she has been found not guilty shall be published by the council only if requested by the accused to do so.

(9) Having considered the decision of and the punishment imposed by the committee, and having decided whether to confirm, review, amend or withdraw any such decision or punishment as provided in section 10(2) of the Act, the council, in its discretion, may cause the final result of the inquiry to be published in such form and publication(s) as it may deem necessary or appropriate: Provided that notification of the final result of the inquiry and the nature and extent of punishment imposed upon the accused shall be communicated to him/her in writing.

(10) The costs of any inquiry which the complainant or the accused may be ordered to pay in terms of section 29 of the Act shall be recoverable from the person concerned by action instituted against him or her in court with appropriate jurisdiction by or at the instance of the council, the complainant or the accused, as the case may be. Costs due to the council shall be payable within such period as the council in its discretion, may determine. Any award of costs made in terms of section 29 of the Act shall include all costs reasonably disbursed in connection with the inquiry, including the legal costs of an attorney or counsel appointed in terms of section 30(1)(c) of the Act, on the scale of charges recommended by the applicable Law Society for non-litigious matters. whatever form or any other legal issue arising in connection with, or in the course of, any inquiry convened in terms of these rules shall be made in committee.

(12) Notwithstanding anything to the contrary contained in these rules, the chairperson of the committee of inquiry shall have exclusive discretion to rule on any issue relating to the form or admissibility of evidence presented to the committee, or to the nature and extent to which any witness may be examined by any party to the proceedings, including other members of the committee, or to any adjournment or postponement of the proceedings, and in respect of such rulings the Chairperson shall be guided but not bound by the general rules of evidence applicable in a court of law.

(13) The proceedings of all inquiries conducted in terms of these rules shall be preserved by the council. If the proceedings have been mechanically or electronically recorded the tapes of such recordings shall be placed in a sealed container and authenticated by the signature of the chairperson of a committee of inquiry as soon as reasonably possible after the inquiry has been completed. If the proceedings of the inquiry have been recorded in the form of typewritten minutes, such minutes shall be preserved by the council and authenticated, after confirmation, by signature of- the chairperson of the committee of inquiry as soon as reasonably possible after the inquiry has been completed. If the mechanically or electronically recorded tapes are required to be transcribed for any purpose whatever, such transcriptions shall be submitted to the chairperson of the committee of inquiry for verification and authenticated by him or her by his or her signature as soon as reasonably possible after completion of the transcription.

(14) A person registered in terms of the Act in the same division of the register as the accused, may attend an inquiry: Provided that the committee shall have the right to exclude any person: Provided further that the reasons for such exclusion shall be recorded in the minutes.

CHAPTER X
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18. Titles and letters of designation

(1) A professional land surveyor who is registered in terms of section 20 of the Act may append after his/her name the letter and title Pr L (SA) (Professional Land Surveyor, South Africa): Provided that the council may determine such categories of professional surveyor and the designation as will be necessitated by circumstances.

(2) A surveyor who is registered in terms of rule 8(1) or (3), may append after his/her name the letter and title S (SA) (Surveyor, South Africa) or such other designation as the council may determine.

(3) A survey technician who is registered in terms of rule 8(2) or (5) may append after his/her name the letters and title ST (SA) (Survey Technician, South Africa) or such other title as the council may determine.
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GOVERNMENT GAZETTE, 10 FEBRUARY 2017

CODE OF CONDUCT IN TERMS OF SECTION 19(1) OF THE GEOMATICS PROFESSION ACT 19, 2013.

The South African Geomatics Council has, in consultation with the Minister of Department of Rural Development and Land Reform, prepared a code of conduct for registered persons for the purpose of publication in terms of section 19(1) of the Geomatics Profession Act 19, 2013 (Act No. 19 of 2013).

The attached code of conduct shall come into effect after thirty (30) days from the date of publication.

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South African Geomatics Council

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Draft Code of Conduct of the Geomatics Profession

Revision 5

Framed in terms of section 19(1) of the Geomatics Profession Act, 19 of 2013

1. Definitions

(1) In this Code, unless the context indicates otherwise -

"allied professionals" means any person registered in terms of

(a) Section 18(1)(a) of the Architectural Profession Act, 44 of 2000, or

(b) Section 18(1)(a) of the Engineering Profession Act, 46 of 2000, or

(c) Section 18(1)(a) of the Landscape Architectural Profession Act, 45 of 2000, or

(d) Section 13(1)(b) or section 13(1)(c) of the Planning Profession Act, 36 of 2002, or (e) Section 18(1)(a) of the Quantity Surveying Profession Act, 49 of 2000.

or any other person registered in terms of any other Act of the Parliament of the Republic of South Africa and accepted by Council in consultation with the Minister to be an allied profession, provided that such acceptance shall be published by notice in the Government Gazette.

"Council" means the South African Geomatics Council established in terms of section 3(1) of the Act;

"document" shall include any plan, report, letter, opinion or certificate, whether required in terms of other legislation or not, which is produced in the course of a member's professional duties;

"environment" means environment as defined in section 1 of National Environmental Management

Act, 107 of 1998;

"geomatics equipment" means anything used in the carrying on of the work of the geomatics profession and includes any instrument, machine, aircraft, vehicle, vessel, computer programme or any system;

"geomatics practice" means a

(a) sole proprietorship owned by a member practicing in the business of the geomatics profession, or

(b) a partnership, in which the partners include at least one member engaged in the business of

the geomatics profession on behalf of the partnership, and may include allied professionals, provided that Council has agreed in writing to the inclusion of any allied professional in the

partnership, or

(c) a company as contemplated in section 17(1) of the Act;

"information" includes drawings, designs, records, reports, specifications, calculations, contractual documents, as-built records or plans and any other documents, including electronic data, that form part of any of the records relating to the geomatics profession work carried out by a member of geomatics practice;

"member" means a geomatics practitioner as defined in section 1 of the Act;

"the Act" means the Geomatics Profession Act, 19 of 2013.

(2) In this Code, any word or expression derived from a word or expression defined in subsection (1) has a corresponding meaning unless the context indicates that another meaning is intended.

2. Preamble

(1) The purpose of the Code of Conduct is to -

(a) Make rules prohibiting actions or conduct by members or by geomatics practices, as the case

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may be, which constitute improper conduct, and where such actions or conduct give rise to a charge of improper conduct against a member or a geomatics practice, which must be investigated by Council in terms of section 20 of the Act; and (b) to ensure that all registered persons apply their knowledge and skills in the interest of their profession, the public and the environment and execute all work with integrity and professionalism.

(2) All members and all geomatics practices are subject to the rules.

(3) All members are obliged to carry out geomatics work in a professional manner guided by skill, competency and integrity.

CHAPTER I: TRANSPARENCY AND EQUITY

3. Transparency and equity in the geomatics profession

(1) Members and geomatics practices may not perform any act or conduct themselves in any way which knowingly or deliberately frustrates the implementation of the transparency and equity principle prescribed of section 2(c)(v) of the Act.

(2) Members and geomatics practices shall as far as is possible give effect to the transparency and

equity principle of the Act when offering employment and training opportunities and in assessing the suitability of members for promotion, inclusion in partnership or appointment as directors or shareholders of companies contemplated in section 17 of the Act.

CHAPTER II: QUALITY AND INTEGRITY

4. The integrity of the geomatics profession

(1) Members and geomatics practices -

(a) must state their professional qualifications truthfully; and

(i) may not undertake or offer to undertake work which may only be performed in terms of any law by a person registered in a specified category, which category is defined in terms of the Act, or which is work which may only be performed by any other profession;

(ii) may not misrepresent, or permit misrepresentation of their academic or professional qualifications, competency or experience, nor exaggerate their own degree of responsibility for any professional service;

(b) must discharge their duties to their employers, clients, associates and the public with integrity, fidelity and honesty;

(c) must not undertake any professional service under conditions or terms that would compromise their ability to carry out their responsibilities.

(d) must not engage in any act of dishonesty, corruption, bribery or unethical conduct;

(e) may not, unless required by law or by these rules, divulge any information of a confidential nature obtained in the exercise of their professional duties;

(f) must notify the Council immediately if they become aware of a violation of these rules by any other member or geomatics practice; and

(g) must notify the Council immediately they are declared insolvent by any Court in the Republic of South Africa.

(h) may not without satisfactory reasons destroy or dispose of, or knowingly allow any other person to destroy or dispose of, any information within a period of 10 years after completion of the professional service concerned;

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(i) may not issue any information in respect of geomatics profession work prepared by them or by any other person under their direction or control, unless such information bears the date of issue, the name and registration number of the responsible member or geomatics practice.

(2) A member must make professional decisions and/or recommendations and/or provide professional opinions that are independent, honest, objective and based on an investigation and knowledge of facts relevant to any matter in respect of which he or she is consulted by a client or employer;

(3) A member must not sign or otherwise identify as having been issued by him or her or his or her practice, any document of which he or she or his or her practice is not the bona fide author;

(4) A member who serves in a geomatics practice as sole proprietor, partner or director must ensure that adequate supervision and control is exercised over persons in the practice undertaking geomatics profession work.

(5) A member who is employed in his or her professional capacity must ensure that adequate supervision and control is exercised over persons who are answerable to or under the control, direction or supervision of the member, when undertaking geomatics profession work.

5. Appointments, fees and payment for geomatics profession work

(1) Members and geomatics practices shall ensure that all appointments for geomatics profession work include -

(a) the fee or fee estimate or rate for the work;

(b) the deliverable products or services;

(c) the estimated delivery date or estimated time to completion;

(d) the specification for the work; and (e) any direct costs or expenses which may occur or be reasonably assumed to occur and which are to be paid for by the client, provided that a where a client waives the requirement for any of the items in sections (a) to (e) these need not be provided.

(2) Members and geomatics practices will charge reasonable fees for services rendered.

(3) in the absence of fees having been agreed between a member or geomatics practice and the client prior to commencement of the client's instruction, members and geomatics practices may not charge more than the fee permitted by a recommended tariff published in terms of the Act.

(4) Members and geomatics practices may not accept appointment for geomatics profession work conditional upon the payment of a deposit or any other form of payment, by the client, prior to commencement of such work;

(5) Members and geomatics practices may not demand or accept payment for geomatics profession work prior to completion of the work; provided that this rule will not be interpreted to prohibit progress or staged or phased payment for work by prior agreement between the member or practice and the client.

 6. Supersession No member or geomatics practice may supersede another member or practice, as the case may be on any geomatics profession work which he, she or the practice knows, or ought to have known or suspected, had been entrusted to such other member or practice without first ascertaining from him or her or the practice, in writing or by any other means satisfactory to the council, that the client's instruction has been terminated.

7. Partnership with allied professionals

 A member may not in his or her professional capacity enter into a partnership unless all the member's partners are members; provided that a partnership may include allied professionals; provided further that members may enter into a partnership with persons who are not allied professionals with the written consent of Council.

8. Touting and paying for work

Members and geomatics practices may not tout or canvas for geomatics work, either personally or through any other person, or improperly seek to obtain an appointment, or by way of commission or otherwise, make or offer to make payment to a client or prospective client or employer or prospective employer or any other person for obtaining such appointment.

9. Direct interest, gratuities and commissions, and conflict of interests

(1) Members and geomatics practices may not, either directly or indirectly, receive any gratuity, or commission or other financial benefit on any article or process used in or for the purpose of the professional service in respect of which they are employed, unless such gratuity, commission or other financial benefit has been authorised in writing by the employer or client concerned.

(2) Members and geomatics practices must take all reasonable steps to avoid a conflict of interests between clients or employers.

10. Name and style of carrying on a geomatics practice

(1) No geomatics practice may use a name with any misleading content for the title and style or name of the practice nor claim in any practice name, letterhead, advertising material, document or publication, or in any other way, either directly, indirectly or by inference, to be competent to perform work which may only be performed in terms of any law by a person registered in a specified category, which category is defined in terms of the Act, if no such suitably registered person is a sole proprietor, partner or director, or full-time employee as the case may be, of the geomatics practice. (2) In the event that a geomatics practice does anything or causes to be done anything in

contravention of section (1) then the sole proprietor, partners or directors, as the case may be, of the geomatics practice may be held, jointly and severally to be in contravention of section 4(a) of this Code and may be held, jointly and severally, to be guilty of an offence in terms of section 36(6) of the Act.

11. Documentation and advertising

(1) Members and geomatics practices may not advertise their professional services in a laudatory manner which undermines the dignity of the profession or brings the profession into disrepute.

(2) All media used by a member or a geomatics practice for the purpose of advertising, marketing, professional communication or professional correspondence, including press advertisements, letterheads, reports, electronic communication, and social media communication may display the following -

(i) the name of the member or geomatics practice and relevant branches of practice;

(ii) the name or names of the sole proprietor, partners or directors as the case may be, and their registration numbers

(iii) the category or categories of registration for the sole proprietor, partners or directors, as the case may be;

(iv) a description of the geomatics profession work which the member or geomatics practice may undertake; (v) relevant physical and postal addresses, telephone numbers, fax numbers, email addresses and company and VAT registration numbers, if applicable.

(3) A member or geomatics practice may display a name plate or panel of plain character bearing his or her name or the name of the practice, as the case may be, at the entrance to the office of the member or practice and at the entrance to a building in which the office is located. (4) Members and practices may not reproduce, use or display Council's logo in any form or manner without the written

approval of Council.

12. Advertising of geomatics equipment

No member or geomatics practice may permit his or her name or the name of the practice, as the case may be, to be used in connection with the direct advertisement of any geomatics equipment.
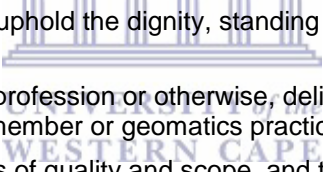
13. Work outside the borders of the Republic of South Africa

Members and geomatics practices must order their conduct in connection with work outside the borders of the Republic of South Africa in accordance with these rules in so far as they are not inconsistent with the law of the country concerned; provided that where there are recognised standards of professional conduct in a country outside the Republic, they must adhere to those standards in as far as they are not inconsistent with these rules; provided further that where there are no officially recognised standards or rules of professional conduct in such country, these rules shall apply.

CHAPTER III: PROMOTION OF THE PROFESSION, COMPETENCE AND STANDARDS

14. The dignity and reputation of the geomatics profession

Members and geomatics practices -

(a) must order their conduct so as to uphold the dignity, standing and reputation of the profession and of Council;

(b) may not, whether practicing their profession or otherwise, deliberately or knowingly injure the professional reputation of any other member or geomatics practice;

(c) must provide professional services of quality and scope, and to a level, which is commensurate with accepted standards and practices in the geomatics profession;

(d) must discharge their duties to their employers, clients, associates and the public effectively with skill, efficiency, professionalism, knowledge, competence, care and diligence;

(e) may not undertake or offer to undertake a professional service for which their education, training and experience does not render them competent; and (f) must when providing professional service, engage in and adhere to acceptable practices.

15. Technical and Professional competence

(1) Where geomatics profession work is performed by a person on behalf of a member, the member shall be responsible for supervising the work, for completion of the work, and for the quality of the work, regardless of whether or not the work is reserved in terms of section 16 of the Act or is reserved in terms of any other legislation.

(2) A member should not allow an unregistered person to perform the work of a Geomatics Practitioner.

(3) A member shall regularly engage in continuing professional development activities in order to ensure that he or she remains up to date with developments within the geomatics fields and maintain his or her professional expertise and competence.

CHAPTER IV: THE ENVIRONMENT

16. The environment

Members and geomatics practices must at all times have regard for and promote practices and procedures that protect the health, safety and welfare of people and the environment and shall -

(a) in carrying out the work of the geomatics profession strive to avoid adverse impact on the environment; and

(b) comply with any legislation the purpose of which is to protect the environment and to promote sustainable development.

(c) Make good on any unauthorised damage.

CHAPTER V: TRANSFORMATION

17. Transformation of the geomatics profession

(1) Members and geomatics practices may not perform any act or conduct themselves in any way which knowingly or deliberately frustrates the transformation purpose of the Act or which frustrates the implementation of the principle stated of section 2(c)(v) of the Act.

(2) Members and geomatics practices shall wherever possible give effect to the transformation purpose of the Act and the principle stated in sections2(c)(i) and 2(c)(v) of the Act through the enhancement of professionalism and competence of persons registered in terms of the Act and through development and transfer of geomatics profession skills, knowledge and standards.

CHAPTER VI: GENERAL
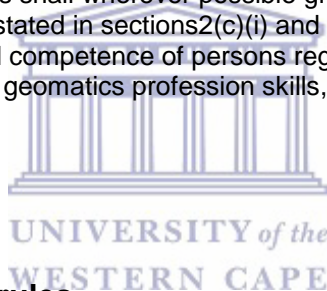
18. Replacement of existing rules

These rules replace chapter VIII, entitled "Improper Conduct" of the rules published in terms of The Professional and Technical Surveyors' Act, 40 of 1984.

Rules
SAGI Code of Conduct

The South African Geomatics Institute (SAGI) hereby, in terms of the Constitution of SAGI, makes known and implements the following rules in the Schedule.

SCHEDULE

Objectives

1. The objectives of this Schedule are to ensure that members -
1.1. apply their knowledge and skill in the interests of society and the environment;
1.2. execute their professional service with integrity, sincerity and in accordance with generally accepted norms of professional conduct;
1.3. respect the interests of their fellow beings and honour the standing of the profession;
1.4. continuously improve their professional skills and those of their subordinates;
1.5. encourage excellence within the Geomatics profession.

Definitions

2. In this Schedule any expression or word that has been defined in the PLATO Act has that meaning, and unless the context otherwise indicates –
2.1. **"business undertaking" means** any business enterprise or entity, joint venture, consortium, association or any such organization or entity**;**
2.2. **"information"** includes drawings, designs, records, reports, specifications, calculations, contractual documents, built-records or plans and any other documents, including electronic data, that form part of any of the records relating to a members professional service;
2.3. **"work"** means any Geomatics work normally carried out by members as well as work ancillary to the core Geomatics work.
2.4. "**professional service**" means conducting any work in a professional and ethical manner.

Rules of Conduct: Ethics

3. SAGI members, in fulfilling the objectives contemplated in clause 1 above must comply with the following rules-

Competency

4. **Members : -**
4.1. must discharge their duties to their employers, clients, associates and the public effectively with skill, efficiency, professionalism, knowledge, competence, due care and diligence;
4.2. may not undertake or offer to undertake a professional service of a nature for which their education, training and experience have not rendered them

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competent to perform;

4.3. must, when carrying out their professional service, engage in and adhere to acceptable practices.

Integrity

5. **Members : -**

5.1. must discharge their duties to their employers, clients, associates and the public with integrity, fidelity and honesty;

5.2. must not undertake any professional service under conditions or terms that would compromise their ability to carry out their responsibilities in accordance with acceptable professional standards;

5.3. must not engage in any act of dishonesty, corruption or bribery;

5.4. must disclose to their employers and clients, or prospective employers or clients, in writing: -

5.4.1. any interest, whether financial or otherwise, which they may have in any business undertaking, or with any person, and which is related to the professional service for which they may be or have been employed; and

5.4.2. particulars of any royalty or other benefit which accrues or may accrue to them as a result of the professional service; with the client or employer concerned;

5.4.3. the status pertaining to professional indemnity insurance cover;

5.5. may not, either directly or indirectly, receive any gratuity, or commission or other financial benefit on any article or process used in or for the purpose of the professional service in respect of which they are employed, unless such gratuity, commission or other financial benefit has been authorised in writing by the employer or client concerned;

5.6. must avoid any perceived, real or potential conflict of interest;

5.7. may not knowingly misrepresent, or permit misrepresentation of their own academic or professional qualifications or competency or those of any other person involved with the professional service, nor knowingly exaggerate their own degree of responsibility for any professional service or that of any person;

5.8. must give decisions, recommendations or opinions that are honest, objective and based on facts that are used in reaching recommendations or opinions given to clients or employers;

5.9. may neither personally nor through any other person, improperly seek to obtain an appointment, or by way of commission or otherwise, make or offer to make payment to a client or prospective client for obtaining such appointment;

5.10. may not, unless required by law or by these Rules, divulge any information of a confidential nature which they obtained in the exercise of their duties;

5.11. must notify SAGI immediately if they become aware of a violation of these Rules by any other member;

5.12. must notify SAGI immediately they become insolvent.

5.13. must without delay notify SAGI if they become aware of any SAGI member who is subject to one or more of the following:

5.13.1. removal from an office of trust on account of improper conduct;

5.13.2. being convicted of an offence and sentenced to imprisonment without an option of a fine, or, in the case of fraud, to a fine or imprisonment or both.

Public Interest

6. **Members : -**
6.1. must at all times have due regard and priority to public health, public safety and public interest;

Environment

7. **Members must at all times -**
7.1. have due regard for, and in their professional service avoid, adverse impact on the environment; and
7.2. adhere to generally accepted principles of sustainable development.

Dignity of the Profession

8. **Members : -**
8.1. must order their conduct so as to uphold the dignity, standing and reputation of the profession in general and specifically that of SAGI;
8.2. may not, whether practicing their profession or otherwise, knowingly injure the professional reputation or business of any other member;
8.3. must provide professional services of quality and scope, and to a level, which is commensurate with accepted standards and practices in the Geomatics profession;
8.4. may not knowingly attempt to supplant a member in a particular engagement after the client has employed such member;
8.5. may not advertise their professional services in a self-laudatory manner that is derogatory to the dignity of the profession;
8.6. may not review for a particular client the professional service of another member, except-
8.6.1. with the prior knowledge of the other member, who must be afforded a reasonable opportunity to submit comments to the client on the findings of the review; or
8.6.2. after receipt of a notification in writing from the client that the engagement of the other member has been terminated; or
8.6.3. where the review is intended for purposes of a court of law or other legal proceedings, including proceedings arising from these Rules or proceedings under PLATO.

Administrative

9. **Members : -**
9.1. may not without satisfactory reasons destroy or dispose of, or knowingly allow any other person to destroy or dispose of, any information within a period of 10 years after completion of the professional service concerned;
9.2. may not place contracts or orders, or be the medium of payments, on their employer's or client's behalf without the written authority of the employers or clients;
9.3. may not issue any information in respect of the professional service prepared by them or by any other person under their direction or control, unless –
9.3.1. such information bears the name of the organization concerned; and
9.3.2. information so issued is dated and signed by the Full Member concerned or another appropriately qualified and authorised person;
9.4. must order their conduct in connection with any professional service outside the borders of the Republic of South Africa in accordance with these rules in so far

as they are not inconsistent with the law of the country concerned: Provided that where there are recognised standards of professional conduct in a country outside the Republic, they must adhere to those standards in as far as they are not inconsistent with these rules.

9.5. must always ensure adequate supervision of, and take responsibility for, any professional service carried out by their subordinates;

9.6. must ensure that, while engaged as partners, directors, members or employees of a business undertaking which performs a professional service, the control over the professional service is exercised, and the responsibility in respect thereof is carried out by a Full Member;

9.7. must, when requested by SAGI to do so, in writing provide SAGI with all the information available to them which may enable SAGI to determine which full member was responsible for any act which SAGI may consider prima facie to be improper conduct;

9.8. must notify SAGI without delay of any change of his or her physical address;

9.9. must within 30 days, reasonable circumstances permitting, respond to correspondence received from clients, colleagues and SAGI in so far as it relates to any professional service or proceedings in terms of these Rules.

Price Competition

10. **Members : -**

10.1. when requested to submit tender proposals, must structure any offer such as to enable them to discharge their responsibilities to the client adequately in every respect;

10.2. must not, without satisfactory reasons, submit a proposal, whether priced or not priced, for the same or substantially the same project for which proposals have previously been submitted to the same body within the preceding six months;

10.3. must inform SAGI of instances, of which it becomes aware, of a client body putting out a call for proposals for a project within six months of a previous call for the same or substantially the same project;

10.4. must not undertake any professional service for fees and under conditions which may jeopardize the quality of the professional service to be rendered.

Short title

11. This Schedule is called **SAGI Code of Conduct**.

The GISSA Code of Ethics

Structure of the document
- Definition of Terms
- Objectives of this document
- Obligations to Society
- Obligations to Employers and funding Organisations
- Obligations to Colleagues and the Profession
- Obligations to Individuals
- Bibliography

Definition of Terms

GISc
Geographic Information Science. (Focus here is on the generic 'Science', rather than the proprietery 'Systems')

GIS
Geographic Information System. (Focus here is on the systems and technology used in GISc.

GIS practitioners
Any person, regardless of his / her NQF level who is operating in the Geographic Information Science Industry.

NQF
South African National Qualifications Framework

NSIF
South African National Spatial Information Framework

SAQA
South African National Qualifications Authority

Objectives of this document
- To serve as a foundation for ethical decision-making.
- To be broad enough to be applicable in most situations.
- To provide direction and goals for the GIS practitioners.

Obligations to Society

As GIS practitioners we recognise that our work impacts greatly on society in general, but in particular that the information we provide may be used for decisions

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that can influence all or parts of society as well as generations to come. We therefore need to guard against civil abuses.

Legal responsibilities

As citizens and residents of the Republic of South Africa we will obey the laws of the country. In particular, we will familiarise ourselves and fully comply with the new Spatial Information Bill.

Social responsibilities

We have an important responsibility towards the society we live in. In case of any conflict of interest, the interest of society will be our deciding factor. Therefore, we as the GIS practitioners shall:

1. Promote procedures that protect the health, safety and welfare of people and the environment as well as meet individual and institutional objectives
2. Consider the short and long-term relevancy of what we provide
3. When presenting or releasing information, we will consider immediate consequences as well as the future impacts of our work. Our procedures may require reviewing social and environmental impacts (e.g. environmental impact reports).
4. We will represent our organisations in a socially responsible manner.
   - We will guard against presenting information in isolation and we will seek the advice of co-workers and experts.
   - We will outline the options for the proposed action.
   - We will consult with all the relevant persons and groups.
   - We will promote and articulate social responsibility and ethical behaviour in the organisation.
5. We will contribute to society's well being
   - We accept that a 'well society' includes both a safe social environment, as well as healthy natural environment.
   - We will be cognisant of other cultural values. We will attempt to understand the culture and value systems affected by our projects, and establish project management procedures that do not negatively impact the worldviews of others.
   - We will respect the privacy of others
   - We will observe the privacy of others by preventing disclosure of personal information.
   - We will use only that information necessary for the project and will not collect or distribute irrelevant data that unnecessarily compromises an individual's or an institution's privacy.
   - We will prevent the release of information that may damage or hurt individuals or institutions.
6. We will avoid causing harm
We will avoid injury or other negative consequences (i.e. loss of information, loss of or damage to property, loss of life, or negative environmental impacts).
7. We will evaluate moral and legal imperatives
If faced with an ethical dilemma, we will strive to do what is right, not just what is legal. To assist in making the decision we will recognise a moral issue, get the facts, evaluate alternative actions, and then review the results of the action taken.

Do the Best Work Possible

As GIS practitioners we are proud of our vocation. Therefore we will:
1. Be objective, diligent, and fully apply our education and skills.
2. Practice integrity and not be swayed by the demands of others when these are against this code.
3. Provide full, clear, comprehensive and accurate information regarding all aspects of the work we do.
4. Strive to do what is right, not just what is legal.

Contribute to the Community to the Extent Possible

As GIS practitioners we recognise our dependence on the communities we live in. Therefore we will:
1. Strive to make our data and findings widely available. In this regard we especially recognise the role of the NSIF in South Africa.
2. Strive for broad citizen involvement.
3. Donate our services to community organisations. In this regard we especially recognise the need for involvement with GISSA and the SAQA GIS Standards Generating Body.

Speak Out About Issues

As GIS practitioners we recognise the value of the contributions and opinions of everyone in our community and flowing from this, the need to communicate and to be transparent. Therefore we will:
1. Give our opinion about public issues, especially those related to our personal expertise.
2. Listen to those of our profession and give heed to what they say.
3. Call attention to unpractitioners work or breach of this code of ethics by others. However, we will not do so publicly, and if possible, we will first take our concerns to the person/s or organisation suspected of such behaviour. Only if this does not provide satisfaction will we take escalating action. Such escalating action will include:
   - Discussion with the employer (if the matter concerns an individual)
   - Discussion with the client (if the matter concerns an organisation involved in a project)
   - Discussion with GISSA
   - Discussion with the local press if other actions has no effect.
4. Admit when we ourselves make mistakes.

Obligations to Employers and funding organisation

As GIS practitioners we acknowledge that we are indebted to those who provide the funding for us to do our work. Without employers and / or funding organisations there will not be a GIS vocation. In particular we recognise that we have been hired to deliver needed products and services and that our employers (or Funding

organisations) expects quality work and practitioners conduct. Therefore, we as GIS practitioners shall:

Deliver Quality Work

1. We will ensure that we will accept only those tasks that we are qualified for.
2. We will keep ourselves current in the field of GI Science through readings and targeted practitioners development.
3. We will identify and manage risks, both for our employer / funders and ourselves.
4. We will constantly seek to define alternative strategies to reach the goals of our employers / funder, as well as the implications of each.
5. We will ensure that our work is well documented and that others will be able to continue our work even when we are not present. This includes both metadata and program documentation.

Have a practitioners Relationship

1. We will hold all information we work with confidential, unless we have specifically authorised to release it.
2. We will avoid all conflicts of interest with clients and employers, but when these are unavoidable, we will disclose this to the relevant people / organisations.
3. We will avoid soliciting, accepting, or offering any gratuity or benefit connected to a potential or existing business or working relationship.
4. We will accept work reviews as a means to improve our performance.
5. We will honour our contracts and assigned responsibilities.
6. We will accept the decisions of our employers / funders, unless these are illegal or unethical.
7. We will help develop security, backup, retention, and disposal rules.
8. We will acknowledge and accept rules about the personal use of employer resources. This includes computers, data, telecommunication equipment, the Internet and other resources.

Be Honest in Representations

1. We will state our practitioners qualifications truthfully.
2. We will make honest proposals that will allow the work to be completed for the resources requested.
3. We will deliver an hour's work with earnest effort and best thought for an hour's pay.
4. We will never use any information coming to us confidentially in the performance of our duties as a means for making private profit
5. We will seek to find and employ more efficient and economical ways of getting tasks accomplished
6. We will describe products fully.
7. We will be forthcoming about limitations of our work. This includes data, software, assumptions, models used, methods, and analysis.

Obligations to Colleagues and the Profession

The GIS practitioners recognises the value of being part of a community of other practitioners.
Together, we support each other and add to the stature of the field. To this end, the GIS practitioners will:

Respect the Work of Others.

1. We will cite the work of others whenever possible and appropriate.
2. We will honour the intellectual property rights of others. This includes their rights in terms of software, data and models.
3. We will accept and provide fair critical comments on practitioners work.
4. We will recognise the limitations of our knowledge and skills, know the skills of other practitioners, and draw on them to complement our expertise as needed. This includes both those in other disciplines and GIS practitioners with deeper skills in critical sub-areas of the field.
5. We will work smoothly and capably with others in GIS and other disciplines.
6. We will respect existing working relationships. These include formal and informal relationships between employees and employers and between clients and contractors or vendors. We will avoid interfering with these relationships and will not attempt to supplant another GIS practitioners, vendor or organisation.
7. We will deal honestly and fairly with prospective employees, contractors, and vendors.

Contribute to the Discipline

1. We will publish results so others can learn about our contributions. Our audiences may include the public, students, policy-makers or other practitioners; our mediums may include the GISSA and other journals, conference proceedings, or self-publication on the web or otherwise. We will disclose sufficient details to substantiate our conclusions.
2. We will volunteer our time for practitioners educational and organisational efforts, local or national.
3. We will support individual colleagues in their practitioners development. We will give special attention to underrepresented groups.
4. We will report unpractitioners activity.

Obligations to Individuals

We as GIS practitioners recognises the impact of our work on individual people and will strive to avoid harming anyone. Therefore, the GIS practitioners will:

Respect Privacy

1. We will protect individual privacy, especially about sensitive information.
2. We will be especially careful with new information created about an individual through GIS-based manipulations (such as geo-coding) or the combination of two or more databases.

Respect Individuals

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1. We will encourage individual autonomy. We will allow individuals to:
- Withhold consent from being added to a database
- Correct information about themselves in a database
- Remove themselves from a database.

2. We will avoid undue intrusions into the lives of individuals.

3. We will be truthful when disclosing information about an individual.

4. We will treat all individuals equally, without regard to race, gender, or other unique characteristics.

Appendix 2 - Digital storytelling assignment briefs 2012 – 2015

UNIVERSITY *of the*
WESTERN CAPE

2012 assignment brief

Department of Civil Engineering & Surveying
SPA300S   SPATIAL ANALYSIS 3

Assignment : Digital Storytelling and Spatial Analysis

Tell a story using maps
You are to tell a story that must be able to be followed on a map, and must contain numerous spatial analysis techniques.
The story might be:
- Your life story up to now;
- A trip you have taken;
- An analysis of some specific event (in your life or someone else's);
- An analysis and explanation of some historic event;
- …..

Analysis
You must do all the analysis. The spatial analysis you use must be incorporated into the story. The spatial analysis and GIS processing contained in the story must, at a minimum, have the following:
- Data capture (e.g. digitizing, co-ordinate importing, or raster image georeferencing)
- Database analysis;
- Overlay analysis;
- Buffer analysis
If you use other types of analysis, you will be awarded extra marks. If you use other analysis techniques that have not been covered in this course, you will be awarded even more marks!

Submission
There are numerous ways that you can submit:
- A video file containing a narrated story (audio) and still maps (images) or moving maps (videos captured from the GIS);
- A website containing the story, with hyperlinks to videos, maps, analysis screenshots, etc.;
- A presentation by you to the rest of the class (if you choose this option, you get an extra week as the presentation will be scheduled a week after the hand-in date). This could be a PowerPoint presentation.

Some useful information
Free website creation: Wix.com, yola.com, webs.com, webnode.com, etc.
Free screen capture software: camstudio.org
Free audio editing software: http://audacity.sourceforge.net/
Free moviemaking software: Photostory (still images and narration): http://www.microsoft.com/en-us/download/details.aspx?id=11132
Windows MovieMaker (still images or movies) http://windows.microsoft.com/en-ZA/windows-live/movie-maker-get-started
Media converter: Real player http://uk.real.com/
Images editor: Artweaver http://www.artweaver.de/download-en/

Due Date: Friday, 19 October 2012
If you choose to do a presentation to the class: 26 October 2012

This assignment counts for 15% of the total course mark

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2013 assignment brief

Department of Civil Engineering & Surveying
SPA300S   SPATIAL ANALYSIS 3

Assignment : Digital Storytelling and Spatial Analysis

Tell a story using maps
You are to create a video that tells a story. The story must have a spatial component (you must use maps in telling the story), and must contain numerous spatial analysis techniques.
The story could be your story or someone else's story. It could be about a social issue that you are interested in. The script must be written by you.

Analysis
You must do all the analysis. The spatial analysis you use must be incorporated into the story. The spatial analysis and GIS processing contained in the story must, at a minimum, have the following:
   - Data capture (e.g. digitizing, co-ordinate importing, or raster image georeferencing)
   - At least 3 types of spatial data analysis

Presentation: Conference
On the day of the conference:
   1. Present a video file containing a narrated story (audio) and still maps (images) or moving maps (videos captured from the GIS);
   2. After your video presentation, there will be a 5-10 minute discussion.

Some useful information
The script should not be longer than 300 words.
Free screen capture software: camstudio.org
Free audio editing software: http://audacity.sourceforge.net/
Free moviemaking software: Photostory (still images and narration): http://www.microsoft.com/en-us/download/details.aspx?id=11132
Windows MovieMaker (still images or movies) http://windows.microsoft.com/en-ZA/windows-live/movie-maker-get-started
Media converter: Real player http://uk.real.com/
Images editor: Artweaver http://www.artweaver.de/download-en/
Other students' digital stories: search for "CPUT stories" on YouTube

Conference Date: Thursday 31 October 2013 at 9:00
Questionnaire: after the conference, you will be asked to complete a questionnaire about what you have learnt.

This assignment counts for 20% of the total course mark.

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2014 assignment brief

Department of Civil Engineering & Surveying
SPA300S   SPATIAL ANALYSIS 3

Assignment : Digital Storytelling and Spatial Analysis

Tell a story using maps

You are to create a video that tells a story. The story must have a spatial component (you must use maps in telling the story), and must contain numerous spatial analysis techniques.
The story could be your story or someone else's story. It could be about a social issue that you are interested in. The script must be written by you.
You may work in teams (not > 2 people) for this assignment. If you work in a team, do a story on an issue that both of you agree on.

Analysis
You must do all the analysis. The spatial analysis you use must be incorporated into the story. The spatial analysis and GIS processing contained in the story must, at a minimum, have the following:
- Data capture (e.g. digitizing, co-ordinate importing, or raster image georeferencing)
- At least 3 types of spatial data analysis

Presentation: Conference
On the day of the conference:
1. Present a video file containing a narrated story (audio) and still maps (images) or moving maps (videos captured from the GIS);
2. After your video presentation, there will be a 5-10 minute discussion.

Some useful information
The script should not be longer than 300 words.
You may publish the story in the name of a nom de plume, if you wish for your story to published on the internet anonymously.
Free screen capture software: camstudio.org
Free audio editing software: http://audacity.sourceforge.net/
Free moviemaking software: Photostory (still images and narration): http://www.microsoft.com/en-us/download/details.aspx?id=11132
Windows MovieMaker (still images or movies) http://windows.microsoft.com/en-ZA/windows-live/movie-maker-get-started
Media converter: Real player http://uk.real.com/
Images editor: Artweaver http://www.artweaver.de/download-en/
Other students' digital stories: search for "CPUT stories" on YouTube

Conference Date: Thursday 30 October 2014 at 9:10

Questionnaire: after the conference, you will be asked to complete a questionnaire about what you have learnt.

This assignment counts for 20% of the total course mark.

2015 assignment brief

Department of Civil Engineering & Surveying
SPA300S   SPATIAL ANALYSIS 3

Assignment : Digital Storytelling and Spatial Analysis

Tell a story using maps

You are to create a video that tells a story. The story must have a spatial component (you must use maps in telling the story), and must contain numerous spatial analysis techniques.

The story could be your story or someone else's story. It could be about a social issue that you are interested in. The script must be written by you.

You may work in teams (not > 2 people) for this assignment. If you work in a team, do a story on an issue that both of you agree on.

Analysis

You must do all the analysis. The spatial analysis you use must be incorporated into the story. The spatial analysis and GIS processing contained in the story must, at a minimum, have the following:
- Data capture (e.g. digitizing, co-ordinate importing, or raster image georeferencing)
- At least 3 types of spatial data analysis

Assignment process - steps
1. Story circle: This will take the form of a discussion, when each person/group will present their story to the class. You will present the basic idea of the story, the storyline, the main character/s, the maps and the analysis that you will produce. Presentation: **8 October 2015**
2. Storyboard: You will hand in a storyboard that contains a graphic representation of your story. You must choose 6 (or less) of the most important scenes from your story, and draw it onto the storyboard. Each scene should have a description or some of the script written under it. Hand in the storyboard (hardcopy) on **15 October 2015**.
3. Conference: You will play the video at a mini-conference for the rest of the class to watch. Your video will contain a narrated story (audio) and still maps (images) or moving maps (videos captured from the GIS). After each video, there will be a short discussion. Conference: **29 October 2015**.
4. Questionnaire: In the week following the conference, you will be asked to complete a questionnaire about what you learnt during the term.

Submission requirements

To pass this assignment, you must complete steps (1)-(4), in which case you will automatically get a mark of 50%. The remaining 50% will be based on the mark you obtain for your video submission.

Some useful information

The script should not be longer than 300 words.

You may publish the story in the name of a nom de plume, if you wish for your story to published on the internet anonymously.

Free screen capture software: camstudio.org

Free audio editing software: http://audacity.sourceforge.net/

Free moviemaking software: Photostory (still images and narration): http://www.microsoft.com/en-us/download/details.aspx?id=11132

Windows MovieMaker (still images or movies) http://windows.microsoft.com/en-ZA/windows-live/movie-maker-get-started

Media converter: Real player http://uk.real.com/

Images editor: Artweaver http://www.artweaver.de/download-en/

Other students' digital stories: search for "CPUT stories" on YouTube

Conference Date: Thursday 29 October 2015 at 9:00.

This assignment counts for 25% of the total course mark.

Appendix 3 – Digital storytelling task assessment rubrics

2012

Date: 19 October 2012 Conference		
Video	Mapping Analysis	Data capture
		3 types of GIS analysis
	Presentation	Text, speech, flow of presentation
		Music, pictures
		Creativity
	Research	Effort, quality of product
		Extra marks for social issue

2013

Date: 31 October 2013 Conference			
Video	Mapping Analysis		70
		Data capture	
		3 types of GIS analysis	
	Presentation	Text, speech, flow of presentation	
		Music, pictures	
		Creativity	
	Research	Effort, quality of product	
		Extra marks for social issue	
After video	Discussion		20
	What types of analysis did you use? Why?		
	What was the result of your analysis?	Interpretation of analysis	
	Participation in the conference.	Asking/answering questions	

Date: 5 November 2013		
Question naire	What did you learn from other presentations:	10
	- did your GIS knowledge improve? Explain	
	- did your general knowledge improve? Explain	
	- did you learn anything about any social issue? Explain	
	If you had another chance, how would you change your presentation?	

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Date: 30 October 2014			
Conference			
Video			80
	Mapping	Quality of cartography	
	Analysis	Data capture	
		3 types of GIS analysis	
	Presentation	Text, speech, flow of presentation	
		Music, pictures	
		Creativity	
	Research	Effort, quality of product	
		Extra marks for social issue	
After video			15
	Discussion		
	What types of analysis did you use? Why?		
	What was the result of your analysis?	Interpretation of analysis	
	Participation in the conference.	Asking/answering questions	

Date: 3 November 2014		
Question naire		5
	What did you learn from other presentations:	
	- did your GIS knowledge improve? Explain	
	- did your general knowledge improve? Explain	
	- did you learn anything about any social issue? Explain	
	If you had another chance, how would you change your presentation?	

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Work plan for digital storytelling task

Week 1 Story Circle
Present first ideas of your story Group discussion Idea sharing, suggestions for classmates

Week 2 Storyboard
Hand in a storyboard showing most important scenes from your digital story (6 max)

Week 4 Conference		
Video		60% of footage must be original
	Mapping	Quality of cartography
	Analysis	Data capture
		3 types of GIS analysis
	Presentation	Text, speech, flow of presentation
		Music, pictures
		Creativity
	Research	Effort, quality of product
		Extra marks for social issue
After video	Discussion What types of analysis did you use? Why?	
	What was the result of your analysis?	Interpretation of analysis
	Participation in the conference.	Asking/answering questions

Week 5 Questionnaire	
What did you learn from other presentations: - did your GIS knowledge improve? Explain - did your general knowledge improve? Explain - did you learn anything about any social issue? Explain If you had another chance, how would you change your presentation?	

Appendix 4 – Student story transcripts

Ndingubani na? Ndivela phi na ?

My name is Zanoxolo. My surname is Pama and my clan name is Nqana ooMdande ooNakisa ooNomakhungelo oDlala alidliwa the Great Mpondomise.
Lady Frere is my hometown, situated adjacent to Queenstown, Cala, Cofimvaba in the Eastern Cape province of South Africa.
Xonxa is my home village, situated approximately 979 km from Cape Town, 804 km from Johannesburg, and 621 km from Durban, where youth mostly go to search for better jobs and better education.
My lineage traces from the Central Africa where Bantu people spread to different directions.
In as early as the 3rd century A.D, my ancestors migrated from Central Africa towards South East and settled at a place called Kanazi village near the great lake of Africa, located on the borders of Uganda, Tanzania and Kenya where Nguni was born.
Nguni fathered Zulu, Xhosa, Swati, Ndebele and I am from Xhosa.
In as early as 4th century A.D., Nguni travelled across Zambezi River in Mozambique and settled along the river.
King Sibiside who is from Xhosa lineage led Xhosa nation to Swaziland and fathered twins Mpondo and Mpondomise.
Twins occurred to be leaders in the country of Swaziland and Mpondomise established a homestead at a place called Manzini, now a capital city of Swaziland.
A descendent of Mpondomise, Malangana led the nation of Mpondomise from Manzini Village to Fuleni Village along Umfolozi River in Zululand, now known as KwaZulu-Natal.
About 1420 Mpondomise nation battled with Nyambozi the Zulu nation and migrated to tributaries Of Ndenxa village in the present district of Maclear.
The Mpondomise gradually spread throughout the whole of the present district of Maclear, but they were not happy with their newly found country.
It was too cold in the winter, too wet in the summer, the crops planted by them failed, the grass were too sour and not edible for their cattle.
They gradually left the highland of the area and moved down to lower lying, warmer and fertile area in the vicinity of Tsolo and Qumbu.
Around 1800, some Mpondomise descendants migrated from Ntabelanga in Tsolo.
After a great famine, searching for greener pastures. After a very long route, they discovered a fertile empty land along Cacadu River in Lady Frere and named it Xonxa.
Sadly, in 1970, Mpondomise were dispossessed of their land due to the dam that was going to be constructed for irrigation purposes. In 1976 Xonxa Dam was completed and Mpondomise gradually spread along Cacadu River and south of the dam.
Community leaders subdivided the land into erven and constructed a good network of gravel roads.
Xonxa is now one of the most beautiful villages in the Eastern Cape attracting lot of tourists.
This is my house. This is my primary school, Xonxa Junior School.
This was the shortest distance from home to school.
Indeed, I am Xhosa, I am the son of Fikile, grandson of Laqhomfela, grand grandson of Pama. I am Mpodomise. I am Bantu. I am from the Great Lakes. I am originated from the Central Africa
Embo!! Embo!! Apho kutyiwa ngendebe endala ndisatshaya ndingumAfrika

The Unlikely Rhino Poacher

[Narrated:]
The rhinoceros, a native of Africa and South Asia. These animals have very few natural predators. However recently, they face a much more deadly and unforgiving enemy – the human.

[Gunshot, images of living rhinos, followed by images of dead and dying rhinos, victims of poachers].

[Subtitles over pictures of dead or dying rhinos:]
13 rhinos poached in S.A in 2007.
83 rhinos poached in S.A in 2008.
122 rhinos poached in S.A in 2009.
333 rhinos poached in S.A in 2010.
790 rhinos poached in S.A in 2013.

[Further subtitles:]
Who is responsible for this?
Let's look at the buyer first…

[Narrated:]
Meet Chumlong Lemtongthai, recently held in South Africa on suspicion of rhino horn trading following an incriminating video published in the South African media. He is suspected as being one of the kingpins of a syndicate operating in Thailand. China, Vietnam, Thailand – the three biggest markets for poached rhino horn from Africa.
You may begin to ask yourself: what do they want with the rhino horn? What would drive people to kill so many rhinos?
Well, the horn is very popular in certain parts of East Asia, because of the misguided belief that it possesses aphrodisiac properties. This of course, and according to scientists, is nothing but a myth.
But hey, business is booming; Africa supplies the raw material, as always.
Going down the chain there are scores of other people involved in this tragic story of the rhino.
The most remarkable story perhaps, comes from South Africa, home of the biltong, land of the boerewors.
Meet Marnus Steyl, a game farmer from the Free State and an excellent marksman.
This man hardly fits the description of your stereotypical rhino poacher.
Well, he's not. He's a game farmer.
He's one of the people who are supposed to be taking care of the rhinos right?
[Gunshot]
Wrong.

[The rest of the story is subtitled, with no narration]

Due to technical difficulties, the following segment could not be narrated…Please accept my apologies.
The Van Deventer brothers…
They tell a story of how they hunted rhino in the Kruger National Park.

They would enter the park and choose one of the busiest roads… "So as to not arise suspicion".

They would then drive around tracking a rhino…

Once they spot one, they would kill it quickly, either with a bow or a rifle equipped with a silencer and leave it on that spot… Sometimes within 15 metres off the road!!

They would then check into a rest camp like this one for the night, under false names.

The next morning, they would come back and cut off the horn with a saw or axe.

The job would take about 20 minutes… This was the riskiest part of the whole event.

Their best disguise? The general public… Plus the fact that they didn't fit the profile of a rhino poacher.

In essence… The brothers could've killed a rhino off any of the highlighted roads and get away with it.

The Van Deventer brothers entered and exited the Kruger National Park several times with rhino horn and weapons in the car…never being searched even once.

They don't fit the stereotypical profile of a rhino poacher…

Something to think about next time you think about a poacher!

Lets all do our part in saving the rhino and African elephants being killed on a daily basis…

Thank You!

Appendix 5 – Information sheets and consent forms

<u>**STUDENT INFORMATION SHEET**</u>

Project Title: *Storytelling in Geomatics Education*

What is this study about?
This is a research project being conducted by Mr Motala, and this research will contribute towards his PhD studies. The aim of this study is to investigate what are the benefits of using storytelling in surveying and GISc education. You are currently registered as a student in the Spatial Analysis course at CPUT, and your participation in this course will be researched.

What will I be asked to do if I agree to participate?

If you are registered for the Spatial Analysis course:
  a. You will be asked to complete and present a digital story as an assignment;
  b. The presentation of your digital story will take place at a mini-conference, attended by your class, your lecturer, and 2 other lecturers. At the mini-conference, you will be explained the purpose and details of the research process, as well as any ethical considerations, and you will be requested to complete a written consent to participate;
  c. In addition to presenting your digital story at the mini-conference, you will be asked permission to distribute your digital story via the internet (on the CPUT Digital Story Repository), or at other teaching and learning settings (such as other classes, conferences or training courses);
  d. During the mini-conference, you and your class will be asked to discuss each other's presentations, and these discussions will be recorded and transcribed for analysis;
  e. At the end of the semester or at another convenient time, you will be interviewed about your impressions of the course, in particular, you will be asked to comment on your perceptions of the storytelling elements of the course.
  f. Whether or not you give this permission, is entirely your personal decision, and it is entirely voluntary;
  g. There will be no rewards for giving this permission, as there will of course be no penalty for refusing it;
  h. You have a right to withdraw your permission at a later stage – so long as it is prior to any publication – and the researcher would then refrain from including your story in the research.

Would my participation in this study be kept confidential?
The interviews are completely anonymous and there will be no confidential information obtained from them. In the case of the digital stories, no confidential information will be shared, unless you publish personal information in your story. If you wish for your story to be published anonymously, you may use a *nom de plume*. The interview data will be kept in locked cabinets, and in files and documents which are password protected. The data will be destroyed within 4 months after analysis.

What are the risks of this research?
Although it is unlikely, there may be some unintended risks from participating in this research study. However, if you do feel emotionally uncomfortable while participating in the survey your can withdraw. If you do become visibly distressed, the researcher will refer you appropriate counselling services.

What are the benefits of this research?
CPUT staff and students will benefit from this study, as this intervention is at the forefront of teaching and learning research. The results could be used to inform policy and interventions to improve teaching and learning at CPUT.

Describe the anticipated benefits to science or society expected from the research, if any.
The results of the study will contribute to the growing scholarship on teaching and learning in engineering education, locally and internationally.

Do I have to be in this research and may I stop participating at any time?
Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalised in any way.

Is any assistance available if I am negatively affected by participating in this study?
If you are traumatised in anyway then the researcher will help you access a counsellor.

What if I have questions?
This research is being conducted by Mr Siddique Motala of the Department of Civil Engineering and Surveying at Cape Peninsula University of Technology.

Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

Researcher: Mr Siddique Motala
Lecturer, Department of Civil Engineering & Surveying
Cape Peninsula University of Technology
P.O. Box 652
Cape Town
8000
Tel. 021-953 8771
motalas@cput.ac.za

Research supervisor: Prof. Vivienne Bozalek
Director: Teaching and Learning
University of the Western Cape
Private Bag X 17, Bellville, 7535
Tel. 021-959 2848 / 3069
vbozalek@uwc.ac.za

Project Title: *Storytelling in Geomatics Education*

What is this study about?
This is a research project being conducted by Mr S. Motala, and this research will contribute towards his PhD studies. The research site is the Department of Civil Engineering and Surveying at the Cape Peninsula University of Technology, and the PhD is registered for at the University of the Western Cape. The aim of this study is to investigate what are the benefits of using storytelling in surveying and GISc education. Furthermore, this research is being conducted to interrogate the philosophical underpinnings of geomatics education in South Africa. Your knowledge is valuable to this study, and you will be asked to take part in an interview.

What will I be asked to do if I agree to participate?
Upon approval by the Senate Research Committee of the University of Western Cape, the researcher will contact you to ask you to do the following:

- After explaining the purpose and details of the research process as well as ethical considerations, the researcher will invite you to complete a written consent to participate;
- Participate in a face-to-face or telephonic interview with the researcher, who will record and transcribe your interview for analysis;
- At the end of the research information about the research findings will be shared with you.

Audio taping/Digital Recordings
This research project will involve the recording of your interview. The audiotapes are a way of recording what you have said so that the researcher can remember what has been said and use this for the research. The audio files will be stored in a secure environment for a maximum period of five years, after which they will be destroyed. If a report or article about this research project is produced, your identity will be protected to the maximum extent possible.

Would my participation in this study be kept confidential?
The interviews are completely anonymous and there will be no confidential information obtained from them. The interview data will be kept in locked cabinets, and in files and documents which are password protected.

What are the risks of this research?
Although it is highly unlikely, there may be some unintended risks from participating in this research study. You may talk about or recall traumatic experiences in your past and present during the interview. This may be emotionally uncomfortable or cause emotional or psychological distress. If you do become visibly distressed, you will be referred to appropriate counselling services.

What are the benefits of this research?
The geomatics community will benefit from this research, as it will assist in the development of a more socially just geomatics curriculum. It will contribute to the broader research field of engineering education. CPUT staff and students will also benefit from this study, as this intervention is at the forefront of teaching and learning research. The results could be used to inform policy and interventions to improve teaching and learning at CPUT.

Describe the anticipated benefits to science or society expected from the research, if any.
The results of the study will contribute to the growing scholarship on teaching and learning in engineering education, locally and internationally. The interconnections between the discursive communities of the 'hard' and 'soft' sciences have been few, and this research will investigate how points of compatibility can be identified and demonstrated. The research will provide a critique of the current state of geomatics education in South Africa, and propose design principles for a decolonising methodology that involves storytelling. Geomatics educators and the larger geomatics community will potentially benefit from this. Student participants will be empowered to produce digital stories that are directly related to their chosen field of study. The pedagogy employed will also contribute towards student social, environmental and ethical conscientisation. Their contributions will also generate findings which will lead to the improvement of teaching and learning practices.

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Do I have to be in this research and may I stop participating at any time?
Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalised in any way.

Is any assistance available if I am negatively affected by participating in this study?
If you are traumatised in anyway then the researcher will help you access a counsellor.

What if I have questions?
This research is being conducted by Mr Siddique Motala of the Department of Civil Engineering and Surveying at Cape Peninsula University of Technology.

Should you have any questions regarding this study and your rights as a research participant or if you wish to report any problems you have experienced related to the study, please contact:

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vbozalek@uwc.ac.za

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STUDENT CONSENT FORM

Title of Research Project: Storytelling in Geomatics Education

I, …………………………………………………………………..hereby give my consent to participate in this research project which aims to assess the effectiveness of using storytelling in geomatics education at CPUT.

- I understand that the project is being conducted by Mr S Motala at CPUT.
- The study has been described to me in a language that I understand and I freely and voluntarily agree to participate.
- I fully understand the aims of the study and my questions about the study have been answered.
- I understand that I may withdraw from the study without giving a reason at any time and this will not negatively affect me in any way.
- I understand that any information will be treated with utmost confidentiality and that my identity will not be disclosed.
- I agree to be audio-recorded during my participation in the study.
- I understand that the data obtained from my interview will be kept in a digitally secure way and will be destroyed within 4 months after analysis.
- I authorise Mr Motala to use or distribute all or part of my final digital story for the following promotional or educational uses (Please place a checkmark next to each option that you agree to):

  ☐ Teaching and learning, classroom and community settings,

  ☐ Educational research, trainings and conferences,

  ☐ Potential inclusion in the CPUT digital story repository

Participant's name……………………………………………
Participant's signature…………………………………..
Witness's name…………………………………………..
Witness's signature…………………………………..
Date………………………

Researcher: Mr Siddique Motala
Lecturer, Department of Civil Engineering & Surveying
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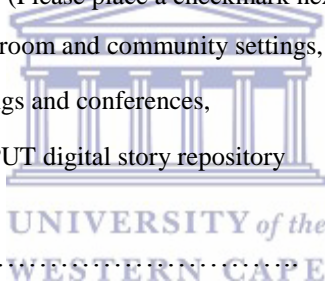Tel. 021-959 2848 / 3069
vbozalek@uwc.ac.za

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INTERVIEWEE CONSENT FORM

Title of Research Project: Storytelling in Geomatics Education

I, ………………………………………………………………..hereby give my consent to participate in this research project which aims to assess the effectiveness of using storytelling in geomatics education at CPUT.

- I understand that the project is being conducted by Mr S Motala at CPUT, and contributes towards PhD research on geomatics education
- The study has been described to me in a language that I understand and I freely and voluntarily agree to participate.
- I fully understand the aims of the study and my questions about the study have been answered.
- I understand that I may withdraw from the study without giving a reason at any time and this will not negatively affect me in any way.
- I understand that any information will be treated with utmost confidentiality and that my identity will not be disclosed.
- I agree to be audio-recorded during my participation in the study
- I understand that the data obtained from my interview will be kept in a secure way and will be destroyed within 4 months after analysis.

Participant's name…………………………………………..
Participant's signature……………………………………….
Witness's name…………………………………………….
Witness's signature………………………………………..
Date………………………

Researcher: Mr Siddique Motala
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Appendix 6 – All student stories' information

Number	Year	Title	Style	Race	Gender	Proximity	History	Environmental	Theme1	Theme2	Notes
1	2012	The story about myself	autobiography	Black	Male	close	short		hardship	Rural and township life	hardship
2	2012	The places I lived in CT	autobiography	White	Male	close			Travel		
3	2012	Tennis club search	autobiography	White	Male	close			Sport		
4	2012	That road trip and the sights	autobiography	White	Male	close		yes	Travel		Good use of music.
5	2012	My footballing days	autobiography	Black	Male	close	short		Sport		
6	2012	My student life at CPUT	autobiography	Black	Female	close			Student life		
7	2012	Roodepoort tornado	Documentary	Coloured	Female	far	short			Rural and student life	
8	2012	My digital life	autobiography	Black	Female	close	short	yes		Rural and student life	Affirmative transformation of a disability
9	2012	My life story	autobiography	Black	Male	close	short		hardship	Rural and student life	
10	2012	The story of my life	autobiography	Black	Male	close	short		hardship	Rural life	
11	2012	Tygerberg high school hockey league	autobiography	White	Male	close			sport		
12	2013	Soweto uprising	Documentary	Black	Female	far	longer		politics		
13	2013	Robben Island -from incarceration to liberation	Documentary	Coloured	Female	far	longer		politics	Natural history	
14	2013	2010 world cup	Doc/auto	Coloured	Male	close	short		Sport		Humour
15	2013	Fire in Nyanga	Documentary	Black	Female	far	short	yes	hardship	Township life	
16	2013	The unlikely rhino poacher	Documentary	Black	Male	far					Boundary crossing
17	2013	50 shades	Documentary	Black	Female	far					Longing for a White life
18	2013	history of CPUT	Doc/auto	Black	Female	close	longer			history of CPUT	
19	2013	Ndingubani na	Doc/auto	Black	Male	close	longer				Bantu migration
20	2013	Simons Town	Documentary	Black	Male	far	longer			history of CT	
21	2013	Road trip	autobiography	Black	Male	close			Travel		
22	2013	Proposed nuclear power station	Documentary	White	Male	far		yes			
23	2013	What if Koeberg was the next Fukushima?	Documentary	White	Male	far		yes			
24	2013	Kalk Bay history	Documentary	Coloured	Female	far	longer				
25	2014	Humanity is dead...Long live humanity	Documentary	Coloured	Male	far	longer		politics	Genocide	Graphic violent images
26	2014	Gansterism in khayelitsha	Doc/auto	Black	Female	close	short		hardship		
27	2014	My Eastern Cape	Documentary	Black	Male	close	longer	yes	hardship		deaths around initiation
28	2014	Crime SA	Documentary	White	Male	far	longer		politics		
29	2014	It's Oscar Time	Documentary	Coloured	Female	far		yes			Violence and trauma of Oscar Pistorius case
30	2014	Ebola	Documentary	Black	Female	far					
31	2014	Refugees	Documentary	Black	Female	close	longer		politics	politics	problems in other countries
32	2014	African horse sickness	Documentary	White	Male	far		yes			
33	2014	District 6 - then and now	Documentary	Coloured	Female	far	longer		politics		
34	2015	Forced removals in SA	Documentary	Black	Female	far	longer		politics	politics	
35	2015	Behind the name	Doc/auto	Black	Female	close	longer		politics		Links famous people to local context
36	2015	Port Nolloth to Cape Town - small town to city	Autobiography	Coloured	Female	close	short		Travel	Student life	
37	2015	Romanskraal	Autobiography	White	Female	close		yes			
38	2015	The Chernobyl disaster	Documentary	White	Male	far	short	yes			
39	2015	Merging of 2 cultures	Autobiography	Black	Male	close	longer		politics	Cultural exchange	Border crossing across cultures
40	2015	Welcome to Khayelitsha	Autobiography	Black	Male	close	short		hardship		
41	2015	Unsung economic warriors in SA	Documentary	Black	Male	close	longer		politics	Hardship	
42	2015	Ramfest	Autobiography	White	Female	close					
43	2015	The story of Jony	Autobiography	Black	Male	close	short		hardship	Travel	Metaphor for the journey of life
44	2015	The journey	Documentary	Black	Female	far	short		politics	Travel, hardship	anti xenophobic
45	2015	Urban sprawl	Documentary	White	Male	far	longer	yes			
46	2015	to the cape flats with love	Autobiography	Coloured	Female	close	short		hardship	place	

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Appendix 7 – Student story themes

		Style			Proximity		Themes				
							Politics/hardship	History		Environmental	
		Documentary	Autobiography	Doc/auto	Close	far		Short/personal	Longer		
White	12	6	6		6	6	1	1	2	7	
Black	25	11	10	4	17	8	15	10	10	1	
Coloured	9	6	2	1	3	6	4	4	4	1	
Totals	46	23	18	5	26	20	20	15	16	9	

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Appendix 8 – Interview questions

Questions for geomatics academics

- Provide basic information about the geomatics offering/s (e.g. qualification/s, first year intake, number of qualifying students, staff and student profile, history of the department).
- What is the relationship between your department and other departments?
- How do you view the relationship between geomatics as a profession and other professions?
- What are the characteristics that make a successful geomatics practitioner?
- How do you try to cultivate these characteristics in your courses?
- How knowledgeable should geomatics practitioners be of issues around sustainable development/climate change/the environment? What is being done in your curriculum in this regard?
- What international benchmarking do you do for your geomatics qualification development?
- How do you decided on what to include in your programme?
- How much of your personal interest comes through in what/how you teach? How do you think this benefits the students? How do you incorporate these ideas into your teaching?

Questions for geomatics practitioners

- Comment on the nature of work that you do, and the changes that the industry has gone through.
- Do you think that geomatics practitioners are generally honest and ethical? Did your tertiary education prepare you to operate ethically? Comment on the ethical awareness of your employees, and geomatics graduates in particular. Has this changed over the period that you have been here? How?
- What role do you think geomatics practitioners should play in sustainable development? Did your tertiary education concientise you wrt environmental issues?
- Is there much room for art in geomatics practice?
- How do you think surveyors / GIS practitioners interact with other professions? Who are the professions that need to be dealt with regularly? Did your education help you in dealing with these groups? Which other professions do you think surveyors of the future will need to deal with?

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Appendix 9 – Links to selected student digital stories

Story 12 – 'Soweto uprising'- https://youtu.be/jnL6_KPGsiI
Story 16 – 'The unlikely rhino poacher' – https://youtu.be/MMgtDYLTfK4
Story 19 – 'Ndingubani na?' – https://youtu.be/560BukipHJU
Story 26 – 'Gangsterism in Khayelitsha' – https://youtu.be/ypfe2beMX2A
Story 27 – 'My Eastern Cape' - https://youtu.be/WUrG1WGL_PM
Story 31 – 'Reasons why refugees come to South Africa' - https://youtu.be/mgP6rVFgg7c
Story 39 – 'Merging of two cultures' - https://youtu.be/pWf83vq72uY
Story 40 – 'Welcome to Khayelitsha' - https://youtu.be/1qbdh_Xr9cA
Story 43 – 'The story of Jony' - https://youtu.be/Nx4_AzcDYmE
Story 44 – 'The journey' - https://youtu.be/RhSo_TxT2R8

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