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Section 1.
Science and SIMULATION – constructing knowledge *[2000 words]*

> *"Technologies and scientific discourses can be partially understood as formalizations i.e. frozen moments, of the fluid social interactions constituting them, but they should also be viewed as instruments for enforcing meanings"*
>
> *Donna Haraway [p164]*

Ontologies of science - constructing knowledge

Are there such things as facts, that we can build devices in order to discover or is 'reality' defined by experience? The former, a 'Realist' point of view traditionally seen as one adopted by 'hard sciences' such as conventional physics, where objects have a mass that can be measured. The latter, 'constructivist' position, is not concerned characteristics or 'essentials' of things, instead only allowing things to be defined by how they are 'interpreted' and has been seen as the position of 'softer sciences' and humanities. Is their a place for both of these standpoints and if so, how can these two, contradictory positions, be resolved?

Bruno Latour and Steve Woolgar, in their book Laboratory Life, describe through ethnographic study, the processes of 'making science' in biological laboratory, and describe something that is far messier than the 'public face of science'. Latour and Woolgar are interested in 'materiality' as the means of exploring the scientific practices that 'construct' the output of the lab, namely scientific facts. This focus on materiality leads to one of their conclusions is that, rather than producing scientific fact, the primary output of the lab is paper. Furthermore, they make a radical step in linking directly the process of experimentation and the production of the printed output. Their 'material method' describes this a single process, in which the materiality of the experiment if transcribed into the materiality of the document and it is the document, rather than the material of the experiment itself that is the focus of analysis.

They describe how it is diagrams used to describe results of experimentation themselves are the means by which 'facts are constructed'. The shape of a graph's curve, as 'inscribed' is used to indicate the status of a given substance and that the presence of two or more similar statements [or inscriptions] could elevate a substance from subjective statement to ontological 'reality'. The 'inscription', and by extension the 'inscription device', as part of a single material process, are for Latour and Woolgar, critical in the construction of 'fact'.

In presenting their ethnographic account of scientific practice, they do not claim it to be a 'privileged' account. Nevertheless it is a strongly 'constructivist' expression, describing as it does, the information flow from the symbolic, through the operational to the material. Katherine Hayles states the limitations of such a rigid constructivist approach, asserting that it is limited by its adherence [albeit reversed] of the thing which it rejects, namely the realist approach [Hayles]. Hayles goes on to claim that Latour himself has since 'softened' his earlier constructivist standpoint and adopt the position that;

> "...the objects of scientific research are at once discursively constructed, socially produced *and* materially real..."
>
> [p209]

Manuel De Landa attempts to make a description of just such 'objects of scientific research' through an explanation of the philosophical position of Deleuze, both ontologically and epistemologically. De Landa makes the assertion that Deleuze is a 'realist' philosopher rather than a 'constructivist' but differs from other realist positions that consider 'things' to have a set of properties that can be used to define and describe it, and that Deleuze contests not only this idea of 'essences', but also the implication that they are unchanging. [De Landa REF]

Deleuze's ontology, explains De Landa, is about doing away with 'essences' and replacing them with dynamic processes of difference. Within this, it is not these properties that define something, or in fact its 'resemblance' to something (as this too, would in some way be reliant upon an idea of essence to be able to make the 'comparison'). Rather its the 'morphogenetic' processes that gave rise to them.

This removal of 'classification' is not only about, say, animals but must then include things like cells and atoms. Deleuze's use the term 'multiplicity' to make this shift, with the specific aim of leaving fully behind the idea of 'essence' (rather than shifting to a classification of 'process' rather than 'thing').

> "multiplicities specify *the structure of the space of possibilities"*
>
> [p10]

De Landa goes on to address this concept of 'multiplicity', with a technical description of differential geometry, group theory and dynamical systems theory. He links the concept of multiplicity to the mathematical concept of the 'manifold' as a means of providing a suitable description of 'space' that goes beyond the geometric. The term 'manifold' is part of differential geometry' (rather than 'analytical geometry'). Differential geometry does not rely on the 'thing' being placed 'within a coordinate system', rather the 'thing' becomes a space in itself. Differential geometry is about relations - so much so that it is 'reflexive', creating its own field of measure, rather than relying on an 'external' framework and the manifold is was used to develop an approach to 'n-dimensional' spaces. Deleuze's concept of 'multiplicity' is similar to the manifold in that it can address problems at an 'n-dimensional' level, and it doesn't require an 'external' (n+1) framework to be constructed/ applied in order to analysis it (e.g. to 'co-ordinise it).

The manifold is theoretical model which can be used to simulate a system and the ways in which it can change. In other words, the manifold is the 'space of possibilities'.

DeLanda 's example is of a swinging pendulum that has two degrees of freedom - position and momentum - and these can be modelled within a manifold to describe all possible configurations of the pendulum (the system). What is interesting here is that, even within this simple example, there is already the question of 'system definition' – the swinging of a pendulum is one aspect, but, as DeLanda goes on to mention, the pendulum could also melt under high temperature – a 'possibility' that is not mapped with the manifold. Further to this, DeLanda acknowledges a trade between 'actual' and modelled complexity in the manifold.

> "As with any model, there is a trade-off here; we exchange the complexity of the object's change of state for the complexity of the modelling space. In other words, an objects instantaneous state, no matter how complex, becomes a single point, a great simplification, but the space in which the object is embedded becomes more complex."
>
> [p14]

Here, DeLanda expands the scientific terminology to include 'the state space' - a single point in the manifold that describes a condition of the system at a given moment. Changes of state are 'observed' through the tracking, the trajectory of this point through the manifold. Trajectories that begin in different points, but 'tend' towards the same point within the manifold describe topological features of the system – *singularities.* These singularities (called 'attractors' in chaos theory), describe long term tendencies within a system (which may also contain multiple attractors). These singularities – topological points – 'guide' (i.e. 'attract') the trajectory of a given point on the system. During this process, our 'point' may adopt changing physical forms. This is crucial – the topological description is not at the 'essential' level, or even the 'systemic' but at the level of process (specifically *morphogenesis*) – and the relationship(s) between the 'state space' and the 'attractors'.

This is called 'progressive differentiation' - DeLanda uses an example (as a metaphor) of an egg, undergoing changes as in physical form as it goes from 'topological' egg to fully differentiated individual' - and consists of 'symmetry breaking transitions.' DeLanda illustrates this with a description (developed by mathematician Felix Klein) of how euclidean geometry can be 'derived' from 'topological geometry' (via other geometric systems) and goes on to describe how this approach is used in physics to derive the four basic forces (gravity, electromagnetism, strong and weak nuclear forces) from a single 'topological' thought to exist under the extreme conditions at the start of the universe.

> "Using these new concepts we can define the sense in which the metric space we in habit emerges from a non-metric continuum through a cascade of broken symmetries."

[p25]

'Progressive differentiation' raises an interesting question and a challenge to the notion of 'physical laws' as a constant ('essential'). It describes how even the most fundamental of aspects of physical science can be re-conceptualized as mutable. Furthermore, the 'phase transitions' (say, liquid to gas) that constitute progressive differentiation expose the fact that 'essential' observations made either side of a transition, can result in them being unrelated and therefore 'broken'.

DeLanda explains Deleuze's use of the *virtual,* the *real* and the *actual* in the context of the manifold. The actual is a combination of the real (as in a 'realized' state – a trajectory in the manifold) and the virtual is the *structured* space of possibilities within the manifold. The structured aspect is important here – it is not that virtual is simply an array of other possibilities – for Deleuze, you cannot simply jump between the two, as they each exist due to process of 'individuation' (or 'progressive differentiation') and therefore there cannot be this notion of 'resemblance' between the actual and the virtual. Instead, there is a process of 'individuation' that corresponds with a 'multiplicity'.

"...similarity and identity are contingent on the process of individuation..."

[p39]

One of the outcomes of this undermining of 'essences' is disintegration of pre-existing archetypes and therefore any notion of 'normal' (and by association deviations from normal. This is a 'flat ontology'.

"...interacting parts and emergent wholes..." and is one that requires the identification emergent processes, which for Deleuze are *intensive*."

[REF]

DeLanda goes on to make further moves against the 'essentialist' position, again turning to scientific terminology, looking specifically at 'intensive' properties and 'extensive' qualities (definitions taken from the field of thermodynamics). Extensive qualities – say, mass, or length – and can be understood as 'divisible' (if you cut it a thing' of 'X' length in half, its the value of its extensive property of length is also halved). Intensive properties, on the other hand – say temperature – are unchanged by such an operation. Furthermore, 'extensive' properties can be *summed*, whereas 'intensive' properties *average (or balanced)* - (in adding a volume of cold water to a volume of hot water, the volume is summed, but the temperature is balanced). DeLanda states that 'extensive' qualities are those with a 'metric' (rather than exclusively geometric), whereas 'intensive' are topological (in process terms, and not necessarily 'spatial') and 'non-metric' and that presence (and maintenance) of these intensive properties, are what drives the symmetry breaking events – or 'phase transitions' (think of temperature of water determining a phase transition from liquid to gas). It is the *differences of intensity that drive '*progressive differentiation', and is a key element, DeLanda states, of Deleuze's ontology.

Moving beyond properties (intensive and extensive), DeLanda goes on to describe other aspects of this ontology that influence a theory of assemblage, that replaces the 'essentialist' hierarchies – a 'things' capacity to *affect* and be *affected*. The term capacity can be understood in a similar way to James Gibson's term 'affordance'[REF]. The capacities of a 'thing' cannot be known, as they rely on an interaction with an, as yet, unknown other 'thing'. DeLanda describes the 'openness' of 'things' to be key to approximating the extent of its capacities, and this quality of 'openness' is an aspect of it's topological state – it's individuation. Again, this is not a question of infinite possibilities, but of a question of virtual states within a *structured* space of possibilities and, therefore, progressive differentiation gives rise to varying capacities for assembly.

De Landa's is a complex and detailed proposal, blending contemporary philosophy and science in order to make a strident case for a new kind of 'realist' position that does not rely on 'essential-ism' but focuses on dynamic processes. DeLanda's explanations of Deleuze's ontology contain a direct proposal for 'simulation' and particularly emergent models as a method for exploration of its epistemological consequences. Although hinted at, in terms of the 'complexity swapping' nature of such models, DeLanda does not directly raise issues of designing such models and simulations.

Donna Haraway, however, does.

In her book Simians, Cyborgs and Women, Haraway traces a history of scientific research into primate behaviour, and social order in order to describe how certain political ideas are first inserted into, and then validated by the mechanics of, the (supposedly objective) 'scientific method'. One of the conclusions that these scientists draw from their early experiments is that 'dominance' and in particular the idea of male dominance are central to 'social order'. Haraway claims that this is not the result of 'objective observation' during the experiments, but is instead due to the existence of 'domination' as socio-political principle. This then enters scientific process at its outset, thereby creating a kind of 'pre-determination' of causality;

> "The political principle of domination has been transformed here into the legitimating scientific principle of dominance as a natural property with a physical-chemical base."
>
> [p19]

Furthermore, what is clear to Haraway is that, for the scientists, the primate colonies that are the subject of their study represent a 'simulation' of human society. The problem of simulation, in the construction of scientific knowledge, is that they risk taking the simplified abstraction of the complexity of the world and returning it as it's underlying structure.

There is a further difficulty in dealing with simulation, that rests not with simulations as an experimental method, but that is related to access to the tools of simulation. In Haraway's 'study of simian study', many of the experiments take place in an 'artificially' constructed primate colony. On a private island. Clearly that is beyond the means of an 'independent researcher' and requires significant institutional funding. Contemporary simulations are more commonly undertaken using computational technology but the same problem occurs.

In his essay 'Computing Power', Ron Eglash likens the Marxist idea of ownership of labour (physical power), to the idea of ownership of computers (as processing power), which is a worrying proposition in the context of cloud computing. Web 2.0 technology has provides, in one sense, a 'democratization of technology' through access, structured around the internet as 'operating system', but at the cost of monopolization by large corporations such as Google. One aspect of this can be seen in the way consumer level computer devices are designed. The processor in my phone is more powerful than the laptop I owned in 2004, but the storage capacity is smaller than a £5 USB stick (and my laptop now has 4 processing cores). Major technology companies are buying cheap memory and (generously allowing us to use it), but we are expected to buy the (still expensive) processing power ourselves. Furthermore, there is a significant difference in the 'architecture' of consumer computing, which is discrete (and therefore/ limited in terms of processing power) and elite computing, which is networked and therefore almost limitless).

A similar case could be made regarding the algorithms that generate computational simulations. The educational cost of access, in terms of contributing to or challenging the underlying code, is even more prohibitive than the hardware costs of processors and memory.

Situated Knowledge

Haraway sets out the importance of 'science' - 'the game we have to play' - and suggests that it is, in social constructionist terms, the mechanics and terminology of the' scientific discipline' and the search of 'objectivity' (method, epistemology etc.) that have become a way of closing 'the world' and preventing us from viewing it from our own perspective. Haraway goes on state that it becomes that it is a 'matter of rhetoric and persuasion;

> "...the persuasion of the relevant social actors that one's manufactured knowledge is a route to a desired form of very objective power."
>
> [p184]

For Haraway - "feminist objectivity means situated knowledge" [p188]. She uses a notion of 'vision' as the 'sensory system' from which this 'feminist objectivity will be formed. Although taken initially as a metaphor, it is used as a literal challenge to the visualization methods of modern science that are Haraway claims as being central to the way that objectivity has previously been constructed. Haraway is proposing to change systems of knowledge through (multiple) ways of 'seeing' - of 'mobile positioning'.

Haraway again charts the transformations that this is epistemological shift creates - for example;

> *universal rationality becoming ethnophilosophies*
>
> *world system becoming local knowledge*
>
> *master theory becoming webbed accounts*

This is an acknowledgement of the problem of objectivity (rather than simply an attack on sciences current attempts at creating it). Haraway is not proposing to dis-engage from the pursuit, but instead is suggesting a notion of objectivity that comprises multiple subjectivities - by implication mobile, continuous and open.

Section 2.

Virtual INTERFACES - post humanisms, digital materialism and the myth of the virtual *[2000 words]*

Post-humanisms

> **Donna Haraway, A Cyborg Manifesto**
>
> "The cyborg is our ontology; it gives us our politics"
>
> [p150]

'A cyborg Manifesto' is Donna Haraway's attempt to first describe and then claim a possible 'cyborg future', identifying the cyborg – a cybernetic organism, a hybrid of the 'organism and machine' - as both a reality and a fiction. Haraway states that cyborgs 'exist' in science fiction, in modern medicine, in military hardware, ideas of reproductive (or 'replication') - it is always coupling between the imaginary and the reality.

The manifesto is a call to take ownership of and revel in confusion at that the new boundaries that this ontology creates. For Haraway, the cyborg has no 'origin story' in a western sense as is, as such, creature in a 'post-gender world'. The manifesto, then, is about transgressed boundaries 'fractured identities' and therefore possible 'fusions'. It contests not only what constitutes 'nature' but, by implication, the ontological basis of Western epistemology.

Central to the 'cyborg ontology' are three new distinctions;

1. Human ≠ Animal

2. Human ≠ Machine OR Animal ≠ Machine

3. Physical ≠ non-physical

Haraway goes on to sketch out an alternate epistemological position that are the consequence of this 'cyborg ontology', expressing the transitions from previous, hierarchical dominations to the 'scary new networks' which she names 'informatics of domination'. These are presented as a list that opposes 'natural' with non-natural' terminology, for example reproduction becoming replication;

representation becoming simulation

depth, integrity becoming Surface, boundary

reproduction becoming replication

Community ecology becoming ecosystem

Whilst the manifesto is certainly 'optimistic', it is not blindly utopian - the transitions described above are not taken as *de facto* positive epistemological 'outcomes'. Haraway is concerned with describing the field in which questions of gender, race, identity will be contested, whether we like it or not. This is a call by Haraway to occupy these fields and these 'informatics' represent possibilities - they are the potential sites of control and exploitation as much as they are potential spaces of more positive re-configurations;

> "The cyborg is a kind disassembled and reassembled, post-modern collective and personal self. This is the self feminists must code."
>
> [p163]

Haraway's cyborg proposition is a radical move and a precursor to the broader notion of 'post-humanism'. In much the same way as Haraway outlines, Rosie Braidotti describes post-humanism as;

> "...[as a] generative tool to help us re-think the basic unit of reference for the human in the biogenetic age known as 'anthroposcene', the historical movement where the human has become a geological force capable of affecting all life on this planet."
>
> [p6]

In forming this definition, Braidotti draws direct links between the (earlier) concept of 'autopoeisis', as described by Maturana and Varela and central to 'second wave cybernetics' and Guattari's 'Three

Ecologies'.

The original concept of autopoeisis is about a 'biological' systems closed-ness to external 'input' (i.e. any stimulus acting upon a given system must by definition be part of the system, rather than external to it) [REF]. This is a significant departure from 'first wave' cybernetic theory, in which systems are subjected to external input and are capable of regulating their function accordingly [REF]. Whilst autopoeisis, in its original definition, is concerned with 'biological' systems' Braidotti states Guattari has extended its meaning to include a 'machinic-autopoesis'.

As with Haraways manifesto, this is a description of post-humanism that produces dynamic formations of the subject and is one that implies process of 'becoming'.

Katherine Hayles is more specific in her position;

> "...I understands human and post-human to be historically specific constructions that emerge from different configurations of embodiment, technology and culture."
>
> [p33]

How, therefore, can mind be separated from body? This aspiration, Hayles states, has been present within science since the inception of cybernetics, with Weiner proposing that it would possible to telegraph a human being and is an idea that is still prevalent in science through disciplines such as molecular biology where the human is treated as code.

From this notion that information can move without change through different material substrates, Hayles moves to her version of 'post-human';

> "...my dream is a version of the post human that embraces the possibilities of information technologies without being seduced by fantasies of unlimited power and disembodied immortality, that recognizes and celebrates finitude as a condition of human begin, and that understands human life is embedded in a material world of great complexity, one on which we depend for our continued survival."
>
> [p5]

Hayles is seeking to re-figure the cybernetic post-human, viewing the contemporary context as an opportunity to explore new possibilities of 'post-human', in much the same way as Haraway, and attempting, to claim a version of 'post-human' that is based on a situated reading of the history of cybernetics and one that moves beyond the founding characteristics of 'post-human', example characteristics of which being the privileging informational pattern over material instantiation and the body as the original prosthesis. Hayles suggests that developments and changes in cybernetic theories can not only be traced through it's artefacts, but also reinterpreted, and the idea of 'artefact' can be expanded to include theories (or 'constellations' as described by Hayles).

> "if we want to contest what these technologies signify, we need histories that show the erasures that went into creating the condition of virtuality, we can de-mystify our progress towards virtuality and see it as the result of historically specific negotiations rather than the of the irresistible force of technological determinism."
>
> [p20]

Hayles uses this starting point to describe a relationship between an 'external' human and a computer-bound simulation. She takes as an example a computer program whose purpose is to 'evolve' digital creatures. In this description, she identifies the 'external' [human] software designer as well a the operator who is able to design 'fitness' functions in order to prompt the evolution of the creatures. Therefore, Hayles' definition of the extent evolutionary system at work, that would more normally be described as being held within the computer, is broadened to include those humans involved in it's creation and operation. This is in line with the previously described extension of 'autopoeisis' to include non-biological, as well as biological systems. Hayles goes further and identifies the importance of narrative in the process of simulation. The terminology surrounding the evolutionary simulation – creature, fitness, behaviours – has a narrative quality and an 'explanatory' role. The narrative is used to 'make sense' of the simulation and to confer onto the creatures 'themselves' our own 'intention's. These narrative, Hayles states, act as a bond between ourselves as 'analogue' subject and the 'digital' subjects we are becoming. Hayles takes the view that the ubiquity of computational technology means that the identification and acknowledgement of this bond is relevant, in some form or other, to all of us.

But what of the agency of the software itself?

The more commonly held position is that software possess 'secondary agency' and is capable of extending the agency of its creator or operator. However, the software, once 'released' is capable of acting upon its environment and altering it [Mackenzie, Kitchin, Dodge]. This can easily be understood simply by accepting that a software designer or operator may not fully realise the 'affordances' of the code.[1] Its power though is relational - it is a capacity of software rather than a property - and it varies between software, depending on its capacity to mesh with society. Software, is a 'tool in practice' [Kitchin and Dodge].

Digital materialism

Perversely, it is the ubiquity of this digital technology, its presence in our everyday lives, that has contributed to its 'de-materialization' from our collective consciousness. One recent news article about the 'pirate bay', an organisation synonymous with providing peer-to-peer technology that has allowed access to illegal downloading of digital content and which has been the subject of numerous legal challenges, described how they were moving their serves 'to the cloud', in order to avoid further legal disputes by effectively de-territorialising their hardware [REF]. This anecdote is indicative at least of a wider sense of computational technology as being (finally) 'virtual'. The material consequences of digital technology are rarely considered within this mood of hardcore 'future-ism'.

Jennifer Gabrys employs a 'natural history' as both analogy and methodology to describe what constitutes 'Digital Rubbish' and the processes that are responsible for it. She adopts, as a methodological starting point, Walter Benjamin's own use of 'fossils as the sites of study. As Gabrys explains, this allows the investigation to be freed from the conventional and limiting framework, often associated with technology, of 'progress' and 'invention' an instead focus on the "...the ways in which electronic technologies fail and decay." [p7]. Gabrys is looking for a technological narrative that is able to encompass "...complex and contingent material events." [p8] - political, economic and cultural.

This 'natural history' is constructed through conceiving a system of technology that has been dis-assembled - broken into discrete components; the microchip [the processor], the screen [the interface], the plastic case [the container], the archive [the memory]. These components are recognisable the constituent element of any common personal computer, however, they are used by Gabrys at different scales of 'operation' and at different times of 'functionality' - 'the processor' is the seen as result of precise chemical transformations, 'the screen' is that of the NASDAQ stock exchange in New York and the plastic case in understood through the waste disposal site in Guangdong, China on which it ends up. As Gabrys notes though, each of these 'site's are relevant beyond their purely physical description. Gabrys sees the fossil (and by extension, the fossilised site) not as the (conventional) physical artefact, but instead the intersection between all of the processes by which electronic waste is created.

> “[they are]…. temporal zones that register the speed and volume of production, consumption, and disposal of digital technologies." p14]

Rather than seeing them as 'de-materialized technologies' (as they are often seen by contemporary mainstream - see descriptions such as 'the cloud') Gabrys is exploring the consequences of our current condition of 'technological transience' through a process of materialisation and how we must re-assess this condition in light this theory of 'digital rubbish'.

Through the 'fossilized' site of the chip, we see unfold, through the chemical scale, the complex interactions and transformations necessary in the production of processor chip - the process involved in converting abundant silicon into chips, a bodily scale, the effect of these process on the bodies of the workers and the global scale and the ground contamination from the by-products. What is described is the materialisation of the 'Moore's Law' [that the number of transistors on integrated circuits doubles approximately every two years, as stated in 1965 by Gordon Moore, co founder of Intel].In the context of the material processes associated with the mass-scale production of computer chips, this constitutes less a 'Law' or even a forecast and more of an industry growth strategy and for Gabrys it can certainly be

1 A vivid example of 'primary agency' of software, and digital technology more generally, was provided by John Naughton, referring the dramatic effects that digital files and storage have had on the music and film industries. The technology as not designed to have the effect of completely remaking the economic models of these industries, but it possessed the potential, or the 'capacity' to do so.

seen in terms of a 'self-fulfilling prophecy' rather than the prediction of a far thinking visionary. It is certainly a long way from the commonly held, almost 'mystical', interpretation that there is some, as yet, not fully understood, underlying aspect of computational technology that is driving its development in line with this prediction.

> "New economies, together with new arrangements of labour, altered material and chemical inputs, and spatial distributions, help to create the very conditions through which a technology can take hold, persist, and even become seemingly natural." [p31]

The manufacturing processes described here are some way removed from a more broadly understood idea of 'manufacturing', that is as a, perhaps, nested assembly of components and parts. Instead abundant silicon is transformed in a process Gabrys describes as 'material alchemy'. It is hard to understand a chip as an assembly (in a 'conventional' sense) - in terms of the nature of its components and parts (which are perhaps more easily understood as 'ingredients' even?), the scale of the artefact itself, as well as the fact of its apparent 'static' operation (with no apparent ''moving parts'). This is/ was a *new* (mass) form of process, creating a *new* scale of product, that performed a *new* type of function and the opaqueness of each of these aspects contributes to the problem of a digital technology being widely viewed as 'de-,materialized'.

> "Yet the term de-materialised does not necessarily mean "without material" but may, instead, refer to modes of materialization that render infrastructures imperceptible or ephemeral." [p59]

From the 'de-materialised' manufacturing process of the processor, the interface - or 'the Ephemeral Screen' - is approached through the 'fossil' of the NASDAQ exchange ion New York. Central here are notions of scale; firstly, the distributed network of computed transactions that amplify the turnover of material processes and secondly the building itself as interface with performative screens acting as external façade and interior decoration, nested inside global TV broadcasts made from within and without] that throb with the projections of the consequent fluctuations.

This looping transactional process is described to us by way of 'the interface' - the screen, the building. But what really is conveyed? It is not the means of re-distribution and re-configuration - that remains hidden within. Instead it is the abstract consequences, displayed in the form of ticker tapes readouts and bold graphics describing temporal fluctuations - as de-materialised and depoliticised - "the technopresent" [p58].

Gabrys contrasts this mode with the wastes sites of the discarded computer screens and makes reference to media theorist Lisa Parks when describing consumer societies in which the interface for the user the exterior surface of the computer [the screen, the keyboard], whereas for those whose job it has become is to scavenge and recycle the discarded artefacts it is the inside of the machine that has become their interface.

A clear basis for a 'digital rubbish theory' is clearly set out as the process of materialization as understood through waste creating during it rather than the materialization itself [Victor Buchli] [p18]. Furthermore, within this 'theory of digital rubbish' Gabrys makes direct reference to Guattari's Three Ecologies relevant in addressing the multiple versions of ecologies that describe 'digital rubbish';

> "The natural history of electronics developed here draws on these proposals and suggests that one way to develop "sustainable" electronics would be to address the multiple materialities, politics, ecologies, economies, and imaginings that give rise to electronics" [p153]

The end of the HCI – other ideas of interface

These descriptions of the post-humanism subject, our interactions with computational technology and the material nature of pervasive computing, the traditional modes of discussing 'interface' are clunky and inadequate. The discipline of 'Human Computer Interaction' (HCI) operates through an over simplification of feedback mechanisms 'stimulus' and 'response'. They are then 'designed' with a 'typical' user in mind, one that may be susceptible to such modes of feedback. As Matthew Fuller states;

> "...[it] empowers users by modelling them, and in doing so effects their disappearance, their incorporation into their model" [p13]

How then to develop a discussion of interface with specific reference to software. Fuller advocates a move away from viewing software through the lens of HCI, claiming that one of the most interesting aspects of software is that it holds within it new 'models of involvement '- citing the modular nature of UNIX – that can replace previous 'static elements' such as the GUI. Here, Fuller is advocating a kind of 'software methodology', that includes the following;

CRITICAL SOFTWARE - exploring software through its own devices

SOCIAL SOFTWARE - created by and for those excluded from commercial software, and is changed over time by the social interaction of the participants

SPECULATIVE SOFTWARE - the reinvention of software as its own method

Myth of the virtual - the spatial nature of software

The idea of 'software studies', as something distinct from both the broad topic of 'Science and Technology Studies' (STS) and the more specific discussions surrounding 'networked societies [Castells]. Much of this work is focused on the trans-formative nature of network technologies, rather than specific nature and role of software in such processes.

The utilisation of software and technology in the home is now commonplace, without much need to discuss ubiquitous computing. Laptops, mobile phones, televisions as well as countless other devices all commonly are in some way reliant on software.

Thermostats connected to heating systems regulate temperature in the home and are a s simple example of the building itself relying on 'embedded' software to perform as designed. A more complex example would be the Building Management Systems [BMS] that are commonly used in larger buildings. When such systems crash or do not function correctly, the building will not function as intended and may even become unusable. Such buildings are described by Rob Kitchin and Martin Dodge as 'Code/ Space'. [REF]. There proposition is for a form of software studies addresses at software as code and ways in which software is intertwined with 'transduction of space', rather than merely being present in it.

> "Code/ Space occurs when software and the spatiality of everyday life becomes mutually constituted, that is, produced by one another."
>
> [p16]

The relationship between code and space is therefore not 'deterministic', rather the it is symbiotic.

They make a clear distinction between 'coded space' and 'code/ space', defining coded spaces as spaces where the presence of code makes a difference but it's relationship with space is not 'fundamental'. One example they give is of the use of power point to present to an audience. 'Code/ spaces' can be identified where the presence of the code is required for the space to perform as designed. A simple example of a code/space is could be any space with digital environmental control mechanisms.

In architectural design terms, the feedback loops governing the day to day functioning of the building also operate across a larger scale. Certain aspects of the 'material' design are influenced by the management capabilities of the software For, example, the options for the user to open windows or the depth of the floor plan itself are both tied to the 'built-in' digital technology. In this way, the notion of 'code/ space' can be extended beyond the 'performance' of the space, but the process though which it (and its simulated performance) is designed in the first place. The extension of the principles of code/space to include 'simulated space' is important in developing a strand of software studies that can applied to both 'architecture' and 'architectural practice'.

Section 3

Digital traces – ALGORITMS and CODE

Software As Code

TEXT

Code And Space

TEXT

Algorithms As Stable Code

TEXT

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