

Computers as invocational media

Thesis submitted towards the degree of Doctor of Philosophy

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Summary

This thesis argues that computers are invocational media. It shows how this technological lineage can be defined not only by the power of computation, but also by the power of invocation — storing, generating and recalling images, sounds and simulations. Drawing on Deleuze and Guattari, a wide literature on computer, medium theory and actor-network theory, it argues that invocational media are based on the ‘genetic element’ of invocation. The cultural practice of invocation, which has an ancient heritage, mixes command and memory to produce decisions. Invocational media not only answer calculations; they also invoke any number of dynamic new media environments. Summoning concepts from cultural milieux, they have been called on to invoke (among other things) ‘intelligence’, ‘life’ and even ‘reality’.

Invocational media are as significant as previous historical transitions in media technology. If television brought secondary orality (Ong), invocational media bring *n*th oralities: chat, queries, e-mails and ICQ. Although technology has displaced conventional magic, tropes of magic recur in technology’s cultural imaginary. Invocational magic is domesticated and commodified. Hobbled together from surveillance, spectacle, command and control technologies, its powers are conditional. Users must answer ‘avocations’: standards that condition everything that is invocable. Invocational aesthetics are distinctive. Disregarding the computational aesthetics of pure mathematical form, users appreciate the emergent qualities of the invocational aesthetic: playable games, responsive interfaces, and immersive experiences. Everywhere, invocations are polyvocal, calling to wider assemblages. Hyperlinks combine technological systems, textual conventions and mediations of social commitments in producing invocationary speech acts.

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Computers as invocational media

*I hereby certify that this thesis has not been submitted for a
higher degree to any other University or Institution.*

Christopher Bradford Chesher

Introduction

This thesis introduces and develops the concept that digital computers are invocational media. The invocational assemblage, with its inputs, outputs, processor and memory, is a distinctive meta-media form characterised by the capacity to *call up* numbers, texts, images, sounds and movements. The concept of invocation connects the technical features shared by the diverse range of digital computers developed during the second half of the twentieth century with the cultural practices that emerged around them. I will demonstrate that this concept captures the technocultural lineage of ‘digital computers’ better than other approaches.

The generic term ‘interactive digital computer’ has outgrown its usefulness. All three words in the phrase are problematic. Each of the terms has a forgotten history, leaving not only redundant, but confusing meanings.

First, virtually all computers built after the mid 1970s are ‘interactive’.

Interactivity is where ‘the user is connected directly to a central computer in such a way that transactions are performed directly in response to the commands made by the user’ (Chandor 1987: 248–249). This distinction was meaningful when it distinguished interactive systems from batch processors. In non-interactive systems users had to prepare their jobs away from the computer using, for example, punch cards. The personal computer was never anything but interactive, so the inherited term went on to take on a number of more or less useful meanings (Schneiderman 1986, Carroll 1991, Monk 1984).

Interactivity is a hidden anthropomorphism, suggesting that the machine is an ‘other’ with whom the user engages. It also suggests a turn-taking interaction typical of command line interactions. The range of ways users engage with computers is not usefully captured by the term ‘interaction’.

The term 'digital' is based on an even older distinction. In the 1930s and 40s it distinguished between two quite different approaches to building a computing machine: analogue and digital. Analogue computers, such as the mechanical Differential Analyser built at MIT, had some early success. Analogue computers used continuous voltage or mechanical variations to perform calculations. At an early stage these were faster and cheaper than digital computers. In the longer term analogue computers proved more expensive and less versatile, so the basis of virtually all computers since the 1950s was digital (Kempf 2000, Ceruzzi 1983).

When no longer in opposition to 'analogue computers', the term 'digital computer' becomes not only redundant but confusing. Computer discourse has been responsible for a lot of mystification about the distinction between analogue and digital systems of representation. Digitality is not exclusive to computers. It refers to systems of communication based on discrete values and pre-defined codes, rather than on continuous variations along continua. Digital codes include written language and mathematics — which existed long before computers. Digital elements (characters, phonemes) are always intermixed with analogue elements (gestures, facial expressions), and analogue variations are often described digitally (weight is expressed in kilograms or pounds).

Hence, only part of the so-called digital computer operates with digital logic — the central processing unit (CPU) and memory devices. These components automatically reify principles and procedures developed in the Western tradition of mathematics and logic, all of which use discrete values. Even here, the computer's operations are not actually digital, but rather digital readings of analogue variations of high and low voltages. What makes a digital computer different from a mathematician with a piece of paper is that its operations are automatic, very fast, and not directly observable. Sequential variations in

voltage run through specialised components to perform logical and arithmetical transformations and hold these as electrical and magnetic states.

The digital operations internal to the circuitry are effectively immaterial without the other half of the machine — input and output devices — which use analogue representations. They operate by capturing and expressing analogue variations: key strokes, mouse movements, pixel brightnesses, speaker vibrations, robot gestures etc. Digital computers in many cases work as well or better with analogue information (images, sounds, movements) than analogue electronics ever did. The digital parts of the machine create an intensively charged gap between the analogue events of input and output. The results they generate appear as if by magic as effects on output devices.

The most significant capacity of computers is to transform inputs imperceptibly and automatically into complex, delayed and sometimes unpredictable outputs. The analogue parts of the machine — inputs and outputs — generate and express the digitally encoded information. This arrangement effectively separates digitised content from its material expression. Content is called up almost instantly, at random, often transformed through dynamic interplays between data and instructions. Symbols stored in the past, or sensed at a distance are duplicated, mixed, recombined and transformed in real time.

The picture I've given so far is uncontroversial, but surely these operations are more than 'computation'. Indeed, the term 'computation', itself, is misleading. These devices do much more than *compute*. Even if a computer's operation always involves processing numerical and symbolic values, the term barely captures what they do in practice. It does not encompass the diverse range of actions these devices perform: simulation; textual and media production; gameplay; global networking; and so on. The term 'computer' itself was not

even accepted until the mid 1960s. Before that 'calculator' and 'robot' or even 'electronic brain' were equally appropriate alternatives (Barry 1993).

There is no shortage of specialised terms to describe particular systems of software and hardware — information processors, simulators, databases, word processors, desktop publishing systems, flight control systems, image manipulators and so on. Some in the field make even stronger claims for the capacities of computers: artificial intelligence, artificial life or virtual reality. The concept of 'interactive digital computation' can hardly bear such an accumulation of loaded metaphors.

Even though computers have so many faces, and such a useless name, everyone who knows a bit about them has an implicit understanding that these machines are similar to each other in some fundamental way. They share a 'computerness'. But there is no single term that adequately captures what is common to all digital computers. This term should refer not to what they are made of, but to what they do and how they do it. When a computer is operating, it is constantly repeating a cycle of fetching and executing instructions. This process is also usually described in inadequate terms: processing, computing, executing, running. But among the terms used in computing, though, one is particularly resonant: invoking.

'Invocation' is a reasonably common term in information technology discourse. Some programs are said to run 'in the background' until they are activated with an invocation. This kind of program is known evocatively as a 'daemon' (Sun 1996). For example, the program 'talk' in the UNIX operating system uses a daemon which lies dormant until another user invokes it. It then springs to life, interrupting the user to request a screen-text conversation. In the programming language JAVA, 'remote method invocation' allows a program running on one machine to communicate directly with another elsewhere on the network (Sun

Microsystems 1995–2000). Beyond these specialist meanings, it is legitimate to consider anything a computer does as a form of invocation.

Therefore, I propose that the systems usually known as ‘interactive digital computers’ are better conceived of as ‘invocational media’. It may seem strange that this ancient magical practice is recurring as a trope in the hypermodern domain of electronics. Most people use the term differently. But I will argue that this concept, which has been hidden within computer discourse, can now be brought out and used as a very productive concept. Until now computers have been unable to reveal their own distinctiveness. They have instead masqueraded as other things: artificial intelligence, virtual reality, desktop publishing and so on. As invocational media their distinctiveness is revealed more effectively. Each of these examples can be considered a medium in its own right, because each invokes something different (behaviours; spatiality; documents), but all are invocational.

All new media begin by hiding themselves behind something that already exists. In his book *Cinema 1*, Gilles Deleuze (1986) says it took some time before theorists could become aware of what cinema was and how it worked. Cinema hid its ‘essence’ (the cinematic image) for many decades.

We know that things and people are forced to conceal themselves... when they begin. What else could they do? They come into being within a set which no longer includes them and, in order not to be rejected, have to project the characteristics which they retain in common with the set. The essence of a thing never appears at the outset, but in the middle, in the course of its development, when its strength is assured (Deleuze 1986: 2–3).

The same is true for invocational media. They have always hidden themselves, sometimes as electronic brains (Berkeley 1949), fancy calculators, big brothers, information processors, information appliances, and virtual realities. It is now time to find something like an ‘essence’ behind all these metaphors. We need

more precise historical concepts than 'information revolution'; 'digital economy'; and 'computer age'. What can connect and make some sense of all the disparate conceptions of the computer? What do all computers really have in common?

Digital computers are an electronic manifestation of a far older cultural practice: the invocation. An invocation is an event that begins with a call, and ends with a becoming. An invocation is when some entity calls on another entity to execute a task. It is a point of decision that delegates a task to something outside the subject. It is characterised by a power relation and a language act. The digital computer is a media form characterised by its capacity to mediate invocations.

A traditional invocation summons up support, guidance, inspiration or memory. Invoking is 'to request (to "call upon") God, or some other authority, to be present and to lend authority to a process or deliberation' (Vanderveken 1990). An invocation presumes that the speaker has some special access to the invoked entity. It attempts to delegate some work or responsibility to another. While it resembles a command, it is an uncertain or respectful request rather than a demand. There is often some doubt about whether the request will be granted. An invocation is not a direct call for more power to the self, but a call for knowledge, assistance or authorisation from another.

Most genealogies of computers trace the computer's genesis to traditions of symbolic abstraction: mathematics, physics and engineering (Randell 1982). I think it is equally productive to look to a wider range of cultural practices including techniques and technologies, language, and magic. I will show (especially in Chapter Three) that computers are far from historically neutral or objective scientific instruments. For one thing, their development depended on huge investments from military and corporate institutions. The design of the machine, which in retrospect seems inevitable, and even natural, is actually

quite contingent. The shapes, applications and the terminology around computers were conditioned substantially by where and when they were created. More fundamentally, invocational media emerged from a desire and a will for a certain type of command over the world.

Computers developed as an extension to what I call *invocatory devices*: technologies which perform named actions on the world, reducing the effort and uncertainty involved in achieving a desired goal. The lever is a basic progenitor of mechanical invocatory devices. It reduces the effort required to move an object, but ties the action to a fulcrum. The button or switch is a modern refinement, which is more abstract than the lever, since its effect is less determinate (see Chapter Seven). Switching on an electric light instantly reveals an area that had previously been in darkness. With less effort than it takes to say 'Let there be light!' there is light. The light switch is a device which functions as an extension of language into the world, it performs as a statement: an invocation, that has material and cultural effects. Although light switches are usually taken for granted, the form of command they offer recalls language (asking someone to light a candle), social power (delegating the task to a lower ranked person) and even magic (using secret methods and materials to create an effect).

Invocatory devices are often joined together in complex networks. An apparently trivial event can depend upon very extended but largely invisible systems. The everyday act of switching on a light is possible only with a massive infrastructure of electrical generators, transformers and wiring that connect the switch to a power grid. It works only because a light bulb manufacturer, electricians, and engineers have done their jobs. Even before invocational media, the proliferation of various forms of invocatory device, including electrical lighting, had already changed daily life. McLuhan argues that the electric light is itself a form of media, but the 'content' of electric light includes the activities

that it makes possible: night baseball, brain surgery etc. Without the lights, these cultural forms would not happen (1987: 8).

But as well as what goes on under lights, the act of switching itself is significant. Think of the ceremony that sometimes accompanies turning on Christmas lights, or officially lighting a building or a bridge. Or the magical moment when a spotlight reveals a performer on stage. Or when a light betrays two lovers hiding in the dark. The instant of an event of revealing has its own special intensity. It is a decisive invocatory moment, when a single invocation transforms the situation.

When they are first invented, invocatory technologies appear to be magical. The nineteenth century experiments with electricity were as much associated with mysticism as with science (Marvin 1988). A light switch gives command over darkness: a marvellous capacity to make light at will. An invocatory device puts a part of the world at the user's command. It reliably calls up a certain effect with a minimal effort. People make delegations to invocatory devices in the faith that they will be answered.

Over time invocatory devices become an unremarkable part of the background of everyday life. The emergence of a technically-charmed world has a dramatic impact on what it is to be human. Sigmund Freud argues that in modern society, technology comes to perform the social and psychic functions of religion and magic.

...by his science and technology, man has brought about on earth... an actual fulfilment of every — or of almost every — fairy-tale wish (Freud 1995: 737).

Freud argues that modern technology makes man into a 'prosthetic God' (Freud 1995: 738) (see Chapter One, p.72). McLuhan echoes the concept of prosthesis with his analysis of media as 'extensions of man' (McLuhan 1964). But the concept of extension does not quite fit computers. Invocatory devices are not so

much prosthetic as para-linguistic resources. They extend the voice before they extend the limbs.

An invocation is expressed through some kind of voice (where a *wish* can be purely mental and silent). Of course levers and buttons are not literally voice-activated, but they are technologies becoming language — they offer themselves as clauses, waiting to be voiced. Using a door bell or a light switch creates a proto-language which composes an invocatory sentence. A door knocker can produce the statement: ‘I [person at the door] request entry to this house,’ and reduce it to a gesture.

The connection between computers and the voice is apparent in the long-held aspiration for voice controlled computers. From HAL in *2001* to IBM’s *Dragon Dictate* people have imagined having literal vocal command through invocational media. In invocational media, as in poetry, the presence of the voice is central:

For as the etymology of invocation suggests, the essential feature of the poet’s calling upon a presence is his *vox*, his voice. This voice is at the very centre of what we call invocation (Schindler 1984: 7).

In practice, invocational media mostly operate using different forms of voice. Invocational practices often recall speech in a more abstract way. The theory of invocational media belongs within a tradition Deleuze calls vocalists: ‘anyone doing research into sound or the voice in fields as varied as theatre, song, cinema, audiovisual media...’ (Deleuze 1990A: 28) The emphasis on sound may seem strange, particularly when many computers don’t generate much (intended) sound at all. Invocational media operate entirely through ‘calls’, even if they are not heard by human ears. Programmers invoke calls to subroutines, peripheral devices and remote services. Interfaces offer a silent call and response — a command entered on the keyboard is answered by an image on screen. The

Internet mediates a proliferation of voices through news groups and e-mail. There is actual sound, too, with synthesisers, MIDI and samplers forming a minor but significant history in music and sound generation. Video game playing is primarily a rhythmic, rather than visual practice. Even the clattering of data entry keys becomes an auditory performance.

More importantly the theory of invocational media is 'vocalist', because it rejects the usefulness of thinking about computers outside of time and context.

Computers are most often associated with a dominant formalist and representationalist tradition. This approach talks about computers and software as abstract objects with properties. Objects, functions and even users are static, unchanging, decontextualised (Agre 1997). Formalist approaches are brittle, whether they are in structuralism in humanities or computer science. As formalist approaches break down in the Humanities, 'language is coming to be seen as an activity, so the abstract units and constants of language-use are becoming less and less important' (Deleuze 1990A: 28). In the theory of invocational media abstract units within computers are less important than the events mediated through them (see especially Chapters 6 and 7).

The relationship of invocations to time is significant. They are always made in the present, but open to the future and draw from the past. They are more pragmatic than a *prayer*, but less direct than a *command*. They call on immediate assistance from another.

The invocatory voice of buttons or keys is not always answered — many of these devices are unreliable. An electric doorbell can be faulty. A light bulb may be blown. There may be a black-out. There is always a possibility that an invocation may be unfulfilled. As the degree of invocatory abstraction increases, users gain more power, but lose direct control. They come to depend entirely on the infrastructure that allows them to articulate the invocation. This dependence

is part of what Heidegger fears about modern technology. As we will see in Chapter 1 (pp. 55–65), he claims it changes the nature of being, and hides a deeper truth.

Invocatory devices can be very complex. Some perform a whole set of actions, becoming part of a quasi-language system. Piano keys, typewriters and morse code sets are invocatory devices that demand that users learn both complex motor skills and language systems. They attach to existing systems of written language or musical notation. The individual switch becomes meaningful as one part of a larger system of switches. A single piano key is part of a system of notes available to the trained player who can use it to invoke music. By extension, the key is part of a much larger technical and social network that comprises written music, piano lessons, piano manufacturers, musical genres, ways of listening and so on.

Invocational media develop as a kind of hyper-extended invocatory device. Where an invocatory device invokes a single, named effect (ringing a door bell, turning on a light, playing a note), invocational media insert an interval of indeterminacy between a user's invocations and the invoked effects. The user's command is delegated to a specialised component, the central processing unit, and is stored up in memory devices (see Chapter Four). The decision that invokes the output from that command is deferred, sometimes for milliseconds, and other times for an extended period. The CPU and memory separate input from output, opening up the invocational space for quasi-linguistic computer languages which articulate complex logical and arithmetical transformations and conditional effects. This move from single invocatory effects to invocational sequences fuses command, memory and decision to create the general purpose computer. Beyond this threshold these devices become invocational media.

While the primitive invocation is simple in itself, invocational media come to mediate a huge range of events. The software-controlled invocational assemblage invokes any number of media forms and genres. The invocational sequence is a dynamic cycle that switches between the central processor and memory devices: the fetch-execute cycle. The CPU commands data from memory to produce decisions. Within this cycle, invocational media have a distinctive relationship with their cultural and physical surroundings. They are open to the world through input devices like keyboards, cameras, microphones and so on. They manifest text, images, sounds through outputs such as screens, speakers, controlled mechanical interfaces. These operations are sustained through cycles of fetch and execution, invoking read and write operations, branchings and arithmetical and logical transformations.

This technical arrangement makes invocational media quite distinct from other media forms. For example, the material basis for print media is serial duplication of textual marks on paper. Technologies which extended this material practice were part of substantial and well documented cultural changes with writing and printing (Eisenstein 1980, McLuhan 1962, Ong 1982). A set of cultural practices emerged around printing during the 17th century to create what would become the first modern media form: the newspaper. This practice grew through a combination of generative forces: it developed a sustainable economic model (advertising and sales), textual conventions (columns, news values), professional vocations (journalism), and audiences (growing urban populations). Although the scale and conventions of this activity changed, marks on paper remained the material basis of the form.

Invocational forms are also very different from another media form that dominated twentieth century culture: broadcasting. Broadcasting operates through a synchronous radiation of images and sounds in radio waves. As Raymond Williams argues in *Television: technology and cultural form* (1975), the

technical form of that medium did not simply determine how the culture would take it up. The technical and material basis of broadcasting did constrain and direct the range of possible configurations. It helped create an economic crisis based on the contradiction between centralised transmission and privatised reception (30). Two models of broadcasting, government and commercial, emerged as the (non-technical) solution. Each created a slightly different mix of programming, content and relationships to audience.

Invocation is the genetic event from which all computerised events are built. That is, cultural practices involving computers mobilise invocations as very pliable but distinctive units of force. The lowest order invocations are the equivalent of phonemes in spoken language — individually meaningless, but fundamental to communicating. At higher levels, invocations perform quasi-magical transformations: generating visions, revealing things unseen, carrying messages and any number of similar actions. The invocational ‘essence’ does not transcend the set of components that comprise computers and the networks in which they function. It is not the components, but the diagram: an abstract relationship between components that makes invocations happen.

In principle, computers are ‘universal machines’. Turing proved that with unlimited time, any universal Turing machine could simulate any other Turing machine (Turing 1965). But who has unlimited time? In practice, computers are always *particular* invocational machines. Invocations must be answered in real time. They have to be phrased in culturally familiar terms. They must offer outputs that are meaningful to users. Each invocational form is only a subset of the infinite set of possible Turing machines. They have a capacity to produce immediate outputs which have wider cultural meaning. A theory of invocational media has to combine an analysis of the basic invocational event with the empirical historical contexts in which the medium developed. The

cultural history springs not from twentieth century mathematics and engineering, but from the huge scope of western (and ultimately global) culture.

The myth of the Muses provides the strongest archetype in the western tradition for the invocational relationship (Bulfinch 1993). In looking to the Muses, though, I am not seeking a parable as much as a diagram. I don't want to reach a moralistic conclusion about the promise or danger of computers. Rather I want to develop a conceptualisation of computers as a historically distinctive technological and cultural form (Williams 1974). It does not matter who is invoking, or who is invoked to identify the cultural form of invocation. Events of invocation are distinctive, irrespective of the subject and object involved. But the Muses are a useful point of departure.

There are some interesting parallels between Muses and computers. For one thing, the Muses were notoriously unreliable. The Muses had a bad reputation and could be quite vindictive. In *the Iliad*, when Thamyris, an accomplished minstrel, arrogantly challenged them to a competition, they accepted his challenge. In their vengeance at defeating him, they took out his eyes and 'robbed him of his divine power of song, and thenceforth he could strike the lyre no more' (Homer 2000A). Sometimes computers seem to be equally unforgiving. The failures and potential failures of computer-controlled equipment are notorious — from fly-by-wire aircraft crashes (Stowe 2000) to the feared impact of the year 2000 (Y2k) bug.

Other writers on technology have tended to use Greek myths as parables to analyse the contradictory human relationships with computers. The Promethean myth offers a moralistic story about the dangers (and powers) of technology. Prometheus gave men fire, and was punished for it by Zeus. This myth is interpreted as either a warning about the dangers of technology and the over-reaching of man, or it is inverted as a celebration of human Enlightenment

(Davis 1998: 14). The worst effect of man getting fire was that it gave him unrealistic hope — an aspiration to the powers of gods (Barney 2000).

Hermes is another mythical figure to whom writers sometimes refer (Levinson 1997: 51; Davis 1998: 14–18). Hermes offers a romantic image that appeals to the sensibilities of computer hackers: ‘... god of speed and deceit, of communication and thievery’. Drawing an analogy with Hermes sees computer programmers and users as tricksters: cheekily subverting power through guile and wit. While this is appealing, it is relevant only for marginal uses of computers. While countercultural applications of invocational media sometimes have a high popular profile, the dominant uses of computers are conservative. Computers are most significant in terms of social power when they are used within business and government. ‘Hactivism’, Internet art and cybershamanism are fascinating cultural phenomena, but their political significance is easy to overstate.

Computers, though, are not *big* technologies like dams, jet aeroplanes, hydrogen bombs, or rockets. It is significant, then, that the Muses were ‘inferior deities’ — they didn’t have the direct power of Uranus (the sky), Cronus (time) or Zeus (command) (Murray 1954). Muses lent support to humans, mediating their perceptions and understandings of distant and past events, assisting by presenting images or sounds. Sometimes they connected with other gods to invoke more powerful effects. Like angels in the Christian tradition, they were intermediaries who assisted, channelled and interceded with powers of communication (Serres 1995). Although their effects were largely immaterial, Muses were powerful cultural catalysts and accelerants.

The Muses were the patron goddesses of poets, historians, musicians and artists, who depended on them for inspiration, knowledge and guidance. They helped advance civilisation — hence the terms ‘museum’ (seat of the Muses) and ‘music’ (art of the Muses). Ancient literature, including Homer’s *Iliad* and

Odyssey, are told as invocations to the Muses (Homer 2000A, 2000B). Storytellers and performers in Greece, and again in Classicist movements, invoked Muses for wisdom, knowledge and inspiration.

It is appropriate, then, that many contemporary cultural practices are becoming mediated through invocational media. The ancient Muses may be gone, but invocation has returned as a cultural form. Print, audio, video and cinema are increasingly produced using invocational systems. The cultural record is being digitised as libraries and museums create huge databases of text and multimedia. In changing the means of producing, recording and accessing cultural records, though, invocational media are doing more than providing more efficient techniques. I will argue that the invocational Muses herald more significant change. These changes cannot be reduced to 'effects of computerisation', because they are overdetermined, and ultimately escape reductive analysis. Addressing the 'impacts of computers' requires not only a new set of terms, but a different theoretical approach.

Doing a PhD in Media Studies/Cultural Studies

Approaching the task of writing a Doctoral thesis in Cultural Studies and Media Studies at an Australian University subjected me to contradictory pressures. On the one hand, I am bound by quite strong disciplinary formations within the University. On the other, my tradition has trained me not to accept these kinds of pressures and constraints as natural. But even if my Cultural Studies project hopes to challenge institutional authority, or move outside conventional intellectual practices, as a student and an academic, I am always bound by University regulations. As Stuart Hall points out, there is a difference between intellectual work and academic work, even if the two do overlap (du Gay et al 1997: 274). In writing a thesis the academic constraints are traditionally kept

outside the *intellectual* work. The writer of a thesis is expected to pretend that these are outside the work, and don't matter to the intellectual project.

Therefore I had to find a way to negotiate some of these paradoxes about the position of the thesis as both an academic *and* an intellectual project. As an academic project the thesis is bound by the general constraints of the genre. The PhD is a form that implicitly re-affirms the legitimacy of the institution. It has a set word length; a limited time frame, and it has to fulfil a set of University guidelines. The phraseology of a set of PhD guidelines usually tries to be humanistic and accommodating of the differences between disciplines, but it's basically a contract. For example, the University of Melbourne handbook on the web reads:

The degree of Doctor of Philosophy signifies... the holder has undertaken a substantial piece of original research which has been conducted and reported by the holder under proper academic supervision and in a research environment for a prescribed period. (University of Melbourne 1999)

As a candidate for the admission to the degree of Doctor of Philosophy at Macquarie University, I am bound by rule 3.5:

In the case of the degree of Doctor of Philosophy the thesis must form a distinct contribution to the knowledge of the subject and afford evidence of originality shown either by the discovery of new facts or by the exercise of independent critical power (Macquarie University 2000).

In finding an approach to fulfilling these requirements, while also working within on an intellectual project in the Cultural Studies tradition, I needed to negotiate a tension between specialisation and interdisciplinarity. There is a long-standing pressure on PhD students to narrow their methodological and empirical fields. The PhD, first awarded in the nineteenth century, is a credential used by Universities to establish their authority. Although the University of Bologna granted the first doctorates in the twelfth century, the

PhD became a universal signifier of academic authority only after Yale in the US took it up in 1860. Yale took the idea from the German 'new university' of the late eighteenth and early nineteenth century. This blueprint for the modern University is usually attributed to Von Humboldt. It is this vision that encouraged a tendency towards specialisation. Knowledge was partitioned into Disciplines, which corresponded to University Departments and Schools. Over time, PhDs at Universities created an increasing number of specialists in an ever narrowing range of fields (Gellert 1993).

A PhD is attractive because it seems to promise academic independence and critical thinking. But as Ian Hunter (1997) points out, there is a hidden dogmatism behind the imperative to have a particular kind of critical position. The modern university can be almost as rigid as the system that preceded it: religious education, which taught known truths. The capacity to perform as a critical scholar is, paradoxically, a condition for *conforming* to institutional requirements.

The PhD is built on a particular conception of knowledge heavily influenced by Immanuel Kant. In the Kantian schema, a philosopher has a special access to knowledge. Dividing the world into noumena and phenomena, Kant creates a special role for those trained to distinguish the two. The Doctor can tell the noumena — 'things in themselves' from the phenomena — 'appearances' (Hunter 1997: 44–45). The title 'Dr' indicates that the holder has undergone a philosophically diagnosed transformation of subjectivity. The credential is evidence that the Doctor's knowledge transcends that of the average citizen. Lyotard refers to this as 'speculative knowledge' (Lyotard 1984: 31–41):

True knowledge, in this perspective, is always indirect knowledge; it is composed of reported statements that are incorporated into the metanarrative of a subject that guarantees their legitimacy (Lyotard 1984: 35).

Most Cultural Studies PhDs would hesitate before claiming any privileged position as a Kantian rational observer, or a possessor of 'speculative knowledge'. One of the main tasks of Cultural Studies is to resist and critique special claims to knowledge based on credentials or privilege. So it puts PhD students in Cultural Studies in a paradoxical position. As an academic I have little to gain by confronting these political or ethical paradoxes directly. To be consistent I would have to refuse my degrees and quit my job. Short of this, Cultural Studies academics need at least to address how these contradictions impact on the epistemological and stylistic issues of writing a PhD. Anyone writing a PhD in this area needs to find a way to become a specialist in not being a specialist.

Cultural Studies grew, at least partly, out of the adult education movement in the UK in the 1930s and 40s (Canaan and Epstein 1997). The early writers in the tradition were not subject to the same pressures for specialisation as many academics in Universities. Since then Cultural Studies writers have taken on a range of usefully awkward positions within and outside the Universities in the UK, the US, Canada, Australia and elsewhere. If the tradition is distinguished partly by its attention to the relationship between knowledge and power, as Larry Grossberg (1997) argues, then any cultural studies thesis should first account for its own position as a truth claim, and its force as a performance that admits the writer to a position of authority. But how is it possible to do this without just adding a disclaimer to the first chapter?¹ I think it begins by finding some new answers to some very basic questions.

One of the key conditions for a PhD is that the thesis should make an *original* contribution to its *field*. If the author really is dead, then it seems presumptuous

¹ In a Cultural Studies conference in 1994 at the University of Technology, Sydney, Noel King observed that cultural studies academics often make ritual apologies at the beginning of their conference papers.

for a Cultural Studies academic to claim originality (Barthes 1977: 142–148). The concept of original contributions is modernist, essentialist and elitist, clinging to the questionable authority of the privileged speculative position. If meaning-making is a social activity, embedded in its milieu, authorship can only be partial at best. A claim to originality cannot be offered transparently, but needs to be justified, qualified and positioned. As Lyotard observes, there is a ‘decline of the unifying and legitimating power of the grand narratives of speculation and emancipation’ (Lyotard 1984: 38). The work must stand on its own, and not claim the privilege of the speculative position by relying on a myth of transcendent originality.

The second part of the phrase also presents a problem for Cultural Studies. You can’t assume that *the field* exists prior to the work that constitutes that field. The field was no problem for Von Humboldt. He assumed that the world existed whether it was observed or not. His disciplines divided the world into fields that could be examined in greater and greater detail. So originality was possible by becoming a specialist in some neat corner of a field with straight furrows surrounded by nicely trimmed hedges. Sociology began as a science which assumed that society existed as an object of study like any other. Politics was confident that there were political institutions. English Literature chose poetry, novels and other literary forms, and in the main continues to work with these forms before other texts. Cultural studies resists the faith that the world is simply out there in the same way. Any claim to knowledge is first an act of power. Every project needs to define its own grounds, which do not exist before the work makes them. Every work needs to account for the function that the ‘observer’ is playing. The field is made and remade, never simply found.

The problem of finding an effective strategy to write a thesis in Cultural Studies was compounded when I chose an object of study: computer media in general. I took on an enormous task. The number and diversity of actual computers in

operation is itself unimaginable. There is also a huge amount of intellectual work on computers, and their 'social aspects'. Philip Agre at UCLA recently compiled a list of books on computers and culture. It numbers in the hundreds even in the past two years (Agre 1994–2001). Overall, the field of computers and culture is very large, and very rapidly changing. In spite of this abundance of material, I found there was no literature that defined to my satisfaction why computers are distinctively different as a media form. However, I needed a way to make this project into a manageable task suitable to the PhD genre.

In many ways it would have been easier to set geographical, historical, textual or technical boundaries to my research. I did find some areas I liked, and some gaps around them where there was plenty of space for a thesis. I considered doing a cultural history of Apple user groups in Australia. I could have done an ethnography of an organisation going onto the web in the spirit of Shoshana Zuboff's (1988) *In the Age of the Smart Machine*. I could have worked with the Computer Museum Society to write an Australian-focussed history of computers like Joel Shurkin's (1996 [1984]) *Engines of the Mind*. I could have used a traditional Cultural Studies approach to look at the laptop or palm computers in the way some have taken on the Sony Walkman (Chambers 1990; du Gay et al 1997). Any of these projects would probably have worked.

The problem with this kind of approach for me was that it would tend to accept existing categories too easily. The field of information technology is already striated by layer upon layer of loaded but rarely questioned metaphors (see Chapter Six). I had already explored the promises that virtual reality advocates had made about a technology that they claimed would literally replace experience itself (Chesher 1993). I knew too well that working with computers means living by their metaphors: file tree structures, word processor pages, spreadsheets, e-mail clients and Internet browsers. All these metaphors are highly loaded, and each has its own little history. But I didn't want to choose

one or two of these to analyse. Rather than deconstruct existing metaphors, I wanted to do some work on constructing an alternative concept.

So what do I want to claim about my thesis? What is my field? What is my claim to originality? How can I keep open a piece of writing that is itself a part of systems that operate always to close things off? How can I take on an enormous empirical 'field' and a huge range of literatures that relate to it, and still create a cohesive, self-contained and useful work on computer media?

My contingent solution, my experiment, is to approach creating the thesis as a task of creating and developing a new concept. This is how I can address how computers are different. As I said in the introductory passage, I want to identify what in computers inheres across all their manifestations — from the smallest microchip to the fastest supercomputer. My thesis is structured around elaborating this concept. In this way I can avoid rewriting a history of computers, a sociology of their development, or a philosophy of their significance, while partly doing each of these.

The approach this thesis takes to invocational media could only really work within a discipline like Cultural Studies or Media Studies. In the main, Computer Science develops concepts and techniques that can be applied directly to programming. Many of the social sciences tend to read computers as part of larger processes (society; psyche; textual form). Philosophy is a powerful tradition, but tends to avoid historical and empirical specificities in favour of the universal, or at least the highly abstract. Among all the approaches, Media Studies and Cultural Studies are particularly well positioned to address this theme. They are inherently interdisciplinary, and can draw from a wide range of materials, but they have enough stability to form a cohesive platform on which to create the concept of invocational media.

What is a concept?

I have been using the term 'concept' in a precise sense borrowed from Deleuze and Felix Guattari's *What is Philosophy?* (1994) In this book, which is the last they wrote together, they look back on their past work to distinguish philosophy from science and art. They base the distinction on what each produces.

Philosophy creates concepts (15–34). Science, by contrast, is a totally different creative activity, and works by laying down grids, working with *functions* on planes of reference. Art does something different again: it extracts and preserves *percepts and affects* — virtualised sensations.

The concept of the concept was appealing to me because it avoided the assumption that knowledge was simply about accurate representation. The job of philosophers is not to create an accurate representation of a world or truth outside, but to create concepts that intervene in the world. Philosophy is not a contemplation of universals or a precise description of truth, but a distinctive creative activity in its own right. To say that philosophy creates concepts might seem obvious, but it is important because of what it avoids. It does not partition up knowledge according to territories that each discipline must cover. It does not claim there is a truth out there that thought or language simply refers to or describes. On the other hand, it is not a radical relativism that claims that anything is possible and all things are equal.

Prima facie, a typology which divides all thought into three disciplines seems elitist, reductive and incomplete. But this is not the case if, unlike the traditional Disciplines, the boundaries are never policed. Deleuze and Guattari's typology doesn't proclaim a regime that will exclude each discipline from the territories of the others. Instead, it defines how different kinds of creative intellectual work are distinctive and unique. They are creative practices that are irreconcilably different from one another. Science, philosophy and art are not just different points on a continuum, but fundamentally different and (at least potentially)

equally creative tasks. Unlike the Disciplines based on Kantian philosophy and Von Humboldt's bureaucracy, Deleuze and Guattari's tripartite distinction will never correspond with University departments.

Cultural Studies isn't Philosophy in the Kantian sense, but it is useful for me to claim that it creates concepts. However, its concepts are not philosophical concepts. Unlike Philosophy, Cultural Studies concepts are specific to certain milieux: to times and places — they make no claim to being universal. *What is Philosophy?* is not a rigid proscriptive schema, but a sophisticated self-reflective performance. Deleuze himself makes the analogy that his work involves taking philosophers from behind to produce 'monstrous offspring' (Deleuze 1995: 6). Cultural studies concepts are another such encounter.

While Deleuze and Guattari offer some powerful tools, at times their work grates in a Cultural Studies ear. Their terminology is sometimes loaded (this is exacerbated by reading the work in translation). For example in *A thousand plateaus* the concept of the 'war machine' is presented as synonymous with 'nomadism' (Deleuze and Guattari 1987: 351–423). While the concepts are actually very useful, the terminology is highly loaded. A war machine connotes military industrial complexes, while 'nomadism' has associations with a rather romantic image of exotic cultures and the noble savage. Neither of these connotations are useful to understanding the concept, which positions the war machine as a mode of organisation that works in relation to state or 'royal' power (364). In spite of this, the concept is ultimately useful in developing a critique of that pivotal relationship between knowledge and power.

Cultural Studies is also different from Philosophy because it makes close reference to geographic and historical objects, events and phenomena. This would make it like Science, but it certainly is not pure science in the *What is Philosophy?* schema (Deleuze and Guattari 1994: 117–133). Science seeks to slow

down phenomena, and to plot them onto systems of coordinates. In this sense computers originated within the domain of science. The computer plots everything with which it works on planes of reference: memory addresses. However, each computer also has concepts, which have to be discovered beyond these planes of reference (Deleuze and Guattari 1994: 117).

I certainly do not identify with all writers in Media Studies. Empiricist media studies certainly positions itself as science (Klapper 1960). However, the writers in Media Studies who are closer to Cultural Studies are suspicious of adopting any single plane of reference, and draw attention to the contingency of sciences and their alliances with power (Poster 1995). Cultural Studies doesn't strictly slot into any of the points in the Deleuze and Guattari schema. Cultural Studies at its best creates new kinds of knowledge that aren't quite philosophy, science or art. Paradoxically, this is why Cultural Studies is, at the moment, a good place to create and develop the concept of invocational media. Computers are complex assemblages that are simultaneously technical, linguistic, economic and political. In developing the concept of invocation I draw on specific historical examples, but not in a strictly scientific way. The material in the thesis moves across domains that are sometimes considered to be incompatibly higher or lower cultural forms: sociology, histories, journalism, cinema, TV, news groups, websites, technical manuals, casual conversations or whatever else I find useful.

The dangers for the concept of invocational media

Choosing to base a thesis on a concept like invocation was somewhat risky. Not only did it move outside sociological, historical or textual methodological boundaries, but even as Cultural or Media Studies it could easily be read as suspect and problematic. Because my focus is on the computer, rather than social or cultural phenomena, a predictable accusation would be that this is a technologically determinist approach (Williams 1990: 9–31). A claim that the

theory of invocational media is technologically determinist would miss the point of my task. An artefact is always meaningless outside the attachments it creates with other actors. It is invocational media's capacity to make so many and varied attachments that makes it a worthy object of study. Computers are adopted in many domains, across cultural contexts and social situations — video arcades and offices; weapons systems and online voting; desktop publishing and higher mathematics. These domains seem to share little in common except that they have come to be mediated by computer. By concentrating on invocational cultural practices, rather than computers *per se*, this approach will avoid the dangers of attributing cultural phenomena to technological causes.

Another danger in using the term 'invocation' is that readers might misunderstand the magical metaphysics of the concept. I chose the term partly for its magical resonances. It draws attention to cultural connections between technology and mystical practices and beliefs that Erik Davis has recently explored in extraordinary detail in the book *Techgnosis* (Davis 1998). To point out these historical connections does not constitute a claim that computers offer any form of transcendent metaphysical powers. I am very suspicious of the claims of some technopagans and extropians that computer technologies are intrinsically spiritually or politically liberating.² There is a hint of the ridiculous in the term 'invocational media' that I want to keep. Richard Coyne convincingly traces a long link between technology and Romanticism (Coyne 1999). Promoters of technology often use strategies of mystification to sell more

² Extropians are a hyper-Humanist (transhumanist) movement that advocates strategies that work against entropy. Max More (1995) explains:

We practice and plan for biological and neurological augmentation through means such as neurochemical enhancers, computers and electronic networks, General Semantics, fuzzy logic, and other guides to effective thinking, meditation and visualisation techniques, accelerated learning strategies, applied cognitive psychology, and soon neural-computer integration. Shrugging off the limits imposed on us by our natural heritage, we apply the evolutionary gift of our rational, empirical intelligence, aiming to surpass the confines of our humanity.

computers (Dery 1996: 1–72). Shallis argues that computers are displacing religious faith to become a faith of their own (Shallis 1984). The term ‘invocation’ evokes the hubris of the many totalising dreams of invocational power.

The late 1990s Internet bubble had a dynamic that can only be described as mystical. The raw belief that investors held in the future of Internet companies was apparent in stock values well beyond any rational analysis. Economists speak of ‘animal spirits’ (bull, bear) to explain the dynamics of the market (Middleton 2000). The market has ‘sentiment’ visible only as numbers on screens. There were similar responses in other media stocks like radio and television earlier in the 20th century. All of these have much in common with the famous tulip mania in the 1600s (Schama 1997: 351–367). Tulips were the magical/media phenomenon of that time. The overvaluations of flowers, and flowers futures, anticipated the kind of hype that would be associated with twentieth century consumer entertainment technologies. As Mauss argues, magic is a social phenomenon (Mauss 1972).

Computers don’t carry any spiritual powers. Their powers are more worldly, as I explore throughout the thesis. Technology is embedded in economic, military, political and other forms of social power. Irrespective of their metaphysical status, computer magic is a significant and ongoing cultural phenomenon. It is especially apparent in many media technologies. As German medium theorist Friedrich Kittler stresses, ‘A medium is a medium is a medium’ (Kittler 1990: 229).

On the other hand, I don’t want to deprecate writers who are genuinely addressing the mystical or magical imaginary in contemporary or historical cultures. I am not particularly interested in mysticism beyond its relationship to the technological imaginary. That’s other peoples’ work. I’m not stealing the

word ‘invocation’ forever, I’m just borrowing it to create what is effectively a new concept.

In spite of these dangers, invocation has proved to be a very productive concept. For one thing, it is very scalable: invocation can apply to infinitesimal or enormous phenomena.³ It can address something as simple as the singular action of a light switch, the *invocatory device* with only two states, where the meaning of the event of switching is mainly in what it reveals: lighting a room; turning on a radio, etc. But it scales to conceptualise computers, which create complex meanings with switches, folding them into sequences, programs, and simulations, and unfolding them as images, sounds and control events. These are *invocational media* — all based on the invocational diagram — a meta-medium that not only invokes meaningful symbols, but invokes the entire forms of other media.

The concept of invocation has been built from existing components (literally from describing electronic components, and less literally, by using intellectual traditions dating back to Homer, academic work on culture and technology, etc.). What is (hopefully) new is the combination and expression of these components. I hope the concept of invocation will succeed in cutting new contours into the conception of computers as a cultural event (Deleuze and Guattari 1994: 15–16). I have tried to keep as closely focussed on the productive task of defining and developing the concept of invocation as I can. This is the only way such a wide-ranging project can remain cohesive.

Chapter One is a literature review which gives an account of my search for theoretical resonances with the concept of invocation. It includes a historiographical overview of popular and academic work on computers, including the recent theoretically informed cyberculture research which is

³ McKenzie Wark’s ‘vector’ is another example of a scalable concept (Wark 1994: 21).

closest to my own project. It also gives an account of resonances in some of the major Humanities intellectual traditions with the concept of invocation. Although I chose to avoid adopting any as an overarching system, each contributed to refining the concept. Among the productive connections I explore in this chapter are literary theory's 'implied reader'; Althusser's 'interpellation'; Benjamin's 'aura', Freud's 'magical thought'; Heidegger's 'standing reserve' and 'world picture', and Deleuze and Guattari's 'abstract machine' and 'order-word'.

Chapter Two presents a sideways history of invocational media. It offers tropological rather than teleological narratives from various moments at which computers become something different. It sees computer history as a series of side-ways leaps as well as forward steps. At different times, computer designers imagined they were invoking brains, at others a Big Brother. Magic was a persistent trope in the cultural imaginary around computers, which gradually became domesticated and consumerised. Invoking not only calls up things on interfaces, but calls on surrounding cultural resources to complete the meanings of the invocations.

The mimetic capacities of invocational media emerged because the invocation is fundamentally abstract. It is the genetic event of the medium. This event is mediated by the universal machine, or invocational assemblage. Chapters Three, Four and Five move their attention to different components in this assemblage. The focus moves from input and output devices (Ch 3), CPU and memory (Ch 4), through to users (Ch 5). Each of the components has its own history: input devices are technologies of surveillance; output devices are technologies of the spectacle; command technologies compress distance and time; memory technologies extend duration. The assemblage even creates spaces for people — new forms of user subjectivity.

Chapter Three ‘Ontology of the invocational interval’ concentrates on how the invocational assemblage connects with its outside through inputs and outputs. As their generic name — ‘peripheral’ devices — suggests, these components are generally devalued. In fact, they are highly significant in invocational cultural forms. Users mostly don’t care what happens inside the mysterious gap between input and output. Users care what they can do with inputs, and what appears at outputs. This chapter shows that while this machine was built to Von Neumann’s diagram, a more useful model for the concept of the invocational assemblage is Henri Bergson’s brain. Bergson sees the brain as an interval between sensory organs and motor organs. The sensory organs (input devices) convert variations in the environment into single switches, or bitstreams. This is how invocations are composed: keyboards and mice, buttons and joysticks, trip wires and video cameras. The motor organs (output devices) express the results of invocations: screens, printers, robot arms. But these are not like human eyes and arms; rather, they are social technologies of surveillance and spectacle.

Within the invocational interval are the organs of command and memory: Random Access Memory (RAM) and central processing unit (CPU). **Chapter Four** connects these components with cultural histories of command, memory and decision. The early medium theorist Harold Innis (1951) identifies two functions of media: space-binding and time-binding: command and memory. Computers complicate both by seamlessly blending the two functions within the same dynamic assemblage. The cultural forms that emerged around computers are different expressions of a similar rhythmic cycling that fetches and executes instructions from memory to produce points of decision. The range of invocational forms — from databases to discussion groups, electronic mail to online gaming — are media cultures, not so much what Walter Ong calls secondary orality (1989), but what I shall call *n*th orality. Every new computer program becomes its own new cultural form.

Although they are powerful, invocational media are often inflexible and demanding. If invocations are not carefully phrased, or incompatible, they will fail. **Chapter Five** explores how these restrictions effectively create user subjectivities. Users bend to fit the system. 'User design' is best understood literally as designing users, rather than designing machines for users. Invocational media incorporate spaces for users at four levels: hardware; avocations (software features); user modes; and avatars. Each of these generate new forms of identity mediated through a media form that simultaneously empowers and constrains its users.

Chapters Six and Seven develop the concept of invocation further by using case-studies of computer art (and computer games), and the hyperlink. Again, these chapters stress that invocational media are materially, temporally and historically specific. **Chapter Six** identifies an invocational aesthetic. Unlike the formalist faith that the core of computer beauty precedes expression, the invocational aesthetic is immanent to events of invocation. The traditions of engineering and mathematics that built computers tended to have an aesthetic of pure form, seeking to account for the mysterious quality of beauty with formal analyses of the underlying power and perfection of mathematical equations and elegant code. In practice, though, the computer game player, computer reviewer, electronic music listener and other audiences more often judge computer beauty on the basis of singular events of invocation.

Chapter Seven uses the case study of the hyperlink to illustrate how invocational media forms integrate technical, textual and political / performative components. Many studies of hypertext have tended to concentrate on only one of these dimensions. Theories of technology overlook hyperlinks by addressing broader impacts of whole groups of technologies. The specifics of the hyperlink as a software feature and media form appear insignificant on the social scale of many theorists of technology. The hypertext theorists of the early 1990s see

hypertext as a revolutionary textual form. Many tend to overplay the implications of a form that they see as a radical reconfiguration of textuality. Without an adequately developed theory of the social, economic and political contexts of hypertext, these theorists' optimism shatters against the rapid commercialisation of the world wide web. Their work lacks a theory of how the hyperlink operates as a performative invocation — a language act, in Austin's sense: a statement which transforms things by being spoken. Much of the power of invocational media in general, and the hyperlink in particular, comes from their capacity to articulate performative statements, including making financial transactions, entering details into police databases and tracking the actions of millions of users.

The central task of this thesis is to develop the concept of invocational media. As I have suggested, it is something of an intellectual experiment, but as such it is an approach appropriate to Cultural Studies and Media Studies. The project defines its own boundaries quite artificially, insisting that all academic work necessarily does this, but often pretends to be a slave of forces outside the work. This approach allows me to address extensive empirical and intellectual territories while remaining tightly focussed on the task of creating the concept. Rather than starting with an apology, it fulfils the academic requirement of making an original contribution to the field only after redefining the concepts of 'originality' and 'the field'. The concept of invocational media not only offers a new name for computers, but also challenges the dominant modes of knowledge in both PhD regulations and computer science.

1. Computers and the Humanities

The conventional literature review is itself something of an invocational ritual within the PhD thesis genre. The author lays out an account of the tradition that informs the body of the thesis. Doing this demonstrates an understanding of the field, and positions the original contribution that the thesis will make within that field. As I have said, the task I have set myself is to create a concept, not to contribute something original to a field. I don't accept the conventional concept of originality, nor the belief in pre-existing fields of knowledge. So I will not claim that this chapter accurately represents the traditions it discusses — that would be to claim too much. Rather, this literature review starts to create a 'plane of immanence' around the concept of invocation.

Deleuze and Guattari argue that the process of creating a concept also lays down a 'plane of immanence' (Deleuze and Guattari 1994: 35–60). The plane of immanence is Deleuze and Guattari's attempt to construct an image of thought which is not transcendent or universal. They create instead a spatialised image of the relationship between concepts and the milieux surrounding those concepts: 'Concepts are events, but the plane is the horizon of events, the reservoir or reserve of purely conceptual events' (36). The plane of immanence is not the concept itself, but the field of assumptions that the work as a whole implicitly and explicitly makes about the possibility of knowledge at all. It is an 'image of thought' (37) around each concept. This literature review begins to build a plane of immanence around the concept of invocation.

Traditional invocations call across planes of immanence. When philosophers invoke another's work, they move across pre-existing planes:

Over a long period philosophers can create new concepts while remaining on the same plane and presupposing the same image as an earlier philosopher whom they invoke as the master: Plato and the neo-Platonists, Kant and the neo-Kantians... (Deleuze and Guattari 1994A: 57).

Invocations call on something already pre-constructed to build something else. However, an invocation is always a discrete event in its own right and not simply a duplicate of the older event.

This chapter surveys some of the literatures with which the concept of invocational media intersects, and argues that no single approach on its own would adequately account for invocational events. Anything performed with a computer is simultaneously technical, textual, psychological, social, political or economic, depending how it is perceived and conceptualised. This chapter positions the concept of invocation within wider literatures in the humanities and social sciences in order to identify productive approaches. Given the breadth of the survey, I limit extended discussion to the theoretical traditions in the critical humanities that I encountered which had particular resonance with the concept of invocation, and which helped define the distinctiveness of computers as a media form.

Later in the chapter I will analyse in some detail some of the theoretical traditions I have found relevant in building the concept of invocation. These include literary hypertext's application of the school of reader response theory, Heidegger's phenomenology, Marx's concepts of modern machinery and alienation, Althusser's critique of ideology, Weber's work on vocation and avocations and Freud's 'magical thought'. Each of these approaches (which I will discuss in detail later) offers a more or less overarching interpretive framework, often applied productively to technology and culture. However, while this thesis draws something from of each of these literatures, it does not claim to offer a totalising account of society, the individual or computers.

Rather, invocational media is a conceptual intervention in the conventional cultural positioning of computers and other media.

The literatures relating to computers and culture

There is a huge amount of academic and popular work directly addressing social, historical and technical questions about computers. In this section I will try to give a quick survey of some of the literatures from which I have drawn.

Only a relatively small amount of material is comparable with this project in content and approach, and most of that has been written since the mid 1990s. There was something of an explosion of interdisciplinary cyberculture studies in the late 1990s. Many were richly theoretically informed critical studies of the cultural changes associated with new media technologies. A number of collections were published which drew together essays on cyberculture from multiple disciplines: Benedikt (1992), Dery (1993), Andersen et al (1993), Penny (1995), Jones (1995 and 1998), Aronowitz et al (1996), Brook and Boal (1995), Druckrey (1996), Cherny and Weise (1996) and Hershman Leeson (1996). By the end of the 1990s, publications in the cyberculture genre were becoming text books (Bell and Kennedy 2000).

Book length works in the latest wave of cyberculture studies came from a very diverse range of fields: literary studies, computer science, structuralist semiotics, critical theory, feminism, philosophy, sociology, architecture as well as cultural studies and media studies. These include Katherine Hayles (1999), Phil Agre (1997), Pieter Bogh Andersen (1997), Mark Poster (1990, 1995), Brian Cantwell Smith (1996), Sadie Plant (1997), Alluquere Rosanne Stone (1995), Friedrich Kittler (1990, 1997, 1999 [1986]), Kroker and Weinstein (1994) Kroker and Kroker (1997), Pierre Lévy (1997, 1998), Erik Davis (1998), Richard Coyne (1995, 1999), Michael Heim (1987, 1993, 1998), Manuel De Landa (1991 and 1997),

J Macgregor Wise (1997), Manuel Castells (1996, 1997, 2000), Darren Tofts (1997) and Hobart and Schiffman (1998).

While each of these books deals with themes of technology and culture using approaches that could broadly be described as critical humanities, it would be hard to describe them as constituting a conceptual tradition. They represent a significant growth in the range of sophisticated critiques around computer media, but not a cohesive school of thought. It is hard to find a common theoretical thread or cohesive approach across all these works. While much of this new work is excellent, it is beyond the scope of this thesis to systematically summarise or engage with it in any detail.

The cyberculture literature in the 1990s was more heterogeneous, and quickly becoming larger, than some of the polarised discussions in critical humanities and social sciences debates of the 1970s and 80s, which were often cast as conflicts between social determinists and technological determinists (Solominedes and Lebidov 1985; MacKenzie and Wajcman 1985). There were other polarisations. The total pessimism of Marcuse's (1972) *One dimensional man*, and Ellul's (1965) *The technological society* seemed to have little in common with the popular but often simplistically applied concepts of the 'information age', or 'post-industrial society' (Bell 1973). Lyotard's *The postmodern condition* (1984), on the other hand, makes a sophisticated argument that relates the emergence of computer technologies to changes in the nature of knowledge. The traditional metanarratives that gave legitimacy to modern institutions are breaking down, in a process that is partly related to the proliferation of computers.

Perhaps the most satisfying solution to the 1970s and 1980s arguments over the precedence of social or technological causes is actor-network theory (Latour 1987, 1991, 1997, 1999, Latour and Woolgar 1979, Woolgar 1991, Bijker and Law

1992). Actor-network theory typically uses ethnographic methodologies to model empirically how groups of human and non-human actors function in dynamic networks. In one study Woolgar looks specifically at the design of a microcomputer (see Chapter Five). Using close, poststructuralist readings of actors (human or non human components in a network of social/ technological entities), these studies demonstrated how deeply embedded technologies are within cultures. Latour argues that sociological approaches tend to ignore the roles that technologies play in maintaining social structure (Latour 1991).

Actor-network theory is also attractive because it doesn't assume technologies are driven by transcendent prior causes. Latour sees complexity as emerging from simple basic processes upwards towards higher thresholds, rather than responding to transcendent universal mechanisms.

...the less intuitive philosophical basis for accepting an ANT is a background/ foreground reversal: instead of starting from universal laws — social or natural — and to take local contingencies as so many queer particularities that should be either eliminated or protected, it starts from irreducible, incommensurable, unconnected localities, which then, at a great price, sometimes end into provisionally commensurable connections (Latour 1997).

The concept of invocation is sympathetic to (but not reducible to) an actor-network theory approach. It will trace the ontological, aesthetic and political implications of computers as mediators of invocational events, as they become actors in a range of networks. But invocation is an event, rather than an actor or a network.

The concept of invocation also needs to provide an account of the specificity of media technologies. The thesis will therefore also move along planes of immanence developed by the 'medium theorists.' Medium theorists are writers who argue that changes in mediating technologies transform human culture.

Innis (1950, 1951), McLuhan (1962, 1964, 1967), Havelock (1963), Ong (1982), Meyrowitz (1985), Elizabeth Eisenstein (1980) and Kittler (1990, 1997, 1999) have written about how new forms of media impact on culture, and even on the reality of events. These writers see changes in media technologies (oral, writing, print, television, etc.) as critical forces in processes of cultural change. The work of the medium theorists is important in creating space for the concept of invocational media.

On the other hand, medium theorists are (sometimes justifiably) attacked for giving too much autonomy to technology as the creator of cultural forms (Winner 1977). For example, early cultural studies writers attacked McLuhan for being technologically determinist (Williams 1990: 126–134). Some medium theory work does make very strong claims about media technologies' influence over culture. However, social constructivism, which was often presented as an alternative (MacKenzie and Wajcman 1985), is no better as a model of technological change. To claim that technology simply reflects social structures attributes too little influence to the specificities of particular media technologies.

Rather than dig again into the trenches pitting social constructivism against technological determinism, it is more productive to look at the empirical specificities of both the social and technical forms surrounding each medium (which is already what the best of both already did). In either case, though, the outcomes are not predetermined, but emergent. There are some regularities that emerge in the processes, such as the invocational assemblage, to which it is useful to attach a concept.

In attempting to conceptualise these processes of emergence or becoming I draw particularly from Deleuze and Guattari, and from their readings (separately and together) of Leibniz, Bergson, Hjelmslev, speech act theorists and Foucault (Deleuze 1993, 1988A, 1998B, Deleuze and Guattari 1983, 1987, 1994). This

approach was reinforced when I read some of the more productive work on technology and culture from writers who apply the work of Deleuze and Guattari, including Manuel de Landa (1991, 1997, 1999), J. Macgregor Wise (1997), David Sutton (1999) and Sadie Plant (1997).

Many contemporary disciplines apply approaches developed in critical humanities. For example, some of the work at the margins of design studies, while not necessarily written as critical theory *per se*, offers some very sophisticated critical conceptualisations of computers and culture. Winograd and Flores' (1986) *Understanding computers and cognition* is already a classic adaptation of cybernetics, speech act theory and Heideggerean approaches to designing computer applications. Langdon Winner is consistently an insightful critic of the politics of artefacts (1977, 1986, 1992). Others in Design Studies look for 'middle range' theories that incorporate political questions into the processes of design (Mansell and Silverstone 1996: 17). The participatory design tradition, originating in Sweden, critiques traditional design approaches which exclude the workers who actually use systems (Schuler and Namioka 1993).

The dominant human computer interface (HCI) design field in the US contrasts with these more theoretical design approaches because it remains predominantly (but not entirely) empiricist. It tends to privilege scientific usability testing over theoretical concepts or collaborative design strategies. However, HCI is a large interdisciplinary field characterised by regular cross-overs between industry practitioners and academic work (Janda 1983, Monk 1984, Shneiderman 1986, Carroll 1987, 1991, Laurel 1991, Apple Computer Inc 1992). In the course of my research I participated in conferences at the Key Centre for Design Computing at Sydney University (1994), Denver SIGCHI 95 (Special Interest Group: Computer Human Interface) and OZCHI96 (Australian special interest group: Computer Human Interface) in Wollongong. While I do

not consider myself to be working within design studies, I found some of the work in the discipline useful.

Since invocation is historically constituted as a cultural and technical form, a lot of my research is historiographical. I am particularly interested in how key figures in the official histories of computers are drawn. The three most prominent figures in the early history of computers are Charles Babbage, John Von Neumann and Alan Turing (Spufford and Uglow 1996, Walker 2000, Cohen 1998, Batchen 1998, Aspray 1990, Golstine 1972, Myhrvold 1999, Britton and Saunders 1992, Hodges 1992, Hodges 1997, Rheingold 2000 [1985]).

There are strong, but unacknowledged, political biases apparent how historians choose to portray the major figures in histories of computers. Von Neumann, an anti-communist, embraced his role in the military hierarchy in the early cold war. Turing was far more hesitant in his involvement in the war effort, and ultimately committed suicide while being persecuted by the authorities for his homosexuality. Biographers and historians expose their own national and political prejudices in how they treat each of these events. For example, where Aspray (1990) tells reverential stories about Von Neumann's impressive capacity to calculate numbers in his head, Rheingold sardonically entitles a chapter on Von Neumann 'Johnny Builds bombs and Johnny Builds Brains'. Hodges' generous picture of Turing (1992) contrasts strongly with Shurkin's brief and dismissive account: 'He was a homosexual. Some of those who admired him most found him hard to like' (140). It is quite apparent that Hodges is English, and politically more liberal than the American, Joel Shurkin.

Not all the work that informs the concept of invocational media is academic. Popular non fiction is another large body of literature, with fewer academic pretensions, which gives some insight into technological developments. There are a number of biographies of entrepreneurs in computer fields (Young 1988,

Spiesman 1991, Sculley and Byrne 1988) and histories of particular companies (Levy 1994, Cusumano and Selby 1995, Stross 1996). Some other books are biographies featuring a particular product or technology as central character. The subjects of these techno-bios include Data General's Eagle minicomputer (Kidder 1981), computer chips (Dunteman and Pronk 1994) and transistors (Riordan 1997). Douglas Coupland's semi-fictional *Microserfs* (Coupland 1995) captures, better than any non-fiction works I have found, the milieu of those working at Microsoft in the mid 1990s. Some of the impressions from this book are substantiated (without the same flair, but with more detail on the development of a particular children's multimedia product) in a non-fiction work by Fred Moody, *I Sing the body electric. A year with Microsoft on the multimedia frontier* (1995).

A number of books written on computers and culture with a specifically anti- or pro-technological bent tend to be somewhat less satisfying. While works like Ellul's (1990) *Technological Bluff*, Shallis's *Silicon Idol* (1984), Roszak's *Cult of information* (1986), Traber's *The myth of the information revolution* (1986), Sven Birkerts' *The Gutenberg Elegies* (1996), Rawlins' *Moths to the Flame* (1996) and *Slaves of the machine* (1997) and Talbott's *The future does not compute* (1995) often contain substantial and well researched descriptions of technological and social developments, the subtlety of their analyses is often secondary to their rhetorical ambitions. This problem is even more acute in the conservative and techno-celebratory rhetoric of John Green (1997), George Gilder (1989, 1994) or Ester Dyson (1997) who present political agendas as though they were technical advice. They claim, in various ways, that change inevitably follows technological change (which they depict as autonomous), and that embracing free market libertarian individualism is the only response available.

Technical journalism is particularly interesting because it has not only reported computing innovations, but played a significant part in their proliferation. Often

magazines have been the first to offer interpretations of a technological innovation's social significance. *Computers and automation* and *Datamation* were important in early days of mainframes and minicomputers. *Popular Electronics* and *Radio Electronics* attracted the attention of hobbyists to the first microcomputer, the Altair in 1974. As the number of microcomputers and personal computers exploded, so did the number of publications, including *Byte*, *Dr Dobbs Journal*, *80 Microcomputing*, *MacWorld*, *PC Magazine* and so on (see Freiburger and Swain 2000: 213–223).

During the early 1990s, a new breed of glossy publications merged technology, post-hippie urban culture, and increasingly libertarian free market hype. The first of these was *Mondo 2000*, which was followed and eclipsed by *Wired*. The Australian magazines *21C* and *World Art* and the European *Mediamatic* avoided the entrepreneurial spin of the US publications by applying critical theory and fine arts approaches rather than American new journalism and advertorials. Meanwhile in the US, technology merged entirely with business in publications such as *Red Herring* and *Industry Standard*.

As computers became more 'mainstream' in the 1980s and 1990s, generalist magazines and newspapers also provided extensive coverage of these forms of technology. *Time* magazine's choice of the computer as 'man of the year' [sic] in 1982 was a key moment in the computer's coming to prominence in popular culture (Friedrich 1983). It was followed by countless articles in *Time* and other newspapers and magazines on virtual reality, Internet porn, e-commerce and so on. In Australia, the technology supplement sections in the *Sydney Morning Herald* and *the Australian* have shifted in emphasis over time. Sometimes they offered how-to guides directed at a hobbyist audiences; at other times they pitched to specific industry groups (IT, business); while at others they addressed a more mainstream audience by looking at technologies as lifestyle choice (such

as the insert *icon*, which began as a technology and lifestyle supplement, and became an annotated list of websites).

Some journalists with a specialisation in technology extended their work beyond feature articles to capture the techno-zeitgeist in books. These alternatively popularised and analysed technical innovations. They often provided fresh anecdotes and analyses of the dangers and promises of new technologies. Most remained focussed on implications for individuals, and sometimes political agendas. Howard Rheingold (2000 [1985], 1991, 1993) and Stewart Brand (1984, 1987) are veterans in the category of more liberal American journalistic popularisers of technological change. Journalist Robert X. Cringely wrote columns in *Infoworld* from 1987–1995, and the book *Accidental empires: how the boys of Silicon Valley make their millions, battle foreign competition, and still can't get a date* (Cringely 1992). He went on to produce the documentaries *Triumph of the nerds* (1996) on the history of the PC industry and *Nerds 2.01* about the development of the Internet. Benjamin Woolley's (1992) *Virtual Worlds* covers a broad territory around virtual reality, but from a more British viewpoint. Woolley extended his interest in the area of cyberjournalism when he presented the BBC magazine program called *The Net* (1998).

Some other wild cards in the literature are the practitioners inside the computer field who speculate about the broader implications of their work. Gelertner (1992, 1994, 1998) often gives excellent technical detail, and has many useful insights into computer aesthetics. However, his approach is too often unreflective and ungrounded because of his quest for a mysterious and ahistorical 'deep beauty' (see Chapter Six). Kurzweil (1990 and 2000) falls into the band of excessively optimistic (and truly technological determinist) assessments about the future social impacts of artificial intelligence. Paul Gilster's (1997) *Digital Literacy* is clearly expressed and approachable, but is ultimately descriptive rather than analytical. Nicholas Negroponte's *Being*

Digital also fits this category. This book strings together a series of insiders' anecdotes and presents them as an apparently cohesive and benevolent social program. Microsoft chief Bill Gates has also published two books which present visions for a future that meshes neatly with his company's business plans (Gates 1996 [1995]; Gates 1999).

On the other hand, others in computer science have done very productive work to undermine some of the dominant assumptions in their field. Phil Agre (1997) critiques the dominant 'mentalist' assumptions about computers. Agre argues that computers should be studied in the context of interactions they have with their context, and not as though they are isolated brains in bottles (see Chapter Three). Brian Cantwell Smith (1996) develops an esoteric but sophisticated account of the problem of objects in both philosophy and computing. He shows that the boundaries of objects are always contestable, calling into question the claim that databases present an accurate objective record of the world.

Text books and reference materials on the principles and techniques of computer hardware and software are often useful at several levels. These works are not always as dry as might be expected. Some include 'asides' that illustrate a programming problem with a historical or contemporary example. Appleby (1991) includes 'historical vignettes' about the contexts of development for a number of computer innovations. Although Bierrman's *Great ideas in computer science* (1997 [1990]) uses the programming language Pascal to exemplify his arguments, he presents the book as a more generic examination of 'great ideas' such as decision trees, numerical functions, subroutines and simulation. Even the most technical books choose examples that explain the contexts of the problem. Taub's (1985 [1982]) book on digital circuitry includes exercises on an 'airplane crew' (495), technicians in a chemical lab (497), and traffic lights (514).

While the works above provided much of the subject matter on computers, I also needed to find how the concept of invocation might relate to some of the major traditions in the humanities and social sciences. In the following sections I will deal with these traditions in more detail.

Literary theory takes on hypertext

Although the majority of literary studies academics seem to be indifferent to technology, those who have engaged with computers have done so with some gusto. The first academics to apply computers in literary studies and linguistics used algorithmic analyses to find patterns within large texts. These ‘corpus-based’ approaches could ‘see’ and quantify consistencies in word choice and collocation that were undiscernible to human readers. Stylistic differences could be measured using a range of indexical approaches — reading scales, positional stylometry, computer-aided lexicography and computer-aided thematic analysis (Aitken et al 1973).

By contrast with these ‘hard’ applications of computers in literary fields, the hypertext theorists took up the computer with a romantic fervour. The term ‘hypertext’ was originally coined in the 1960s by Ted Nelson, although many writers attribute its original inspiration to an article by Vannevar Bush in 1945 (Snyder 1996). A hypertext (which by the end of the century is so familiar as to be mundane) is a text which is read from a computer screen in which highlighted parts link directly to other texts or parts of texts. In the late 1980s it suddenly came into vogue as a radical new literary form. Literary theorists and others from Humanities departments in the US convened in a series of conferences, and published a number of books and essay collections that established a lively but short-lived tradition experimenting with and celebrating this technology. They were an intellectual vanguard for hypertext, before the

world wide web took hold as a commercial megalith (Barrett 1989a, 1989b, Bolter 1991, Landow 1992, 1994, Lanham 1993, Joyce 1995, Snyder 1996).

In hypertext's technical and textual capacities, the hypertext theorists saw answers to problems or limitations they perceived in traditional books. They claimed hypertext would liberate writers and readers from the linear and hierarchical frameworks that books imposed on writing. Their effusive rhetoric suggested that electronic writing could overcome broader social hierarchies. They seemed to approach computers as though they had been designed purely for making electronic literature. At the same time, they saw literary experimentation as though it was literally looking for a new medium (Bolter 1991; Landow 1992 and 1994). Literary authors who had experimented with writing that supposedly escaped the standard linear conventions (such as Laurence Stern with *Tristram Shandy*) were retrospectively dubbed proto-hypertexts. The hypertext theorists interpreted the views of critical theorists like Bakhtin, Derrida, Ong and Roland Barthes as criticisms of the medium of print. Seeing how computers could allegedly handle text with greater fluidity, they celebrated how it radically liberated writing and reading. George P. Landow and J. David Bolter both presented electronic text as a culmination of a range of gradual processes that exposed and transcended the limitations of printed text.

Many of these writers and enthusiastic practitioners of electronic text were themselves involved in developing hypertext systems. Landow was on a team that developed *Intermedia* at Brown University; Bolter was associated with *StorySpace*. The design drive behind these systems was a mixture of pedagogical experimentation, political aspiration and product development. Their advocacy for hypertext combined scholarly interpretation with technically-mediated political programs, prophecy and marketing.

In *Writing Space*, Bolter (1991) situates hypertext at the apex of a sweeping history of writing. In a wide-ranging exploration of writing technologies, literary theory and computers, Bolter links hypertext to the Platonic Dialogue (107–119), the encyclopedic impulse (89–97), reader response criticism (156–159) and deconstruction (163–166) among many other themes. Hypertext, he argues, breaks down the implied closure of the individual work that the book form imposed. For him, it offers dramatic aesthetic and possibly political opportunities. He sees the hyperlink as intertextuality embodied in electronics (163–164). But if this is the case, hypertext would not be more liberating than books, but more authoritarian, since it would attempt to give the control over intertextual connections to the author once again. However, the concept of intertextuality already suggests that texts, whether hyper- or non-hyper-, always remain open to connection with other texts. Either way, the link between intertextuality and hypertext is problematic. Beyond literature, its claims become even more questionable because they infer too much about the power of texts to determine social practices. *Writing Space* helped frame the emerging hypertext theory tradition, which extrapolates social implications from the discursive topologies of hypertext.⁴

Landow (1991) gives an even more utopian vision for hypertext in *Hypertext: the convergence of contemporary critical theory and technology*, in which he argues that hypertext's facility to link texts answers a plea for a new textual form that he discerns in recent Continental theorists' critiques of closed and universalising texts. He says that developments in technology and critical theory expressed a common dissatisfaction with the printed book, and with hierarchical thought

⁴ In Bolter's later collaborative work, *Remediation*, many of his excessive claims are tempered by Richard Grusin's evident familiarity with critical cultural studies traditions. (Bolter and Grusin 1999) However, this work also expands to a point where it becomes a theory of all media, not specifically computer media.

(Landow 1994: 1). The experimentation of the avant garde, the poststructuralist attacks on rigid and univocal texts, and reader-response theory, which emphasised the activity of the reader, had all anticipated the coming of hypertext. Hypertext, he says, will transform readers from passive consumers of rigid and linear texts into active participants in fluid dynamic electronic hypertexts. Users are a superior form of reader, liberated and empowered by the technology. This 'convergence of contemporary critical theory and technology' (Landow 1992; Snyder 1996) represents nothing less than a cultural revolution.

Landow sees hypertext as an embodiment of Barthes' vision in *S/Z* (Barthes 1974) of an ideal textual form with a plurality of reversible, open combinations (Landow 1992: 3). He also reads hypertext as an instance of Derrida's argument that linear textual forms are destabilised by other forms of writing (29). Landow finds answers to apparent desires in Barthes' and Derrida's work in the technological form of hypertext. He says links provide multiple pathways through texts. What is literally marginalised in books, as footnotes, marginalia, and readers' comments, is integrated into hypertext, which literally extends beyond the boundaries of the individual text. According to Landow, the distinction between author and reader is broken down.

Landow's hypertext aesthetics extends into a politics (178–190). He claims that hypertext systems have the tendency to be anti-hierarchical and democratic. This might be read as a manifesto or call to arms for hypertext, or, as Landow himself admits, "a hard sell" (202). If the claim is that this technology is democratic in a broad sense, then it is based on a limited conception of politics and society. Even if the claim is more moderate, and applies only to the field of literary studies, it lacks a textured conception of the dynamics of an intellectual community, or processes of technological dispersion, uptake and adaptation.

Of all the literature on new media, the hypertext tradition has most quickly dated and receded with the explosion of e-commerce and the world wide web. The hypertext systems that Landow and Bolter work with were designed to be collaborative. They allowed and encouraged readers to make links and add new text. The world wide web infrastructure that emerged as the global standard over the following decade lacked many of these features. Most obviously, the utopian predictions of democratisation and creativity were undermined by Internet porn, online gambling and the colonisation of cyberspace by large scale commercial interests.

Espen Aarseth's tightly argued conception of 'cybertext' defines more clearly the specifics of hypertext as an instance of a broader type of literature (Aarseth 1997). He argues that Bolter and Landow misread 'postmodern theory' because their understanding of poststructuralist theory 'mistake[s] their descriptive, epistemological investigation of signification... for a normative attack on the limits of a specific communication technology [printing]' (84).

Where Landow's speculations are loose and extravagant, Aarseth's are comprehensive and formalist. He categorises hypertext as one example of 'ergodic literature' in which 'non-trivial effort is required to allow the reader to traverse the text' (1). His 'textonomy' (58-75) encompasses not only computer-based adventure games, arcade games and artificial intelligences, but also the *I Ching*, non-linear poems and novels (66). At the same time, the examples of computer applications he chooses represent only a specialised subset of all computer software. *Cybertext* concentrates on literary and imaginative texts, but not other computer applications. In narrowing its focus, Aarseth's work is more rigorous than the earlier hypertext work. However, for my purposes of searching for continuities across a wider range of computer mediated events, its narrow focus on specific literary genres was only marginally useful.

Approaches that compare literary forms with computers in fact often overlook some of the radical differences in kind between computers and the written book. Computers are not superior or inferior to the book. The two are largely incommensurable.

In an effort to judge for myself, I turned to Wolfgang Iser's original work *The Implied Reader* (Iser 1974), which Bolter relies on for his argument. I found that if you follow Iser's argument carefully and apply it to the computer, the process of reading a novel is qualitatively different from using invocational media. The implied *user* is not reducible to a supercharged implied reader. When Bolter argues 'the new medium reifies the metaphor of reader-response' (158), he has probably misunderstood Iser's conception of the reader.

Iser's analysis is not metaphorical but descriptive. Readers, he argues, do really respond. They really are active in reading a novel. He shows that there is a virtual dimension to novels that is actualised only in the process of a reader engaging with the work. Reading is not an inferior or prototypic experience that only reaches its fulfilment in hypertext, but a set of practices with their own dynamics.

Iser distinguishes two poles of the reading process: the artistic and the aesthetic. The *artistic* pole is the novel's text itself, as written in the pages of the book. The artistic pole of the book doesn't change from reader to reader. Every reader confronts the same text. The aesthetic pole, on the other side, is what the reader experiences when the text is actualised (read). This is the mental event of reading, which is different for every reader. Iser argues that the literary work exists 'half-way between the two' (274) as a 'convergence of text and reader... (which) must always remain virtual' (275) This virtual dimension of the novel is key to the dynamic of reading as a phenomenological event. The theory of the implied reader 'incorporates both the prestructuring of the potential meaning by

the text, and the reader's actualisation of this potential through the reading process' (xii).

Bolter's claims about the nature of hypertext literature are based on a misunderstanding of Iser's artistic/aesthetic distinction. Although it is true that the user gets some control over the process by which the work unfolds (the artistic pole of the work), the aesthetic pole (the experience) remains virtual, internal to the user. Bolter mistakenly sees a user's actions as recorded by the computer as the aesthetic pole made tangible. Even in hypertext, the aesthetic pole *remains* virtual. Invocational media offer programmers and developers a *different* artistic palette to the author of a novel. However, this does not extend to seeing inside users' heads.

Similarly, Bolter claims that the powers of print authors are undermined by the active presence of the reader as the author is no longer the only voice. By this reading, computer texts are a radical democratisation of reading, undermining the authority of the book's author. Again, this is based on a misunderstanding of Iser. The computer never actualises the reader's *reading*. The reading process becomes partly visible, since the user's actions leave a trace within the electrified text. But the programmer if anything gets more power over the artistic pole than the author ever had. Authors can't stop readers from looking at the last page of the book. Programmers define what I call the 'avocations' that delimit what can be invoked. Avocations (which I will explain in some detail in Chapter Five) can block pathways, anticipate users' desires, or restrict certain classes of user from access to parts of a text.

Negotiating an invocational work such as a hypertext is qualitatively different from reading a text from paper. The traces left by invocations are not actualisations of the reading process, but a new kind of event altogether. Invocations have their own forms of virtuality based on a dynamic in which

user invocations actualise avocations. The avocations (computer and application) are 'artistic' components, but the aesthetic (virtual) dimension can no longer be called reading. It is using or invoking. The reader was always active (so is the television viewer, the radio listener and the cinema audience). The activity of the user only resembles that of the novel reader during moments of reading. At most other times, a user's activities are quite different, and more invocational.

Reading a book and using a computer have different relations to temporality. Iser observes the importance of readers' memories and expectations. Readers of novels traverse the text sentence by sentence, continually modifying their expectations about what might be coming up and their interpretations of what they have already read. The text of an effective novel leaves appropriate spaces or gaps for readers to fill. These unwritten parts of the text stimulate readers' creative participation. The written text imposes limits, but the imagination fills in the gaps to bring it to life. Too much detail provided by the author will bore readers, while not enough will strain their imaginations (275).

Authors have to find the right balance between boredom and strain. A long passage of description might create a wonderful image, or if it goes on too long, bore the reader with irrelevant detail. On the other hand, if the narrative progresses too quickly, with not enough detail about the world, the reader's imagination might be strained. In literary texts, though, it is a *defect* if readers' expectations are fulfilled too literally (278). The text moves constantly from familiar into unfamiliar territory, forcing the reader to take on the active process of making sense of the new (282). Readers expect the unexpected, because it's in these gaps that they do their creative aesthetic work in constructing their own *readings*.

Hypertext conventions draw more from commercial software graphical interface design than from hypertext theory. Users have very different expectations about how past and future should relate. Software design also leaves gaps for users to fill, but these are quite unlike the gaps authors leave for readers. It is conventional that users *should* have their expectations fulfilled with confirmation of the action that they have selected. What users invoke should appear reliably and consistently.

Prominent in Apple's human interface guidelines, which define a stabilised set of conventions for user interfaces in 1992, are the principles of consistency, feedback and dialogue and user control (Apple 1992: 7–9). Precisely *because* invocational media *could in theory* sequence events in any order, it is critical for the user illusion that the results of their actions should appear predictable. Where the hypertext theorists celebrate non-linearity freeing the text from the 'one ordering principle — sequence' (Landow 1992: 54), invocation demands new kinds of ordering. Authors in linear media effectively have more scope for experimenting with non-linearity because they can better anticipate how readers will approach the work.

Literary hypertext, supposedly the revolutionary expressive and creative form, failed to live up to its proponents' hopes. Hypertext is effectively more constrictive for users than books are for readers. Hypertext readers are dependent on the navigational aids provided by authors and designers. Authors have the power to define the navigation (avocational grammars) by which users invoke the works. Literary hypertext often resembles a puzzle, which deliberately hides parts of the text from readers. By contrast, the conventions in the dominant forms of hypertext in commercial websites are to make page design and hypertext structures as simple as possible (Nielsen 2000).

User interfaces and novels have different tasks in managing complexity. As noted earlier, Iser argues that authors need to provide enough detail not to strain the readers' imaginations, but not so much that it bores them. Interface designers have a different (but related) task of managing confusion and frustration. Users become confused rather than bored when user interface elements such as a dialogue boxes have too many options. If they don't know which options are relevant to their task, they are more likely to be confused and disoriented than bored. Too *little* avocational power frustrates users because they don't have enough control. Users' frustration comes from an inability to achieve a desired task. This is not the same as a reader straining to comprehend a passage of text in a book.

Human interface conventions have been developed to address these problems. Apple's guidelines (36) suggest a strategy of 'progressive disclosure'. A dialogue box first appears with only the most important elements, but incorporates an option for 'more choices'. This approach breaks from linear sequence, introducing new kinds of ordering based upon avocational spaces and objects. As some architects observe, their discipline has as much to contribute to designing invocational forms as the storytelling tradition (Benedikt 1992).

While hypertext theory might offer new spaces for criticism within literary studies, it is not good as a more general theory of computer media. In trying to apply literary conceptual strategies to computer-based works, I developed a stronger sense of how far dominant applications of invocational media diverged from the literary experiments. The concept of invocation, as opposed to theories of hypertext, constructs a new framework for temporal and spatial relationships between virtual and actual in the new medium.

Heidegger and computers

Iser is not alone in applying a phenomenological approach to technology and writing. In fact, phenomenology has been one of the strongest traditions in resisting the dominant 'mentalist' paradigm of computing. Although Heidegger himself did not examine computers in any detail, several writers influenced by him have applied his concepts to information technology.

Heidegger's work appealed to critics of the dominant paradigms in computing because his work critiques the rationalist foundations on which these paradigms are based. For Heidegger technology is an ontological question — it affects the very nature of reality. His work centres around the concept of Being, and addresses what it means to be in the world. He rejects the possibility of detached rationality, and a correspondence theory of truth. His work challenges the rationalist assumption that computers provide an accurate simulation of the world outside.

The most famous application of Heidegger's work to computers is an on-going debate between Hubert Dreyfus and advocates of artificial intelligence (AI). The debate is centred on the question of whether machines can or will ever be able to replicate human intelligence (Dreyfus 1972, Dreyfus and Hall 1982, Dreyfus 1992, Weizenbaum 1976). The debate began with a Dreyfus paper 'Alchemy and artificial intelligence' (1966) in which he accuses AI of making false assumptions about the nature of thought (see McCoruck 1979: 12). He attacks AI by applying Heidegger's ontological critique to the rationalism which grounded cognitive science at the time. Computers won't be able to replicate human thought, he argues, because they don't have a body — they have a different relation to Being.

Michael Heim makes quite a different use of Heideggerian concepts. He distinguishes Dreyfus's critique of the 'computer as opponent' from his own

analysis of ‘computer as component’ (Heim 1993: 60–61): ‘Instead of confronting a potential rival, we find ourselves interfacing with computers. Computers are woven into the fabric of everyday life’ (60). Heim finds Heidegger’s work on Being is applicable to computers, and, in the book *Electric Language* (Heim 1987) applies this work to a case study of computer writing technologies.

Electric Language is an extended analysis of word processing that offers a philosophical analysis of how the writing and reading process changes when text moves into the ‘electric element’ (42). Heim’s pioneering work makes a number of observations about the ontological significance of word processing. He says that software makes writing processes more fluid, less interrupted by the permanency and physicality of the inscription process. He concentrates on three ways that writing changes in ‘electric element’: (1) increased capacity for manipulation; (2) new modes of formulation; and (3) the powers of linkage (154–163).

Working in the new element, writers manipulate text as data, rather than as marks on paper. Not only can they perform basic editing and cut and paste, but they can also use more powerful features like search and replace, outliners, spell checkers and macros. These facilities encourage writers to change the way they write to take advantage of the fact that the text is more amenable to manipulation. Composing text tends to be quicker because it is easier to correct mistakes or make modifications. This helps overcome writer’s block because, for many writers, the empty screen is not as forbidding as an unmarked page. It is always possible to delete everything and start again. When duplicating documents becomes so easy, it is simple to create multiple versions of the same file by giving the file a new name. The original loses its privileged status.

Heim is one of the first to claim that the advent of word processing has ontological implications in contemporary life — it changes people’s reality. His

argument draws on a longer tradition that claims that writing technologies have a powerful influence on the experience of the world for people living in a culture. Writing is more than a tool; it is an intervention that affects the time and space of human experience. Drawing on Walter Ong and Eric Havelock's descriptions of the change during shifts from oral to written and then print cultures, Heim argues that electronic writing is likely to produce similar shifts in what he called 'psychic frameworks' (46-70).

Heim follows Heidegger's critical view of the technological world picture, finding many negative implications in writing's change in element. He sees the word processor as exhibiting the tendency of modern technology towards 'Enframing' — a specific case of a general danger that Heidegger identifies in modern technology which I will discuss in the next section (Heidegger 1977: 19). Heim suggests that electronic text masks possibilities, imposing a calculative and non-poetic mindset onto word processor users (77-87; 131-137). The speed of writing on a word processor tends to discourage contemplative thought, and encourages quantitatively more text, quickly written, but less considered.

At the same time, though, Heim finds many positives in electronic text. Computers provide new scope for play (150); writing becomes easier and faster; linkages foster a new sense of community (164); self-publishing opens up new possibilities for public self-expression (219). Heim argues that electronic writing represents a significant divergence from writing in other media. However, his conclusions remain close to Heidegger's general views on modern technology. While he applies Heidegger's concepts well, he does not develop any substantially new concepts specific to the emerging media form that might have differentiated the ontological significance of computers from other forms. Heim's approach is largely ahistorical, accepting word processors as though they were not themselves part of a social world. Rather than deal with politics,

he turns to 'Oriental meditation' as a means of escaping the adverse consequences of word processors and other sources of 'technostress' (235–241).

Where Dreyfus and Heim apply Heidegger's theories to computers as outsiders, several writers inside computing disciplines have also used Heidegger's work directly to inform their approach to programming and design. An early computer bulletin board system in the computer company DEC had a forum discussing applications of Heidegger in computers (Feenberg 1991: 100).

Terry Winograd, whose work I will discuss in Chapter Seven, began as an artificial intelligence researcher, but turned to Heideggerian phenomenology out of a frustration with what he called 'the rationalist orientation' shared by cognitive science and computing. In collaboration with Chilean philosopher and linguist Fernando Flores, Winograd wrote *Understanding computers and cognition*, (1986) which (among other things) applies Heidegger's understanding of Being to problems in computer design.

Heidegger — standing reserve and world picture

It is interesting that many writers in the literature specifically on computers who have used Heidegger's work refer predominantly to his early work in *Being and Time*, (Heidegger 1961 [1927]) rather than to his later work which dealt directly with technology (Heidegger 1977A; 1977B; Feenberg 1991: 105). Yet it is in this later work that Heidegger makes the most considered analysis specifically of the ontological significance of technology.

A direct reading of Heidegger's essay 'The question concerning technology', would not find the 'essence' of computers in the devices themselves (1977A: 3–35). Instrumental definitions of causes and process miss the overarching nature of the technological process. Although it is *correct* that computers are a means to an end (processing / storing information), these conceptions are too narrow.

When a society uses instrumental devices, they create a new technological relationship to the world. If Heidegger is right, we should be able to see how computers change humankind's whole world.

Heidegger argues that the essence of technology is related to *poiesis*: a Greek word for 'bringing forth' [*Her-vor-bringen*] (1977A: 10) or 'revealing' [*Das Entbergen*] of truth (11–12). Technology's essence is in the process by which something is revealed. When raw materials undergo a process which arranges them in a particular way, an envisioned final product is brought into 'presencing' [*Answesen*] (11) — revealed in a tangible and particular form. A windmill reveals the energy in the wind, brings it into presencing. What was previously not in our presence is brought forth. The technological encompasses not only the means to particular ends, but a whole set of relationships in the world.

Heidegger says modern technology is a more forceful and invasive kind of revealing which dramatically changes people's relationship with the world: it makes the real available as 'standing reserve' [*Bestand*] (17). More than *poiesis* (revealing), it is a 'challenging' [*Herausfordern*] of nature to reveal itself in a particular form on demand (14). Modern technology 'unlocks and exposes' nature (15). Coal is mined and 'challenged' to reveal the energy stored in it; it is stockpiled so that the energy is on call to produce heat in furnaces. Heidegger uses another landscape — the Rhine River — as his example. It is dammed to store and make available hydro-electric power. The river is put on call. The vacation industry even puts it on call as a beautiful river in the landscape. Once revealed in this way, electrical energy, or tourist bookings can be stored, switched about, transformed and distributed.

Heidegger emphasises that modern technology's particular mode of revealing involves 'Enframing' [*Gestell*] (19), and this is certainly the case with computers.

Revealing is structured and pre-destined by the technologically mediated relationship with the real. Everything is relegated to standing reserve at the call of the particular configurations of technology. The imperative to have the real as standing reserve tends to encourage Enframing. Technological formalisations necessarily impose monolithic form on its object.

Invocation can certainly be read as an example of this modern regime that challenges. Computers store up traces of the real in invocable domains (storage and memory devices) as symbolic standing reserve — a ‘standing reserve of bits’ (Barney 2000: 192). Invocational technologies work with invocable domains (networks, databases) which transcend the ontological limitations of space. They make images and texts available on call, transmit those calls across space, and hold them through time.

Building data structures inevitably involves Enframing. Traces of the ‘real’ are removed from their heterogeneous spatial locations and stored as digital data and avocations. These homogenised data entities are distributed within grids of invocable addresses. The manner in which encoding takes place — choice of code and process by which the data is input — has a powerful influence on the subsequent revealing through invocation. When a written text is stored in ASCII code, any markings which do not fit the 256 characters in the code must disappear, or be converted to an equivalent. A database stores information in fields for a narrowly defined set of objects. Within the frame of the database, invocation is very fast and accurate. But anything which does not fit the categorical boundaries is effectively invisible within that domain. The process of making the data fit the categories is very much an Enframing. Sometimes patterns in data can emerge which bear no relation to the actual referent. Enframed by Windows™, information takes on a life of its own as data, projecting other-worldly visions of virtual patterns with no necessary spatial reference.

Heidegger traces the modern technological relationship to Being to philosophical roots. His essay 'The age of the world picture' presents a view of how people come to relate to the world as subjects. For Heidegger the modern subject appears with the development of modern technological and scientific methods of apprehending the world. The subject experiences the world as picture (Heidegger 1977B: 135). This doesn't mean the world is experienced as an imitation of itself, (129) but that the world is experienced only as it is represented by science. The double movement (subject/world) was largely a result of Descartes' metaphysics. Descartes put the doubting subject, the *cogito*, at the centre of knowledge (127). The subject became the centre of all truth.

From this base, Heidegger argues that the centred subject became responsible for finding the truth about everything around it. The only reliable method of knowing anything outside is science, and experimental research. Research (as opposed to other types of intellectual work) fixes a ground-plan of natural events. It applies mathematics, which deals in 'always-already-knowns' (118–119) to make accurate and calibrated observations. The experimental method seeks to verify laws within an already existing 'exact plan of nature' (122). In this way the world becomes an object of specifically scientific representation (126).

Modern technology, the culmination of this shift, presents the world in line with the picture defined by research, and presents everything to the subject in a manner that fits the subject's existing understanding and experience.

Technology is more than a means to achieve ends; it is the embodiment of a modern conception of 'what is' — the world picture.

The computer seems once again to be the apotheosis of Heidegger's picture. A computer invokes worlds that present only that which has been digitised. It models data according to algorithms that create maps that stand in for parts of

the world. They represent the world in order 'to set out before oneself and to set forth in relation to oneself' (132). Invocation gives users a different way to relate to the world. The physical world is arranged to suit invocations. Physical space begins to resemble invocable domains. Computer peripherals extend the voice and ears of invocations to make certain objects and territories invocable. Bar code scanners require that all products are tagged with machine readable labels. Customers carry debit and credit cards to mark themselves as purchasers. Computer sensors make spaces into invocable domains. Character recognition software reads text from a page; biometric systems read faces, hands and fingerprints. These invocations are integrated into architectures of control, automatically separating insiders from those who do not look right.

Invocational systems formalise and embody social codes of hierarchy and power in a technical form. The particular implementation of a system reflects the interests of the institution that created the database. A police database represents people as suspects and victims (Chesher 1998). A credit card database identifies subjects as debtors and creditors. A customer database identifies people as past and prospective consumers. In each case, the data architecture reflects and reinforces the subject positions systematically imagined and constructed by the institutions that set up the databases.

Heidegger's critique of modern technology helps extend the concept of invocation beyond being simply a mode of delivering text, into an ontological concept. Invocational media are a particular mode of revealing. However, Heidegger's analysis is limited as a tool for evaluating the politics of invocational technologies, and itself begins to break down on close inspection. When he warns of the 'danger' of 'Enframing' — that it may block 'a more original revealing' and 'more primal truth' (1977A: 28), the argument becomes circular. Technology apparently blinds us to seeing some primeval truth; constructed variously as a mystical, idealised, Romantic 'nature' or spiritual

knowledge. Heidegger's viewpoint lacks a critique of social power. He romanticises a mythical past, and apart from his reference to a 'saving power' that is 'also where the danger is' (28), he rejects all contemporary technology in one stroke. He does address particular technological and social formations, but sees these as merely instances of a wider, totalising process that is undermining older modes of Being.

Don Ihde identifies a tendency for Heidegger to privilege 'good' technologies such as the stone bridge over 'bad' ones like the steel highway bridge (Ihde 1993). He argues that Heidegger tends to be nostalgic for technologies which give an embodied relation to the world. For example, he prefers hand-writing to the typewriter. Ihde says Heidegger's nostalgia evades examining the politics of artefacts, which has been of interest to other theorists like Langdon Winner. Tom Rockmore is even more damning, saying '...there is no indication... Heidegger... has a real comprehension of the nature of society' (1995: 141).

Heidegger's analysis of physical technologies does not necessarily translate easily into information and simulation technologies. The concept of *poiesis* applied to invocable domains operates in qualitatively and quantitatively different ways to material technologies. While 'destining revealing' in the physical world results in physically embodied artefacts or places, invocations continue feeding back on themselves to reveal further encodings. Without the ambiguities or inconveniences of physical signifieds, the hyperreal, the simulacra, become increasingly unlike the things in the world for which they supposedly stand.

Invocational media tend towards crises of referentiality when the digital ontological realm starts to supersede the physical world. The connections between data and their referents become fragile and can easily snap apart because of the difference in nature of spatial *address* and invocational *address*.

Actions in invocable domains start taking on their own logic. The stock market crash of 1987 occurred in the virtual geography of the market's invocable domain (Wark, 1994: 171–181). While subjects in invocable domains are more readily accessible than in the physical world, databases multiply the individual. While databases allow institutions to act upon them remotely, it complicates even the Cartesian concept of the centred subject (Poster, 1990: 97). Subjects and objects in data-space constitute additional selves. Heidegger's approach has few concepts to deal with these complications.

Bruno Latour (1993) argues against Heidegger that attributing all the modern ontological and technological changes to Descartes' thought is premature, because 'we have never been modern'. Latour points out that there is a big gap between the philosophical agendas of modernity and how these ideas play out in the field. He accuses Heidegger of losing touch with empirical beings by believing too strongly in the ambitions articulated in the 'Modern Constitution' (65–67). Heidegger blamed Descartes for creating in advance the modern subject/object relationship to Being: 'that which constitutes the metaphysical ground of research (Descartes' *Meditations*) determines first and long beforehand the essence of the age generally' (1977: 127).

Latour refuses to accept Heidegger's faith that Descartes' program was ever actually fulfilled. His own ethnographic work on science as an activity demonstrates that in practice there never *was* any pure scientific knowledge, nor pure economic markets, nor purely instrumental technology (Latour and Woolgar 1979, Latour 1987). Beliefs in pure science, rational politics or instrumental technology are only Modern ideals, which, while announced, were never achieved. If these ideals of making the world into a picture were never fully actualised, what effect did the Modernist strategies actually have? The processes were always partial, created with more or less defined agendas, and

always negotiated by communities and computer users. The questions that remain to be asked emerge from the singular dynamics of invocational media.

Among the significant questions that Heidegger's schema omits are those about relationships of power. Corporate and government hierarchies use computers in the most intensive and extensive ways. Public networks, on the other hand, might give voices to people excluded from mainstream media. The questions that remain are political, and start by paying attention to the directions and strengths of invocational voices. Who can speak? Who is silenced? Who is commanded? Who inscribes invocable domains? Who writes the spells? If the world is increasingly like a standing reserve, which parts are standing, and for whom are they in reserve? What remains outside?

Marxists and Post-Marxists

If Heideggerean approaches lack a concept of social power, Marxist approaches put power at the base of everything. Everything is ultimately reducible to collective material economic relations. Marx argues that socio-economic forces drive technological developments, including — by extension — computers. Invocational media are ultimately products of socio-economic forces. Although this tradition is often limited by a faith in a deterministic vision of history, work in the area developed some complex concepts on the interplay between ideas and labour, technology and culture. Marxist writers work through some complex arguments about the political dimensions of technical systems, and the complex interplay between sources of funding for technological developments, designers' intentions, user resistance and adaptation.

Unlike Heidegger, Marx's own view of technology is actually quite positive (Marx [1867]). Influenced by the father of French Socialism, Saint-Simon, Marx celebrates technological advancement and the command over nature that capitalism was creating (Mitcham 1994: 79). The problem with modern machine

technology is not in the *forces of production*, but the social *relations of production* (Marx 1867). Capitalists are driven to develop more and more efficient technologies by the need constantly to increase profits.

Marxist approaches to technology stress that it is not the same for everyone: like everything in a class system, technology is different for the segments of society who control capital from what it is for those who work for access to that capital. Importantly, they see technological development not simply as a search for the optimal design, but as part of an ongoing struggle for power. Because they are designed by and for the ruling class, technological systems tend to increase the alienation of workers from their own labour.

Marxist writers often see their work as connecting directly with practice. For example, Mike Cooley's *Architect or bee?* (Cooley 1980) is not an abstract piece of analysis, but a direct piece of political action. While at times polemical in tone, this book is a direct response on the behalf of labour to technologies which reduce workers' control. He claims that managers deliberately use invocational media to reduce workers' power. He sums this up with a quote from *Engineer* magazine: 'People are trouble, but machines obey' (96). Cooley's broader concern is that computer technology results in a 'destruction of creativity' (4) in the workplace. Invocational media translate a heterogeneous range of work practices in many fields into various forms of computerised production. He argues computers have extracted people's skills: 'the worker has conferred life on the machine...' (9)

However, although technology alienates, it is also a potential avenue to liberation. Marx and Engels believed that capitalist technology was among the contradictions that would inevitably bring the system down (Marx and Engels 1848). They might have observed that the personal computer and the public Internet are no longer entirely under bourgeois control, and are being used to

organise social movements. The machinery capitalism produces can be like something a sorcerer has called up and can no longer control:

Modern bourgeois society, with its relations of production, of exchange and of property, a society that has conjured up such gigantic means of production and of exchange, is like the sorcerer who is no longer able to control the powers of the nether world whom he has called up by his spells... The productive forces at the disposal of society no longer tend to further the development of the conditions of bourgeois property; on the contrary, they have become too powerful for these conditions, by which they are fettered, and so soon as they overcome these fetters, they bring disorder into the whole of bourgeois society, endanger the existence of bourgeois property (Marx and Engels 1848).

This quote suggests a tension between the tendency for technology to extend bourgeois power, and its propensity to destabilise that power. However, in spite of all the personal computers in the world in the 2000s, in most developed countries, revolution is not imminent. Invocational media are among the phenomena after Marx's time which complicated his predictions that the capitalist system was doomed and revolution inevitable. In some ways computers are just another technology that got out of bourgeois control. But their functions are not simply productive. They are part of the machinery of superstructural mystification that Marx and Marxists call ideology.

Some Marxist writers see invocational media as one of the bourgeois sorcerers' techniques for regaining control over productive forces. For example David Noble's argument in *Forces of production* (Noble 1984) is that technologies which automated work processes are often favoured by managers not because they are more cost effective, but because they give them more control over the workers. Decision makers are motivated more by ideology than efficiency. Yet these tactics do not always work: workers often retain much of their autonomy in spite of the managerial agenda. The history of technological development is one

of constant struggle between classes — not just incremental improvements to make the best design.

Many of the post-Marxist Frankfurt School writers moved away from Marx's optimistic view of technology. Marx predicted that new technology would expose contradictions within the capitalist system, bringing revolution closer. Frankfurt School writers argue, by contrast, that large scale technology is part of the ideological system which hides from workers the true social and economic relations to which they are subjected. For Adorno the culture industries are a uniform, mass phenomenon that has reduced everything to quantification and market segmentation:

The public is catered for with a hierarchical range of mass-produced products of varying quality, thus advancing the rule of complete quantification. Everybody must behave (as if spontaneously) in accordance with his previously determined and indexed level, and choose the category of mass product turned out for his type (Adorno and Horkheimer 1993).

However, this monolithic analysis of mass culture seems to overlook many instances where technology is not as strongly in bourgeois control. Personal computers and the Internet of the 1990s, in line with even older cultural practices such as rock music and indie cinema, seem to contradict or at least complicate the totalised vision of a unidirectional hegemony of the technological cultural industries. While marketing tries to segment and capture consumer choices, consumer behaviour remains unpredictable. Consumption was never simply programmed. The oppressed masses seem at least complicit in their own oppression, and retain some autonomy. Similarly in production, computers rarely simply replaced workers. There are serious limits to what can be programmed. Changes in the workplace and elsewhere are more complicated than a concept of 'mass culture' can capture.

By the 1970s Marxists needed to account for the failure of the proletariat to cast off its chains. Althusser was among the most influential Marxist writers trying to do this. He put great significance on the ideological functions of institutions that sustained the overall capitalist system. In a famous essay on ideological state apparatuses, he develops the concept of interpellation: ‘...all ideology hails or interpellates concrete individuals as concrete subjects’ (Althusser 1972: 162). By recognising and answering the hailing, the subject confirms his position as a subject in relation to Ideology.

The concept of interpellation has some connection with invocation. Both involve relationships of calling. Both imply a relationship that simultaneously offers power and brings alienation. Interpellation offered some conceptual support for a stronger critique of the relationship between users and technical assemblages.

Althusser chose Christian religious ideology as his main example of interpellation. God (or His equivalent) is in the key position as ultimate authority in the relationship of interpellation (165–168). He exists outside the social field, functioning literally as the last word. He addresses by name individuals who are ‘always already interpellated as subjects with a personal identity...’ (166). Religious intermediaries like Moses, the commandments, rituals of baptism, confirmation, and communion mediate His call. But it is the ‘Unique, Absolute, Other Subject’ (166), who is always ultimately the hailer. His subjects recognise themselves in a ‘duplicate-mirror structure’ of collective recognition through these mutual interpellations.

The most obvious difference with invocations is that the call is a generic event that summons a digitised entity into action. Interpellation always calls a subject to an ideology. Ultimately, the event of invocation is more abstract than interpellation, and it is specific to a technical assemblage. Where interpellation positions a subject in relation to an ideology, invocation is a call with no

necessary destination, but a necessary technical medium. It is a virtual relation between caller and called, where either entity can be part human or machine. As I explore in Chapter Five on User Design, invocation does have implications for subjectivity, but these will be more complex than Althusser's image of subjects who submit themselves to a monolithic ideology.

Some writers came to argue quite the opposite: that invocational media are intrinsically democratic and progressive, and capable of counteracting hierarchies (Lanham 1993). Richard Barbrook (Barbrook 2000) makes a more complex argument that the Internet is building 'cybercommunism' with its gift economy. Unlike markets, participants in the gift economies receive far more than they contribute. When they do contribute (like academics who write a paper, or software writers who distribute freeware), their contribution is rewarded with recognition and career advancement. Barbrook argues that cybercommunism will prevail, especially in intellectual property domains, because '[t]he scarcity of copyright cannot compete against the abundance of gifts' (21). He casts the vested interests who try to protect copyright as a commodity as the new Stalinists:

Across the industrialised world, this conservative appropriation of Stalinism now dominates discussions about the Net. Every guru celebrates the emergence of the new technocracy: the digerati. Every pundit claims that these pioneers of the Net are building a new utopia: the information society (Barbrook 2000: 15).

These works show that Marx's attempt to create a scientific proof that material forces determine social outcomes certainly failed to achieve that goal. However, there is no doubting the extent of the influence of Marxist concepts.

Cultural Studies pioneer Raymond Williams was strongly influenced by Marxist approaches and wrote extensively on relationships between technology and culture (Williams 1983, 1990). His work moves away from analysis that reduces

all cultural processes simply to relations of production. His classic work on television is a key example. While it rejects technological determinism as a mode of explanation, it develops a highly textured and specific analysis of television as a technological and cultural form.

Walter Benjamin's work at the margins of the Frankfurt School is also particularly productive. While his work dates from early in the twentieth century, it was only discovered by English readers in the late 1960s. His essay on how the meaning of art changed with its serial reproduction became one of the most influential essays on technology and culture. 'The Work of Art in the Age of Mechanical Reproduction' (Benjamin 1992: 211–244) stresses the historical changeability of human sense perception associated with new media technologies.

If serial reproduction threatened the aura of objects, invocational media eliminate aura altogether, but replace it with a magnified mystique (Nichols 1996). Aura is 'the unique phenomena of a distance, however close it may be' (Benjamin 1992: 216). Invocational media simultaneously bring everything invocable closer, while retaining and reinforcing a new kind of distance, this time embodied in the computer interface. It therefore simultaneously eliminates the aura of the original but reinvests its invoked worlds with mystique. Where aura comes from the authority of an original, mystique accumulates with every copy. Invocational media can copy indefinitely, generating hosts of mystical objects — icons, avatars, daemons, agents, and so on. It promises immediacy, but delivers hypermediacy. Grusin and Bolter call this process 'remediation' (Grusin and Bolter 1999). By now the questions which began as social and political, have also become psychic. The magical dimension of commodity form connects with cultural imaginaries.

Psychoanalysis

An invocation may change arrangements of social power, but these power shifts also have psychological implications for users (and for those who are invoked through invocational media). The invocational object appears to users as a kind of promise to fulfil desires. When users take it up, how does it affect their sense of self? What generates users' desire to invoke something with technology?

Sigmund Freud's concept of the omnipotence of thought begins to suggest that there is a strong psychological dimension to invocation. This concept is developed in *Totem and Taboo* (Freud 1986 [1913]), and applied to modern technology in *Civilisation and its discontents* (Freud 1930). Freud claims that primitives and psychotics often believe that their thoughts have real effects on the world (Freud 1986 [1913]: 132–158). In a dream state, the imagination can call something in memory into consciousness. Magical thought, according to Freud, is the belief that something can be brought into physical presence with an act of pure will.

There is a clear link between magical thought and the technological imperative. In animistic cultures, magical thought is ritualised as magical rites. Although the beliefs behind them may be mystical, these practices are motivated ultimately by pragmatic intentions:

It is not to be supposed that men were inspired to create their first system of the universe by pure speculative curiosity. The practical need for controlling the world around them must have played a part...

Magic has to serve the most varied purposes—it must subject natural phenomena to the will of man, it must protect the individual from his enemies and from dangers and it must give him power to injure his enemies (Freud 1986: 135).

Freud's later work connects the psychic drives behind modern technology with this history of magical thought (Freud 1930: 722-772). In modern life, he says,

technological innovations fulfil the same long-standing desire previously performed by religion and magic. In fact, science and technology are more effective in fulfilling these desires, to the point where technologically-enhanced man almost becomes a god:

These things that, by his science and technology, man has brought about on this earth... are an actual fulfilment of every — or of almost every fairytale wish... Long ago he formed an ideal conception of omniscience and omnipotence which he embodied in his gods. To these gods he attributed everything that seemed unattainable to his wishes, or that was forbidden to him... Today he has come very close to the attainment of this ideal, he has almost become god himself (Freud and Gay 1995: 737–738).

Freud's reading of technology reinforces the association of invocational media with the patterns of magical and religious practices (see Chapters Two and Four). Computers offer a means of articulating desires as invocations, and providing for their instant satisfaction. Or, if they don't actually give satisfaction, they continue to promise the possibility of future satisfaction with further invocations.

However, in spite of its power, according to Freud, technology is never entirely satisfying. Like a poet's discomfort with the stubborn and unreliable Muses, 'man' is not entirely happy with becoming a 'prosthetic god' (Freud [1930]: 738). Technologies give him [*sic*] trouble. Although he is consoled by the promise of future developments, technology doesn't make up for the forms of restraint that civilisation had imposed on him, says Freud. As civilisation developed it systematically repressed individual freedom in the interests of broader values of beauty, cleanliness and order. These social constraints represent a certain 'cultural frustration' of natural instincts (742). The same frustration recurs at the level of the individual psyche during the developments of its own libidinal economy.

Frustration is certainly a part of invoking. Invocational magic is two steps removed from pure forms of omnipotent thought. First, instead of thought, it is voice. In fact, that 'voice' is heard only through input devices. Omnipotence of thought becomes the omnipotence of the voice. Second, this omnipotence is no longer direct and immediate, but delegated to an other (the CPU), and expressed by an outside force (the output devices). The desire for direct power of magical thought becomes a power that is delegated to an invoked entity.

It is tempting to portray the Oedipal family, which is central to psychoanalysis, as recurring in the mythical subtexts of invocational media. The Muses, who gave inspiration and cultural guidance to poets and musicians, were the daughters of Zeus and Mnemosyne, the god of command and the goddess of memory, respectively. The computer offers a parallel capacity to combine memory and command to invoke decisions. There are certainly many possible readings of the psychic implications of the emergence of the invocational medium. Several writers in psychoanalytic traditions do see information technology as presenting something of a crisis for the psyche, and for the Oedipal family (Barglow 1994, Zizek 1998).

Raymond Barglow identifies how computer systems transform the masculine sense of vocation. Before computers, industrial age machinery maintained a clear separation between driver and vehicle. Barglow argues that the rise in software, and decline in hardware has disturbing psychic implications. When the phallic car is replaced by the computer there is a psychoanalytic paradigm shift. The psychic relationship with computers, he argues, is more primitive, permeating the boundaries of the self. The computer/user relation fuses and confuses the driver and the car, creating a crisis of authority.

The automobile is an exemplary Oedipal object, especially for men. It fulfils the classical male fantasy of penetration without entrapment: one hurtles through space to one's destination, but one can stop and exit at any time one

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wants. Conversely, the rage experienced when one's trajectory is impeded expresses a kind of castration. The computer on the other hand, tends to operate in the unconscious at a more fundamental level, as the pre-Oedipal object related to its user as a mother is bonded to its child before its own boundaries and personal identity have been consolidated (Barglow 1994: 14).

Barglow illustrates this crisis by comparing two military recruiting advertisements. The first features an image of a man driving a tank. It reads: '18 years old and you're driving 52 tons of steel' (23). In this case the technology remains a separate entity which 'you' control. The machine remains safely on the other side of the steering wheel.

By contrast, a US Air Force ad features a man with a computer. The soldier sits face-to-face with the mirror-like screen of the computer. The caption reads: 'Technology which lets you program your own destiny' (24). No longer are you just driving a tank, you're programming your own destiny. The self and machine become interpenetrated. The user and his avatar reflect one another, their voices mingling.

This new psychic relationship with technology has radical implications for the notion of vocation: '...the Calvinist notion of calling, to which an individual is predestined, has been replaced here by another, that of self-destination: one is fully responsible for establishing one's identity' (25). Although Barglow doesn't call it this, vocation has become *invocation*. Users have to take responsibility for their own decisions, although I will later argue that options for action are provided as 'avocations' (software and hardware features) by the invocational systems. Barglow shows that there are not only physical, but also psychological shifts when human-technology relationships shift from industrial devices to invocational media.⁵ However, it can be argued that his analysis of the

⁵ This shift from industrial to invocational forms is substantiated by empirical work such as that of Zuboff (1980).

opposition between phallic and maternal technologies is reductive, and can just as easily be reversed.

Slavoj Žižek (1998) argues that the computer mediated subject has to deal with a loss of the Authority of the 'Big Other' — the symbolic father. In the original Oedipal myth, a child has the urge to kill his powerful father and to have sex with his mother. Largely as a result of technological change, the authority of the father figure in contemporary experience is increasingly diminished.

What occurs in cyberspace is the passage from the structure of symbolic castration (the intervention of the Third Agency that prohibits or disturbs the subject's entry into the symbolic order), to some new post-Oedipal libidinal economy (Žižek 1998: 484).

But this newfound independence from the father does not bring joy for the subject, says Žižek. The Oedipal relationship endures but in a new form. In cyberspace, where there are fewer rules, a subject still can't get satisfaction. Because cyberspace is only a simulation of the self, it is not as satisfying as direct experience. The subtle interplays of face to face encounters are lost (487). The split subject can never be sure of who he is, or who the person he's engaging with actually are any more. This is all made worse by the realisation that even without the constraints coming from the Big Other, the superego is compelled even more strongly to seek a pleasure that it is still denied (488–491).

Žižek's analysis does capture some sense of how subjectivity has shifted with the introduction of different computer systems. For example, when computers were used mainly by large institutions, they generated fears of the Big Other, Big Brother (see Chapter Two). When the invocational assemblage was domesticated, microcomputers seemed to promise so much (Nelson 1974). But as a part of daily life invocational media often generate a certain ambivalence, disappointment and frustration. There have been large scale psychological shifts in affective relationships with invocational systems.

However, Žižek's analysis based on lack and loss and Oedipal families leaves many questions about the precise nature of new forms of subjectivity. His conclusions are inconsistent. At one point he diagnoses a new condition of 'perversion' (502–504) that emerges as cyber-masochists try to impose new rules on themselves. Later, though, he claims it might bring the 'most radical experience imaginable: the encounter with our "'noumenal self" ...' (510). Žižek's strict adherence to Lacanian categorisations seems to encourage a conservatism that refuses to see things that might belong outside the schema.

Andermatt Conley rejects another of Žižek's articles, in which he disputes cyberfeminist claims to the multiplicity of new subjectivities in new media (Conley 1999). She sees his rejection of cyberfeminist visions about the possibilities for new subjectivities as a defence of what he sees as a set of stable and natural meanings.

Žižek... bemoans the loss of Being, but from his own longing for closure — that is, for universal schemas, based on mastery, castration, canonical masterpieces, traditional world-views and stable meaning, freed from processual cyberfeminist experimentations (Conley 1999: 136).

A similar criticism might be made of Žižek's article on cyberspace. He ultimately bemoans the loss of the central figure, the Big Other. This loss leads to perversion and deviance. The alternatives he gives are subjecting yourself to a dominating father or sinking into masochistic perversion: hardly appealing alternatives!

Deleuze and Guattari critique Freudian and Lacanian psychoanalysis for continuing to project what they see as arbitrary and limiting figures of the Oedipal relation onto the productive forces of the subconscious. What Freud created, and Lacan retained was:

a theatrical *mise-en-scene* that substitutes merely representative tokens for the true productive forces of the subconscious. So desire's machines become more and more like stage machinery: the superego, the death instinct, become a *deus ex machina*... machines for creating illusions, special effects. All desiring production is crippled (Deleuze 1990A: 16).

While psychoanalysis opens up ways of thinking about the unconscious, it immediately imposes a new order based on the family relations (17). This is a form of idealism that reduces a diverse range of 'desiring machines' to the theatre of the mythical Oedipal family. By contrast, Deleuze and Guattari propose the concept of 'desiring machines' which are immanent to the 'great social machines' (18). In this sense 'machines' are not only technical apparatuses, but entire social, linguistic and technical networks that work together. Desiring machines operate within the very logics of capitalism, and inside the transformation from disciplinary societies to control societies (Deleuze 1990B).

Rather than analysing the psychic impact of the invocational diagram by inserting it into an Oedipal drama, then, it is preferable for this project to remain focussed on the singularity of the invocational diagram itself, and the cultural transformations that accompany its emergence. There are clearly psychological dimensions to invocational media, but all these phenomena cannot be usefully reduced to the psyche alone.

Like the Marxist analysis of class, even with Althusser's less determinist concept of interpellation, or Heidegger's phenomenological world picture, psychoanalysis is useful in this thesis, to a point. It helps develop the concept of a recurrence of magic in technology, but the baggage of the Oedipal family weighs down the argument. Each of these traditions puts me in danger of imposing similar templates onto heterogeneous, incommensurable and interconnected events. It is not useful to reduce invocational media to just another case in a wider theory of class, Being or the psyche. Although each

makes powerful, critical readings of computers in culture, and even helps constitute the concept of invocation, none is abstract or particular enough for the objectives of this thesis.

A more recent generation of critical theory has called into question many of the assumptions underpinning what has come to be called Modernist thought. Derrida is one of the most systematic and effective writers in a project of deconstructing the knowledge claims of social sciences specifically, and Western thought in general (Derrida 1976 and 1995). His work has influenced many of the more sophisticated writers on new media, including Gregory Ulmer (1985 and 1989), Richard Coyne (1995 and 1999), and Darren Tofts (1997). Derrida does not reject Modernism wholesale, but engages with it to reveal paradoxes and contradictions in Western claims to knowledge. Where Zizek and Barglow are interested in measuring and diagnosing psychic maladies that result from computers, Derrida points out that their diagnoses are always going to be suspect. The history they present so confidently is itself subject to limitations of memory and archives. Derrida examines how the paradoxes that emerge with the materiality of knowledge undermine the foundations on which a diagnosis is made, or can ever be made. In this light, invocational media have more fundamental and difficult consequences for the future and the past.

Derrida's most direct engagement with computers in general, and electronic mail in particular, is found in *Archive Fever* (Derrida 1996). In discussing Freud's allusion to the 'Mystic writing-pad',⁶ Derrida observes that prosthetic

⁶ In a short but significant essay 'A Note upon the Mystic Writing Pad' (1971) Freud identifies a domesticated piece of commodified magic: the Mystic Writing-Pad as a useful analogy for the multi-layered relationship between perception, consciousness and memory. The Mystic Writing Pad is a children's toy, still found today, with a wax base, and a plastic sheet on top. Pressure from a pointed stylus on the surface leaves traces in the layer underneath. Pulling up the sheet erases the trace. 'the appearance and disappearance of the writing' is similar to 'the flickering-up

technologies have significant implications for the 'impression' they will make in the future. He takes some care in developing three meanings of the term 'impression', particularly under the influence of Freud's work (25–31).

The first impression Freud makes for Derrida is the 'scriptural or typographic' (26) aspect of the work: his work is constituted by marks in a substrate. This impression, and the materiality of substrates, will become important in the distinction between memory and archives. In this, Derrida echoes the medium theorists' arguments that a change in mode of mediation has substantial cultural implications. For Derrida the change in medium to digital electronic storage can never be transparent, but will have some significant implications.

The second of Derrida's impressions is that Freud never developed a concept of the archive: only an impression of it. The concepts of this archive come later.

When Freud created his work, it did not appear as already an archive.

Archivisation is 'a movement of the promise and of the future no less than of the recording the past' (29). The Freudian archive creates an 'unknowable weight', partly derived from processes of 'repression' and 'suppression', which imprint on the future of knowledge and memory. The way that the Freudian archive (or any record) is taken up is not reducible to a direct logic of recall.

and passing-away of consciousness in the process of perception' (230). What remains in memory is a trace of the impression, which is like the unconscious.

Derrida (1995) explores the Mystic Pad analogy further in another essay 'Freud and the Scene of Writing'. Derrida concludes that the psyche itself is a scene of writing. Memory, then, does not reconstitute presence, but is subject to repression.

Several writers have noted the relevance of the Mystical Writing-Pad to computer-based media technologies (Tofts and McKeitch 1997; Ulmer 1985). The Pad anticipates the capacity of computers to receive traces through input devices, retain them, and restore those traces later through outputs (Tofts and McKeitch 1997: 58–62).

The third impression Derrida has about Freud's work is that after Freud it is impossible to write or think without being marked by Freud:

In any given discipline, one can no longer, one should no longer be able to, thus one no longer has the right or the means to claim to speak of this without having been marked in advance, in one way or another, by this Freudian impression (Derrida 1996: 30).

Whether writers agree or disagree with Freud (or any other part of the traditions to which they are exposed), it is impossible to work outside that tradition.

Freud's work in particular destabilised the faith in the reliability of memory, the truthfulness and originality of writing, and the veracity of the archive. It is impossible to have an archive without a medium of inscription. It is impossible to use an archive without transforming what is recorded in it. It is impossible to paraphrase Derrida's argument here. In fact, that's part of his point. Without including a complete extract of his text, my paraphrasing is already a transformation of the work. Against the conventional faith in the transparency of memory and archiving, Derrida shows that knowledge, interpretation, memory and the archive are all quite paradoxical and problematic.

In the context of this discussion on Freud, memory and archives, Derrida observes that the word processor (25–26), electronic mail and (by inference) databases (16–20) are quite significant shifts:

...electronic mail today is on its way to transforming the entire public and private space of humanity, and first of all the limit between the secret (private or public), and the public or the phenomenal. It is not only a technique, in the ordinary and limited sense of the term: at an unprecedented rhythm, in quasi-instantaneous fashion, this instrumental possibility of production, of printing, of conservation, and of destruction or the archive must inevitably be accompanied by juridical and thus political transformations... (Derrida 1996: 17)

Derrida's impressions are pertinent to invocational media. Invocational media certainly change the medium of inscription — the substrates. The substrates become an addressable matrix of electronic circuits and automatically magnetised surfaces. As Derrida observes, the prosthetic moment of archiving comes when he saves the file:

Was it not at this very instant that, having written something or other on the screen, the letters remaining as if suspended and floating yet at the surface of a liquid element, I pushed a certain key to "save" a text undamaged, in a hard and lasting way, to protect the marks from being erased... (Derrida 1996: 25–26)

The new medium changes not only the manner in which archives are (re)constituted, but how they are created. As Derrida observes, 'psychoanalysis would not have been what it was (any more than so many other things) if e-mail, for example, had existed. If correspondences between Freud and contemporaries had been by electronic mail rather than by post it would have developed at a different pace, and would be recorded in different ways. This point is supported by the transformation in intellectual practices that electronic mail lists, search engines and interpersonal e-mail have brought since the early 1990s.

Derrida does not develop a strong argument about the specificities of the electronic medium here, but points in the direction of compelling questions about writing in general that might be applied to computer media if they are considered as part of systems of Writing that much of his work addresses. Although there are no doubt many productive ways Derrida's work could apply to creating the concept of invocational media, I have not pursued these further in this work. Rather than trace the deconstructive path, I take on the constructive task of creating the concept, influenced more heavily by Deleuze and Guattari.

Deleuze and Guattari

I rejected Marxist, Freudian and Heideggerian conceptual frameworks because of the danger that importing a complete theoretical approach would take over the work of dealing with the specifics of contemporary computers. However, there is an alternative risk that in developing the concept of invocation at a rich enough conceptual level, I might get diverted too far into wider questions — about society, culture and technology in general.

I have already suggested that my approach to this thesis was to gather a collection of useful concepts that apply directly to the process of creating the concept of invocation. I found many of these in medium theorists, in Actor Network Theory and Deleuze and Guattari.

The most useful approaches treat every technical and social event as singular. They tend to generalise from details up, rather than imposing a larger theoretical template from above. They treat intellectual work as a creative process, rather than as a search for objective truths. Psychoanalysis, structuralism, sociology and political science were all somewhat problematic, largely because all were founded with some pretensions to a status as science.

Deleuze and Guattari's work appeals because it does more than move away from scientific and totalising conceptions of knowledge. It takes unflinching leaps towards a different and productive ethico-aesthetic paradigm. Like Derrida, their work belongs in a different generation of scholarship to Marx, Freud, Heidegger and Althusser. Their work is sympathetic with and parallel to that of Foucault (1970), who shows how human sciences are themselves implicated in historically specific processes of creating subjects through discourse.

Without an obligation to produce final explanations (either through logic, philosophical reflection or empirical evidence), Deleuze and Guattari's work

concentrates on creating productive and provocative concepts. They critique and incorporate psychoanalytic, structuralist, linguistic and philosophical approaches within their own work. Their approach is usually not to critique the work directly, but more often to inflect it, turning concepts in new directions.

Of all Deleuze and Guattari's works, *A thousand plateaus* (1987) introduces the largest number of new concepts. Brian Massumi describes their approach in his translator's introduction:

The authors steal from other authors with glee, but they are more than happy to return the favour. Deleuze's own image for the concept is not a brick, but a "tool box." He calls his kind of philosophy "pragmatics" because its goal is the invention of concepts that do not add up to a system of belief or an architecture or propositions that you either enter or you don't, but instead pack a potential in the way a crowbar in a willing hand envelops the energy of prying (Massumi in Deleuze and Guattari 1987: xv).

The collection of concepts used by Deleuze and Guattari contains redundancies (the same concept seems to have several words that define it) and sometimes inconsistent (the same term is used in subtly different ways in different places). For example, the concepts of 'collective assemblage' and 'machine' seem to overlap. For Deleuze and Guattari the term 'machine' does not refer to industrial equipment, or intentional systems. It is more a functionalist concept like the network in actor-network theory. The term seems to change somewhat between when they use it in *Anti-Oedipus*, (Deleuze and Guattari 1994) and when Guattari uses it in later work (Guattari 1995A and 1995B). It is partly the dynamism that drives these apparent inconsistencies that makes their concepts so productive.

In this spirit, I translated my concept of invocational media into a hybrid version of some of the concepts developed by Deleuze and Guattari: invocational media are 'order-word machines'. In the next section I will apply the example of the

'order-word machine' to illustrate the usefulness of the Deleuze and Guattari approach to creating the specific concept of invocational media.

Order-word machines

Invocational media are ambiguous because they seem to work as language and as a technical device, which is exactly why they are usefully considered as 'order-word machines'. Deleuze and Guattari don't separate language from non-linguistic entities, so 'order-words' can be more than what is conventionally considered to be language, and 'machines' can be more than technology. Machines are not limited to psychological, social, linguistic or technical domains, but cross into all of these.

A thousand plateaus proposes a pragmatics of language that extends linguistics beyond information and communication into events themselves (Deleuze and Guattari 1987: 85). Language is not a separate description that works outside events, but is a very part of the event (Deleuze 1990A). Bodies in the world (not just human bodies, but any body that has a proper name or unique identifier), their names and their descriptions connect with the same event. One description never exhausts the event. An event's meaning is contested indefinitely: what one group calls civil disobedience is called disorder and law-breaking by others. However, the majoritarian 'order-word' is likely to prevail because it is backed by power. Any technological or linguistic change changes the event itself.

Events are never isolated. They always move through many layers of collective assemblage. The collective assemblage, a concept which is synonymous with the 'machine', is sometimes a formalised institution such as the economy, or the justice, health and police systems, but more often it is unofficial, temporary or local, with less clearly defined boundaries. The powers in relation to a particular assemblage are expressed with the 'order-word' [*mot d'ordre*]. The order-word is both the issuing of a command and the placing of things in order. Statements

made with language (order-words) assert relations between things. They demand that social obligations be respected. They command events into actuality.

When a speaker utters an order-word, he or she presupposes there are collective assemblages in place that will make the order-word effective (Deleuze and Guattari 1987: 80). When a judge passes sentence what he says is not just an utterance, but a Judgement. His position within the formal collective assemblage gives his word force: he calls on the penitential infrastructure to impose the sentence. The same words spoken in a different context would constitute a different event altogether. No one mistakes an arrest on stage in a theatre for the real thing, even though the same words might be spoken. The change that the act of sentencing imposes is not to the body of the accused, but to their status under the law. It operates as an *incorporeal* transformation.

The order-word attributes incorporeal transformations to bodies in the world. When any event takes place, the status of the body undergoes an incorporeal transformation. When I greet someone in the street, I perform a little transformation that changes the person I have met from unacknowledged to acknowledged. The order-words that a judge and jury make — changing somebody from a free citizen to a convict — are more powerful. Particular collective assemblages have their own order-words, and perform their own incorporeal transformations. The economy has debtors and creditors; justice has guilty and innocent; health has sick and well; the police have suspects and victims. The limits of these roles are often challenged: controversies over trials by the media or vigilantes highlight the boundaries between those who have the right to utter certain order-words and those who don't.

While order-words are not new, computers change the way they are expressed. The difference is invocation. The computer fulfils old desires in the Western

institutional unconscious — to remember; to calculate; to write; and to communicate over a distance unconstrained by the limits of the singular spatial/physical artefact. An institution installs computers to fulfil wills to perceive and act on subjects, individually and collectively, regardless of place, with the least delay and with the minimal ambiguity — a will to invocability.⁷ Computers fulfil these dreams in incomplete and particular ways using invocational assemblages.

Databases do more than transparently represent phenomena in the world. Invocational media in institutions articulate, amplify, memorise and transmit statements within collective assemblages. Modifying records in a database invokes incorporeal transformations that apply to bodies in the world according to the manner in which that assemblage captured them. System designers define the avocations which decide how entities are known, and define the incorporeal actions to which those bodies may be subjected. The designer's decisions most often reassert routine ways that the institution has always dealt with its subjects. Database structures map the possible order-words (reports; macros; scripts etc.) and the possible bodies to which they might apply (fields; relations or objects). When the system is running, it stores, processes and transmits order-words through collective assemblages of digital domains: networks, memory and storage. Once stored up, they are easily invoked, and once again expressed as new events.

The electronic invocation is a form of order-word mediated through data infrastructures. It is a quasi-magical language act articulated through the order-word machine. Computer discourse often has connotations of power:

⁷ Kroker and Weinstein (1994) use a related concept — the 'will to virtuality':

...the prevalent drive of contemporary culture to seek to give itself up to virtual reality and become an incept in the media-net. The will to virtuality is grounded in the fascination with technology as a reaction-formation to the death wish (Kroker and Weinstein 1994: 163).

commands, entries, queries, searches, visualisations. These order-words are decisions heard only with the mediation of invocational order-word machines. In comparison to handwritten notes and typed reports, computer records are immaterial. They are encoded in a form that mimics the ethereal abstraction of a pure event: its presence is ambiguous, simultaneously physical and spiritual. Their image floats untouchable, just behind the glass of the screen.

Once data are entered into the system, they are, for pragmatic purposes, unbounded by geography. Authority (eg. the password) becomes more important than location (physical files and records) in getting access to knowledge. As Hayles argues, without technological mediation, presence and absence were the most important markers of authority. When transactions are made online, though presence and absence are overridden in significance by relationships between pattern and noise (Hayles 1999). It is no longer important where a funds transfer takes place, but the personal identification number must be correct. The engineers who build invocational infrastructures aim to minimise any noise or delays, to make networks effectively placeless. Designers of invocational media aim ultimately at the hubristic goal of making all data invocable anywhere, anytime. However, invocational assemblages have their own geographies, with different speeds (bandwidth, processor speeds), protocols, boundaries (firewalls, security systems, passwords, modes) and entire ontologies in simulated universes.

The incorporeal transformations invoked by a computer are actualised and made physical again by peripherals (see Chapter Three). For Deleuze and Guattari, peripherals are points of inflection that fold over onto wider collective assemblages that articulate order-words. Outputs re-territorialise order-words — trying to bring the world into line with the incorporeal transformations invoked by the CPU. Attached to peripherals, invocational media summon actions directly on bodies. In a military aircraft, computerised guidance systems

use sensors to invoke a target so that the bomb peripheral will destroy it. Computerised braking systems for cars call on algorithms to calculate an ideal balance of forces for the brakes to stop the car. Computer-controlled manufacturing uses peripherals to invoke artefacts directly, displacing human labour. In a bureaucracy, users become the peripherals.

Machines

Invocational order-word machines accelerate and deterritorialise parts of events. In this sense, machines are more than a bunch of components on my desk.

Where machines are conventionally considered to be mechanisms that repeatedly produce the same thing, Guattari looks at them as also generating difference and differentiation. Guattari's machine offers a useful start in generating the concept of invocational media. Guattari develops a broadened (or inverted) concept of the machine throughout much of his work, both alone and in collaboration with Deleuze. The concept appears as the 'desiring machine' in *Anti-Oedipus* (1994B [1972]), as the 'machinic assemblage' and 'abstract machine' in *A thousand plateaus* (1987 [1980]), as 'machinic heterogenesis' and 'On machines' in the essay collection *Chaosmosis* (1995A and 1995B).

The machine is an inclusive concept that encompasses an ultimately infinite multiplicity of forces implicated in forming subjects, societies, technical objects and in fact anything that comes out of chaos. Against a background of chaotic complexity, some forces have enough regularity to be identifiable as 'machines'. The machine is more than a mechanical entity or technical object, it is 'a material and semiotic assemblage... traversing, not only time and space, but also extremely diverse levels of existence concerning as much brain as biology, sentiments, collective investments...' (Guattari 1996: 126). Where Althusser's ideology relies on binary distinctions between 'imaginary' and 'real' relations (Althusser 1977: 156) and class oppositions, Guattari's machines resist

totalisation and encompass a far wider range of forces and relationships that can only be addressed with a more ethico-aesthetic than scientific approach.

Machines are not just 'culture', because they are not opposed to 'nature'.

Geomorphic or astronomical events can be machinic, as much as events that involve instrumental technologies. Talking about machines also avoids talking about structures. Where 'structures' aim to be permanent, machines tend towards their own destruction. The environments of which they are part are always undergoing change (Guattari 1992: 37).

Machines are made up of heterogeneous parts — political, technological, semiotic, psychological and economic. The relations of forces between these parts contribute to ongoing processes that produce not only similar things, but different things. Machines do incorporate signifying systems such as language, but begin with more abstract asignifying systems — the analogue domains of noises and scribblings. Spoken language has sub-representational components in common with ritual and dance. In the same way, computers are humming, glowing, tactile objects, before they are signifying systems. Machines are proto-subjectivities specific to their time and place (Guattari 1995B: 10).

There are virtual components in every machine. To use a very simple non-computer example, a mould and plaster are actual components, but together they comprise virtual statuettes. Until the event of production takes place, the statuette remains virtual. Every machine has 'material, cognitive, affective and social' levels (Guattari 1995A: 35). So as well as the plaster, there are instructions for mixing it, there are aesthetic values that appreciate statuettes, and an economy for distributing and selling them. If all these levels are active, they can be called a 'machinic assemblage'. The actual expression in this example might take form as a contemporary commercial statuette business, or an ancient slave-based imperial order. There are enduring, overlapping regularities with all statuette-making.

What is extracted from these regularities is an overall virtual image of the practice that Guattari calls the abstract machine. Invocation is such an abstract machine. It doesn't create statuettes, but a certain mode of becoming. It appears in ancient Greece as a mythical relationship between humans and gods, recurs in neoclassical poetry, and again in the form of the technical assemblage commonly called the interactive digital computer.

Invocation as an abstract machine

To see invocation return as the invocational order-word machine in modern technology does not mean that it is a universal form, replicating the same ancient event. It is not another instance of the same thing, but a refrain of an abstract set of relationships. The computer gives the abstract machine of invocation an electronically mediated expression. The 'abstract machine' is 'the aspect or moment at which nothing but matters and functions remain' (Deleuze and Guattari 1987: 141).

The 'matters' of invocational media are givens, or data — which are materialised in computers as invisible binary states of sets of digital switches. They are almost immaterial instantiations of matter — invisible, but measurable differences in voltage that deterritorialise any kind of difference (see Chapter Three). The functions in this abstract machine are invocations — circuits and software are organised into layers of virtualised machines and algorithms that transform states of the data and convert data into perceptible expression. The combination of data as matter, and invocations as functions, distinguishes the invocational abstract machine.

However, what defines this abstract machine is not only the act of calling forth and instructing. There have been many simple invocatory relationships in social, technical and even animal forms. It is the way electronic components are arranged to create the abstract *invocational diagram*. Computers in all their forms

have a largely similar configuration of components: inputs, clocks, a processor, storage devices, outputs and (virtual) users.

Babbage's description of the mechanical Analytical Engine in 1837, which features a 'store' and a 'mill', anticipates the invocational diagram (Walker 2000). It includes command and memory components, and Babbage hoped it would mediate rational decisions. It would have summoned results to presence with an invocation at industrial speed. The modern architecture of stored program digital electronic computers was developed in the 1940s and generally adopted after the mid-1950s. A central processor draws instructions and data from memory and from input devices and executes algorithmic transformations. The results of these are sent as data, and as further instructions, to memory devices, or expressed on output devices. A general purpose computer always has this combination of components. Because it can be reprogrammed, it always remains unfinished — an abstract machine that invokes a virtual machine.⁸

This process of reviewing the theoretical literature on culture and technology began constructing a plane of immanence on which the concept of invocational media begins to appear. I have covered some of the basic material in the huge historical and technical literatures on computers (although a lot of new work continued to appear as I was writing). I have extracted a number of very useful related concepts from this survey of modern theoretical approaches — standing reserve, world picture, the implied reader, interpellation, magical thought, and the order-word machine.

⁸ The term 'virtual machine' used in computer discourse is different from Guattari and Deleuze's use of the terms 'virtual' and 'machine'. In computer science, a virtual machine is a simulation in software of a different processor. For example, the program Virtual PC runs on the Macintosh allows PC software to run on the usually incompatible Mac hardware. The JAVA language, which is designed so programmers can 'write once, run anywhere', is based distributing JAVA virtual machine software for use on any hardware platform.

1. Computers and the Humanities

The project of actually writing this thesis, then, is one of building the concept of invocation as an intervention into the literature on computers as a media form. Since I have no other structure, I will use the concept of invocation itself as a machine for writing the thesis. Phenomenology, psychoanalysis, medium theory, literary theory, reader response and so on offer programs, but I take them up as tools, or partial machines. As long as this thesis has internal consistency, clarity and cohesion, it is appropriate to borrow from a wide a range of sources, even if some of these sources are incompatible with others as complete systems.

2. Invoking concepts

What Bricklin really wanted was not a microcomputer program at all but a specialised piece of hardware — a kind of very advanced calculator with a heads-up display similar to the weapons system controls on an F-14 fighter. Like Luke Skywalker jumping into the turret of the Millennium Falcon, Bricklin saw himself blasting out financials, locking onto profit and loss numbers that would appear suspended in space before him (Cringely 1992: 65).

This is the myth of *VisiCalc*. It appears in October of 1979, from out of the blue. There is no program like it. It is inspired by *Star Wars* and a way of using a blackboard in planning schedules and budgets. It is the first electronic spreadsheet software application, and immediately sells 500 copies in a month. A year later it will be selling 12,000 copies a month. The genre will earn Microsoft billions of dollars. This is the first time that a piece of software is so compelling that people buy the computer just to use it (Cringely 1992: 63–72).

Typical histories of computers are complex narratives, with anecdotes, get-rich-quick tales and tall stories about the cultural backgrounds to computer innovations (Kidder 1981, Cringely 1992, Levy 1994, Freiburger and Swaine 2000). In these narratives new applications in hardware or software often seem to come out of a chaotic melange of misunderstandings, conflicts, compromises and thousands of person hours of work (Zuboff 1988, Carroll and Rossen 1984, Woolgar 1991). The stories continue in the life of new technologies on the street, where new things are embraced, resisted or sometimes effectively redesigned in practice.

In spite of these colourful stories, earlier official histories of computers are more often told as narratives of linear progress, or growth towards maturity (Diebold 1969, Goldstein 1972, Fleck 1973, Augarten 1984, Moreau 1984). They create

2. Invoking concepts

teleological explanations, as though history unfolds with an inevitable regularity. Many developments in computer technologies and industries are quite unanticipated, even by participants (Ceruzzi 1986). The historical narratives often claim to discover paths of development that were never apparent to those actually making those histories. The massively profitable PC industry developed almost by accident (Cringely 1992). It is only in retrospect that any of these developments seem natural or inevitable.

Over the decades, computers changed dramatically not only in technical performance, but also in how they operated and functioned as cultural objects. This is part of the difficulty of conceptualising them as media forms: they are more than one medium. The hobbyist computers in the 1970s were radically different to the systems installed at a small number of institutions during and after the second world war. Personal computers in the offices of the 1980s were different again. Computers in the 2000s are not just faster and more powerful, but radically different in form and function.

As I argued in the introduction, computers need a new name. The current name doesn't capture the heterogeneity of expressions of this device. Computation is only one of the multitude of its possible functions. I claim that 'invocational media' better captures the shape-shifting powers of this constantly changing technological lineage. At a lower level, the invocation fuses memory and command to produce decisions (see Chapter Four). At a higher level, which is the concentration of this chapter, invocational media are quasi-universal machines that invoke concepts. They are *becoming machines* that mimic and metamorphose into new images.

As with any innovation, it is possible in retrospect to discern that computer applications had precursors or prehensions — virtual existences before the assemblages actually appeared. So there were proto-computers in the

imaginations of mathematicians, engineers and others who designed these devices. They were also in texts, sci-fi stories, circuit diagrams, algorithms, functions and principles in mathematics and engineering. They existed as mechanical, electrical and electronic technologies, typewriters and cathode ray tubes, relays, circuits and appliances. They existed as manufacturing plants and modes of production and distribution. They existed as educational systems, military industrial complexes and consumer economies. The actualisation of invocational devices involved strategies and programs enacted by already existing human and non-human actors arranged in interwoven networks (Latour 1991).

But what is the process by which something new emerges from all these resources? In Latour's terms (Latour 1991), how were the new networks of actors formed? In Bergson's terms (Bergson 1991), where was the 'becoming in general' of the computer? Because the formalist discipline of computer science tends to be predisposed to a teleological epistemology, historical works within that tradition are often presented as narratives of linear or evolutionary development (Couffignal 1982 [1933], Los Alamos National Laboratory 1998).

Technical developments usually 'progress' by gradual iteration, with small improvements on existing designs. There are, however, key moments when there are sudden leaps sideways. Instead of *teleological* progress — incremental change that follows a predictable purpose — development takes a *tropological* jump.⁹ A teleological history traces logically consistent chains of causation. A tropological approach identifies sudden unexpected swerves and substitutions

⁹ Thomas Kuhn (1996) distinguishes between 'normal science' which develops through puzzle-solving, and paradigm changes, when the assumptions of older paradigms break down and new schema emerge. Software controlled invocational media are a medium of accelerated paradigm shifting, particularly because their development is unconstrained by professional values of objectivity or experimental verification characteristic of scientific practice.

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that don't operate as logical connection or progressive development. This kind of change, which is the most dramatic and significant kind of change, is ironically the type of problem that computers are least suited to modelling.

In literary theory, a trope is a figure of speech. Examples of tropes include metaphor, metonymy, synecdoche and irony (Burke 1969). A trope transposes meanings away from an expected correspondence between one thing and the next. It opens into new territories. It creates a 'line of flight', away from 'stratified' formations — a 'deterritorialisation' (Deleuze and Guattari 1987). Tropes or lines of flight are not only linguistic events. Whether in language, history or technology, tropes deviate from logical connections (White 1978). Tropological cultural innovations can never be reduced to finite equations, because they combine unanticipated and monstrous mixtures of technological components, language, bodies and images.

The peculiar propensity for tropological jumps is part of what makes invocational media distinctive. A computer is re-programmable — a general purpose or universal machine that invokes identities rather than building them. Invocational media are more open to rapid tropological shifts than other technologies. New software makes a new machine. However, universal machines are only universal potentially, since each new computer application becomes an actual machine.

This chapter deals with the notorious shape-shifting powers of computers. It presents some stories about what invocational media actually invoke: whatever programmers and users at the time imagined and implemented. Programmers typically imagined things by gathering familiar entities and events. In many cultural practices metaphor is a powerful force (Lakoff and Johnson 1980). In invocational media, metaphor is more than interface deep.

Computing and metaphor have always been fundamentally linked. Even the central principles of computing are close to those of metaphor: programming one machine to act as if it is another (Condon 1999: S1, p.3).

Invocation revives the special power attributed to names in fairy tales and ancient magic (Wells 1993). A trivial example is the way that names are critical to the technical functioning of many computer systems. At a low level, file names, programming language acronyms and URLs (Uniform Resource Locators) turn names into addresses, or quasi-magical events. Computers are notoriously sensitive to syntax errors and bugs that mostly come from uttering the wrong name or command. Even entering text in capitals instead of lower case can make an invocation ineffective. This sensitivity recalls the importance of names to the cantankerous Rumpelstiltskin in the Brothers Grimm fairy tale.

At a higher level, invocational media invoke something more than the isolated name. Inventing a new name for a program or system brings up an invoked Universe with its own logical and topological geographies. Naming something begins to give it form. At different points in the history of computing, designers find a new name: 'word processor', 'electronic brain' or 'virtual world'. These new concepts attach to the invocational assemblage as a software or hardware development paradigm. Each new development changes the general conception of the nature of this mutable abstract machine. It reterritorialises on another expression — a new name, a new business model, a new configuration, a new virtual machine. These changes are never linear.

In this chapter I present some sideways histories of invocational media. Rather than looking for precursors of lineages that slowly change over time, it will try to capture moments at which the invocational assemblage suddenly invokes a new concept. At these moments the abstract machine of the invocational assemblage reterritorialises in a new territory. It finds a new name, a new

concept. The question at each point concerns what meanings and cultural resources the assemblage invokes from its surrounding milieu.

1943 – The giant brain

A golden collie emerges from the dark waters of a freezing river, shakes herself dry and continues on her courageous journey. The dog has a look of tired determination on her face. She must find her way hundreds of miles across the Scottish and English countryside to find the family who had to sell her because they were too poor to keep her. In the classic ‘family’ film *Lassie Come Home*, released in 1943, this dog embodies all the humanistic virtues of courage, intelligence and loyalty.

In the Lassie narrative, the dog is imputed with intelligence and a sense of morality. She is passing as a cinematic central character, a role conventionally played by humans. But that’s not all. As England is at war, the scenes of English countryside are actually shot in Washington on the US West coast. The Pacific North West is passing as Yorkshire. The female dog who was to play Lassie is unreliable and starts losing her hair, so the film-makers switch her with her stunt double, Pal. So Lassie is a male dog passing as female. Everything about the Lassie story seems to be masking a world of shifting identities: things imputed to be something else.

If the real (fictional) Lassie had got very lost, she might have passed an ultra-secret collection of buildings at Bletchley Park north of London. Inside one of the buildings is COLOSSUS, the first large scale electronic computer to go into service. It is a special purpose code-cracking machine used to decrypt messages sent by the German command using the so-called ENIGMA code. It takes its name from one of the wonders of the ancient world: the Colossus at Rhodes — a

huge bronze statue built two centuries BCE¹⁰ to honour the sun god, Helios. This modern allusion to an engineering feat of an ancient civilisation reflects the classical educations of the academics who created it. It also hints, with some irony intended, that the designers are conscious that building a machine that thinks moves them into the territory of gods.

Like Lassie, COLOSSUS is imputed to have intelligence. Certainly, it does automatically perform calculations previously performed by *human* computers. For the mathematicians, electronic engineers and physicists who built it, including Alan Turing, intelligence is already very important to them. In one sense of the word, the objective of their work is to collect intelligence about enemy activities. In another sense, their reputation for being intelligent justifies their privileged position in the bureaucratic hierarchy. The complexity of the machine itself becomes testament to their superior intelligence. It seems only natural to perform a thought experiment, in an electronic rendering of *Frankenstein*, that computers might eventually even supersede their creators in a hierarchy of intelligence.

After the war, the Turing Test paper (Turing 1950; see Chapter Five) articulates the challenge to engineers to create a machine that will pass as intelligent. This helps establish in the popular imagination the paradigm that computers are machines 'who' think (McCorduck 1979). The computer is imputed with the capacity, at least in theory, of intelligence that is equivalent to human thought. Von Neumann models the design of the computer itself on his image of the brain (Von Neumann 1958; see Chapter Three).

The electronic brain appears in a world in which intelligence is reified as an alienable and quantifiable phenomenon, and where an individual's perceived value to society is related to this quantity. IQ tests are inspired by similar

¹⁰ Before the Christian Era

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assumptions. Alfred Binet pioneered intelligence testing in France in 1905 to help clinicians identify learning difficulties (Aby 1990). American researchers took up systematic large scale IQ testing in the 1910s with a different set of goals. They hoped to prove theories on innate intelligence based on racial difference. Testing large groups of soldiers, they claimed to find different levels of intelligence in different races. The tests were based on the assumption that intelligence is an intrinsic property, possibly genetically predetermined, based on brain structures (Eckberg 1979).

The IQ test provides an apparently meaningful scale on which to compare Lassie, an automatic computer, people of different races, and mathematical geniuses. 'Intelligence' is in the air, highly prized. But the assumptions behind IQ tests are highly questionable. The questions used to try to measure a universal intelligence are culturally specific. The results are strongly influenced by culture and socio-economic factors. The tests arguably measure nothing meaningful beyond the capacity to take IQ tests (Gould 1996). However, in pragmatic terms, it does not matter what IQ testing measures, only that there is a faith that the results are meaningful. The IQ scale is useful as a bureaucratic instrument for individuating and managing populations and allocating resources. In this sense it fits into similar social machines as the computer, which becomes an ideal medium for counting and managing populations. The results of IQ tests are useful in making the argument that differences in wealth, income and health are based on intrinsic properties of individuals, rather than on relations of social power. If differences are intrinsic, progressive political action is likely to be ineffective.

Early computer science capitalises on the perceived value of intelligence by invoking the 'giant brain' trope (Berkeley 1949). It helps the new discipline of artificial intelligence (AI) to attract research funding. AI is founded on a similar assumption to IQ tests: that intelligence is essential, alienable and intrinsic,

rather than embodied, culturally situated and heterogeneous. Again, the assumptions behind AI are strongly contested by philosophers, linguists and others (Dreyfus 1972, Penrose 1989, Searle 1986). Although a passable invocation of intelligence is still not achieved by the end of the century, AI never was a scientifically disprovable proposition. It is often a romantic concept that promises an unimaginable moment of transcendence at some indeterminate point in the future (Broderick 1997, Kurzweil 2000). Research continues with almost undaunted confidence into the 2000s (Jubak 1992, Kurzweil 1990, 2000). It has become somewhat more diverse, and less bound to mentalism. While some specific projects in AI — expert systems, and to a greater extent, neural networks — have invoked applications with some pragmatic force and application, the promised moment of nirvana remains elusive.

AI has had an influence which far exceeds its practical successes. It has attracted substantial research funding to universities and some commercial applications. More than anything, AI has influenced popular images of the computer. Minsky was a consultant for Stanley Kubrik in *2001. A space odyssey*. The psychopathic artificial intelligence, HAL, is quite a dystopian view of artificial intelligence (although he does turn good in the sequel). But cinema anthropomorphises anything — from dogs to machines — so giving the same treatment to the computer is no stretch. The *Star wars* droids, *Blade runner* replicants and terminators in *T2* are other visions of machines becoming human.

Whether or not developers ever invoke a passable expression of conversational intelligence, it is clear that intelligence is not the primary defining attribute of invocational media. While computers might have been modelled on Von Neumann's image of the brain (see Chapter Four), they are not at all equivalent to human brains. They are invocational assemblages. Invoked intelligence is only one of many invocational projects.

1948 – Big Brother’s data processor

Contrary to doctor’s advice, George Orwell sits up in bed for much of the year, typing up the final manuscript of another novel. He has yet to decide on its title. It will either be *The last man in Europe* or *1984*. In this novel he develops an image of a dystopian world in which technology serves a regime of totalitarian control over its population. In the world of the novel every room has a two-way telescreen that watches the residents, and supplies an endless stream of images. Every utterance, every movement, every thought takes place under the eye of Big Brother. This image of totalitarian power draws not only from the histories of Fascism and Soviet Communism, but also from Orwell’s own experiences in boarding school, bureaucracies and political movements (Meyers 1985). For the next half century it provides the dominant nightmare vision for centrally managed and technologically augmented oppression (Clark 1994).

In January of the same year, less than two years after its initial plans were drawn up, IBM launches a showcase machine — the Selective Sequence Electronic Calculator. It is a hybrid electronic and electro-mechanical computer, and has the innovative capacity of operating in random sequence. It is one of the first large scale commercial computer systems, and although it is a one-off, it will be seen as a precursor to the IBM 701, IBM 650 and System/360 that will establish two decades of IBM’s domination of computing. The SSEC maintains a continuity with the office equipment used for the previous 60 years by using standard IBM punch cards (McPherson et al 1982 [1948]). While this machine’s design will not be as directly influential as the EDVAC, and it will never be produced in numbers like UNIVAC, it is the first electronic computer built without involvement from a University. The SSEC’s most powerful impact, though, will be on the popular image of this machine (Bashe 1982).

The SSEC is installed on the corner of Madison and 57th St in New York. Its huge bulk, and the flashing lights of its memory registers, are visible from the street.

For IBM it stands for American science and progress. They offer scientists the use of the machine for worthy purposes. Among the tasks it performs are calculating the relative positions of the earth and moon for years ahead. These calculations will be used by NASA in planning and executing the moon launch in 1969. However, for the man on the street the SSEC has a more menacing subtext. A giant brain in a corporation's headquarters seems nothing less than an electronic incarnation of Big Brother.

Computers in general, and IBM in particular, become icons of the anxieties about technocratic domination by governments and corporations. The punch card's famous inscription 'do not bend, fold or mutilate', speaks in the paternalistic and mildly threatening voice of big government and big business. The cards and paper tapes used in these early large scale invocational systems are a legacy of industrial age surveillance and control technologies. They were used in the Jacquard loom (1805), in Babbage's design for the Analytic Engine (1832) and by Herman Hollerith for tabulating the US census (1890). Hollerith's company was one of three which merged to form IBM in 1911. Hollerith's electro-mechanical card equipment continues to be the core of IBM's business until the 1950s. Cards remain in service long after this as a means of input to computers. Workers' jobs involve moving decks of cards between special purpose machines that punch, sort, collate, verify or multiply the details stored on the cards. Humans read the results from dials on each machine (Shurkin 1996 [1984]: 66–92). The operators' work is not much different from work on a production line that made cars or weapons.

Another concept emerges with the practice of managing data using large stacks of cards — that of 'data processing'. The data processing concept constructs data are as tangible and uncomplicated raw materials as iron ore or cotton fibre in mining or agriculture. It requires a faith that quantitative measurement is an authoritative means of knowing the world. But there is a trade-off that

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processors make for being able to process data in such volume. All aspects of the world must be defined according to positions of holes on cards. Anything unique or qualitatively different must be discarded from the calculation, or translated to the nearest available value.

The 'data processor' performs as industrial equipment for handling people's attributes. Data are metaphorically raw materials, mined or harvested and then refined, cleaned up, made comprehensible before being transformed into reports. The term 'data processor' is appropriate to the bureaucratic organisations which use these early computers. What computers do to language is an automated mode of Orwellian Newspeak.

The data-processor concept attracts forms of critique and resistance that in many ways accept the transparent correspondence between the data and its objects in the world. Orwell himself shares with technological optimists a faith in the technical perfectibility of oppressive technologies. His nightmare vision assumes that mechanisms of total control, both political and technical, are possible, if not already in place (Bolton 1984: 157–160). The image he creates becomes the iconic totalitarian dystopia, often invoked in the face of new technologies that centralise power (Davies 1992). The computer remains a metonymic object for the fear of total dominance of instrumental technology (Adorno and Horkheimer 1983, Marcuse 1972).

Many computer-related institutions have a culture of secrecy that inadvertently helps maintain an aura of mystery. In the military, secrets are kept in the name of national security. Corporations protect their intellectual property as commercial secrets. Insiders tend to form what are effectively magical secret societies. Dirk Hanson (1982) refers to developers of integrated circuit as the 'new alchemists':

Like their historical brethren, members of the silicon priesthood stand jealous guard against other adepts of the inner circle by signing oaths of fealty... (Hanson 1982: 103).

Programmers and engineers are bound by non-disclosure agreements and need-to-know principles that protect innovations from competitors and enemies. In many ways it is in the interests of programmers and their employers to maintain a perception that their work is complex and possibly magical, because it inflates the value of their talents.

If the distinction between technology and magic is that technology is less bound to secrecy and arcane methods, programmers are undoubtedly magicians. They claim it themselves. The most highly regarded programmers are 'wizards', 'gurus' or even 'gods' who practise 'magic', and 'deep magic' (Hacker's dictionary). Programmers develop their own mysterious subcultures: playing practical jokes, eating pizza and throwing nerf balls at one another. As Daniel Harris (1995) observes, this behaviour itself reinforces their aura:

Such compulsive wackiness... engenders respect among the lower echelons of the workforce, who are fascinated by the new group of specialists whom they perceive as nothing less than a new breed of white-collar shamans (Harris 1995: 198).

Popular culture fills the gaps left by the institutional policies of secrecy with fantastic stories that mix speculations about technical powers with the occult. Distance tends to create aura. In the 1990s television programs (*The X-Files* and *Buffy the vampire slayer*), newspapers (*The Weekly World News*), novels (William Gibson (1984, 1987), Neal Stephensen (1992)) and many other forms freely mix magic, technology and government conspiracy. Films feed off this culture of indistinct paranoia around technology. In *The Net* Sandra Bullock's character has her identity erased along with her computer files. The computer's powers threaten her very existence. Uploading consciousness into computers and

downloading it into humans is another common set of themes: Cronenberg's (1999) *Existenz*, Brett Leonard's (1992) *Lawnmower man* (1992) and John Flynn's (1994) *Brainscan* all deal with intelligence augmentation and evil. All accept the total power of the invocational assemblage as though computers really performed as advertised.

Ironically, the machines which generated so much fear in the 1960s and '70s were far less powerful in processing and data access speed than even a laptop in the 2000s. Batch-processors lacked the real time invocational relationship that came with the interactive systems that emerged in the late 1960s. Input and output processes of data processing were often separated in space and time. Long term storage was held in linear devices like cards, magnetic tape and paper. While the term 'data processing' is still used in computer discourse, it has become an anachronism. The real magic of invocational media came with 'real time' interactive computing, which took thirty years to move slowly out of the military into the mainstream.

1952 – Consulting the Sage

April 16, 1952 — hundreds of US Air Force pilots scramble to their jets. Gunners run to anti-aircraft batteries. Air Defence Headquarters has called a general alert after reports from Alaska and Maine of unidentified aircraft approaching. There is confusion and fear. Telephone and telegraph links aren't giving commanders an adequate picture of the evolving situation. It turns out to be a false alarm, but this incident contributes to a desire to accelerate command and control over the nuclear missile arsenal.

After World War II there is a pressure to develop real time computers, much of which comes from a perception, based on experience, that leaders face a level of complexity and speed of change that threatens to overcome their capacities to cope (Bush 1945; Engelbart 1988: 189). Invocational machines are part of a

generalised response to a 'crisis in control' that has developed since the late 19th century, particularly in the US (Beniger 1986). The capacity of humans to affect their physical and social environments has dramatically increased in scale, but the degree of control over this power has not grown as rapidly.

Nuclear weapons are the apotheosis of this crisis. They present the most urgent need to accelerate command. Following the Japanese surrender it seems that the bomb will give America nearly unlimited global military power. Nuclear weapons give US commanders a god-like destructive power. In the mid-1940s Colonel Gervaise Trichel, an amateur classics scholar, names the 'Nike' missile after the Greek goddess of victory, setting a precedent for naming missiles and rockets after mythological figures — Apollo, Triton, etc. (Bruce-Briggs 1988: 47). Oppenheimer's famous reference to the *Bhagavad-Gita*: 'now I am become Death, the destroyer of worlds...' is only a slight overstatement (Goodchild 1985).

Then the Soviet Union reveals that it too has the bomb. The threat of attack generates a climate of terror. This quickly becomes a pretext for dramatically increasing the funding for active defence systems to get real time centralised command. This imperative is a powerful catalyst in the development of invocational systems (Bruce-Briggs 1988, Mackenzie 1990, de Landa 1991, Edwards 1996, Rochlin 1999: 188–209, Winkler 1997).

The most prominent figure in the historiography of the early development in both nuclear weapons and computers is John Von Neumann (Aspray 1990, Aspray and Burks 1987, Macrae 1999, Rheingold 2000 [1985], Air Force Space Command 2000). As a consultant he encourages several branches of the military and government to build computers in the late 1940s, including the RAND Corporation's JOHNNIAC, the Air Force's MANIAC, University of Illinois's ILLAC and ORACLE at Oak Ridge (Aspray 1990: 56). He also strongly advocates the development and use of the hydrogen bomb against the Soviet Union.

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Early computers and nuclear weapons are developing very much in parallel. Military needs have accelerated technological innovation many times before, but never with the scale and speed of the Cold War arms race (Mumford 1963 [1934]: 60-106). The first of the large scale electronic computers is installed at the Moore School in the University of Pennsylvania. ENIAC is a general purpose machine built for military applications like artillery firing tables. Von Neumann uses it to calculate the geometry of implosive lenses in the atomic bomb (Aspray 1990: 28) and complex chain reactions in hydrogen bombs (Aspray 1990: 47).

However, these early machines are not fast enough to use for real time command and control. Modern computers need to operate at a speed set by potential nuclear missile attacks. Weapons systems need to work inside a slender window of time, and across an extensive space of a global exchange of nuclear weapons. These requirements, determined in the urgent political climate of the Cold War, drive computer engineers to develop re-programmable real time digital computing applications and resilient communication infrastructures. Miniaturisation and networking will eventually flow on to consumers as integrated circuits and the Internet.

The most influential project of this era is the Semi-Automatic Ground Environment (SAGE), a computerised defensive system established by the US Air Force between 1952 and 1961.¹¹ It manages continental air defence command by combining data in real time from multiple radar installations to sense enemy aircraft and to issue commands to fighters on where to intercept the attackers (Edwards 1996: 94). SAGE establishes symbolic domains that attempt to create

¹¹ IBM's work on the development contract for SAGE earned that company half a billion dollars. Perhaps even more significantly, the groundwork that the SAGE development laid in designing and building core memories helped secure IBM's dominance in the industry overall (Ceruzzi 1998: 53).

for the commanders a real time fusion of perception and action.¹² It reduces battle worlds to data, and fields of action to commands. Perception and action are made invocational.

Some observers within the military are sceptical when SAGE is first proposed because of its seemingly magical claims. Defending the entire US from attack by soviet nuclear missiles and bombers is virtually impossible because of the scale of the continent and the speed and number of likely incoming missiles. General Hoyt Vandenberg complains:

the hope has appeared in some quarters that the vastness of the atmosphere can in a miraculous way be sealed off with an automatic defence based on the wizardry of electronics (Edwards 1996: 95).

In spite of this resistance, SAGE is funded. Even if they don't understand it, the press and politicians support the 'shield of faith' (Bruce-Briggs 1988). Although there is never an attack from the Soviet Union to test it, SAGE is probably not entirely effective as a defence system. Even the influential US military strategist Bernard Brodie will see the development of SAGE as a grand tribute to the general faith in technology:

That is not to say that effective active defences against the missile are technically impossible, or that their development should not be pursued; it is only to point out that one must have extraordinary faith in technology, or a despair of alternatives, to depend mainly on active defences. The relevant problems are political and social as well as technological (Bernard Brodie quoted in Bruce-Briggs 1988: 431).

¹² Paul Edwards *The Closed World* (1996) recounts the history of the development of anti-missile systems during the cold war. He shows particularly how the theories about computers and psychology, and the metaphors used during the building of these systems, impacted on the development of the systems.

The faith in active defence (and attack) is sustained for decades. Computer-based systems come to analyse satellite-gathered intelligence images, and triangulate positions of multiple objects on a global battlefield. They model battlefields in 3D in real time, so that commanders in the Gulf War will observe virtual effigies of the campaign. The dream is to overcome the 'fog of war' by mapping the field of battle as a real time simulation. The commander can perceive and act in this virtual field, which draws a line between the imaginary and the actual.

The magic of command

The real time invocational powers of SAGE and the real time invocational systems that follow it are motivated by a much older desire for total command. SAGE manifests the same impulses that rulers and magicians have had for centuries. The infrastructures that mediate these commands are built by modern equivalents of shamans and magicians in the Middle Ages. They serve the power of commanders and the nation state by offering their special and secret knowledge. In return they get virtually unlimited resources.

Science fiction writer Arthur C Clarke famously claims that 'any sufficiently advanced technology is indistinguishable from magic.' If magic and high technology have so much in common, why is there such an apparent distance between the two in cultural value? Magic and religion are traditionally science's biggest adversaries. Science is always at pains to show how different it is from magic. In fact, it is because the origins of science are so close to magic that it is essential to stress how different they are. Scientific knowledge must be transparent, quantifiable and verifiable. Their methods are supposedly the antithesis of magic. Its methods produce disenchanting scientific proof. Modern scientific knowledge is incommensurable with anything previous or outside. It makes an absolute break with the past.

As we saw in the introduction, the French science studies writer Bruno Latour refutes the distinction between magic and modern beliefs. He argues not that scientific modernism should be resisted, nor that we are beyond the modern era, but simply that modernity never actually happened (Latour 1993). He argues that the Western modernist project attempts to create two 'Great Divides'. The first separates Nature from Culture. Objective knowledge of Science is partitioned from other knowledge, which becomes less valuable because it is 'cultural' and subjective. Science claims the authority to this special type of knowledge by using technological apparatuses and methods: the laboratory and experimentation.

The second divide is even more significant. It separates the West from all other cultures, distant and past (97–103):

They do not claim merely that they differ from others as the Sioux differ from the Algonquins, or the Baoules from the Lapps, but that they differ radically, absolutely, to the extent that Westerners can be lined up on one side and all the cultures on the other... (Latour 1993: 97)

Because SAGE and missiles on one side, and voodoo dolls and blow darts (for example) on the other, are on either side of this Great Divide, science refuses to acknowledge any similarity between them. At best primitive magic is an anthropological curiosity. Latour claims that modern science created the Great Divides simply by using a special set of practices and equipment: including the vacuum flask, and the laboratory. But it claimed that these scientific methods could create an entirely different kind of knowledge.

Modern 'scientific' methods may produce larger and more reproducible effects than magic, but the pragmatic, political, ritualistic, affective dimensions of primitive artefacts still inhabit the new technologies. SAGE expresses the same will to command as magic, but invocational technology comes closer (within very defined parameters) to expressing commands reliably. Modern scientific

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practices are different in scale, complexity and speed, but they are still magic. Both forms of magic react to fears of enemies and of mortality, desires for protection and guidance, wills to power and command. Cleanly partitioning off the modern era masks the complex remaining entanglements of technology in cultural practices in all their messy, irrational, political complexity.

Latour advocates a symmetrical anthropology that does away with the epistemological breaks between nature and society, between subjects and objects, and between modern and ancient technologies (91–116). Ritual practices are ritual practices, whether their efficacy is judged in magical or scientific terms. This is not to say that SAGE is identical with a voodoo doll, but that they should be compared without an uncrossable line being drawn between them. Their difference is in scale and speed, but not in kind (Latour 1993: 108).

Some critics of modern technology agree with advocates of new technology that modernity represents an absolute change from the past. Anti-modernist writers like Herbert Marcuse share the assumption that Modernity brings in a new era, entirely different from previous times. For example, in *One dimensional man* Marcuse critiques analytic philosophy and positivist approaches to language and society (Marcuse 1972). He claims that these reductive approaches actually end up producing something irrational.

The technical achievement of advanced industrial society, and the effective manipulation of mental and material productivity have brought about a *shift in the locus of mystification*... the rational becomes the most effective vehicle of mystification...

Today the mystifying elements are mastered and employed in productive publicity, propaganda and politics. Magic, witchcraft, and ecstatic surrender are practised in the daily routine of the home, the shop, and the office, and the rational accomplishments conceal the irrationality of the whole (Marcuse 1972 [1964]: 153–4).

I agree with Marcuse's observation that daily life remains subject to mystification, but I disagree with his assumption that Modernity ever was entirely rational.

Even with modern technology, the lines between commands and their execution are never straight. In relationships of command, the will of a powerful commander calls on collective and highly ritualistic practices. Military discipline is established through rites of institutionalised honour and humiliation. One of the mottoes of basic training in the US Marines is: 'One must first be stripped clean. Freed of all the notions of the self' (US Marines 2000). Maintaining command is not only an exercise in brute coercion and hierarchy; it also relies on two related processes: co-opting those with understandings of technology, and gaining the consent of those who are ruled. These conditions were as true in the development of SAGE as they were for rulers in the Middle Ages, when magic and science were indistinguishable.

For complex technologies to work effectively, they need careful supervision and maintenance. Supposedly automatic systems still require people to develop routines. Hardware must be monitored, maintained and upgraded. Operators must be trained. Software must be debugged and updated as conditions change. Users have to learn how to mutter their spells and perform their ritual acts in accordance with valid procedures. Through these practices, routine procedures become rituals.

Developing SAGE also inadvertently builds communities. In spite of secrecy constraints, chains of command develop into webs of conversation. Many of SAGE's components — real time computing, networking, projectile tracking — are generalised and applied elsewhere. Many of the same people, manufacturing techniques and elements have a life beyond SAGE. They go on to develop invocational forms that attach to other cultural machineries. Even

beyond the individuals who worked on SAGE, the language, artefacts and procedures take on a life beyond that system as ritualised practices that again, resemble magical traditions.

In the late 1960s smaller, cheaper and more interactive minicomputers emerge. These expose more people outside institutions to the magic of invocational media. While they do not eliminate the (justifiable) fears about military and commercial megatechnics, they offer alternative visions of a domesticated and miniaturised face of high technology.

1965 – The powers of the mini

September 18, 1965 — a NASA astronaut is forced to eject from his Mercury type space craft when the third stage rocket misfires. The telemetry systems tracking the path of re-entry malfunction, and the ground station loses track of the capsule. It lands on an island in the South Pacific, and the astronaut is stranded, outside communications range. Waiting for the search and rescue team, he explores the area and finds an ornate bottle that dates from Ancient Iraq. When he picks it up a strange pink smoke emanates from the stem, and materialises into a woman in a tight miniskirt. He has rescued the bottle's inhabitant, Jeannie, from a two thousand year old curse. She is obliged to grant her rescuer three wishes. At first he can't understand her, until he wishes she could speak English. His next wish is for a rescue helicopter, and magically one appears (Screen Gems Network 2001). However, she refuses his third wish: that she leave him alone. She smuggles herself back to his home and tries anything to remain close to Tony Nelson. This strange juxtaposition of ancient magic and space age technology becomes the pivotal premise for the '60s sitcom series *I Dream of Jeannie*. Jeannie's naive love and magical powers always show up the plodding bureaucratic high tech world of NASA.

Also in 1965, Digital Equipment Corporation (DEC) releases the Programmed Data Processor 8, or PDP-8 minicomputer.¹³ As the first computer under \$20,000 it will be considered the 'Model T' of the computer industry (Jones 2000). It is the first 'portable' computer, even if it is the size of a fridge. The DEC marketing department are quietly happy to hear that one has been stolen. They promote it as the first computer small enough to suffer this fate. At around US\$18,000, depending on configuration, PDP-8s are far cheaper than the IBM computers that have dominated the market for over a decade. Their success anticipates the inundation of markets by even cheaper microcomputers and embedded microchips during and after the 1970s. For their day, PDP-8s are wildly successful, selling more than 50,000 machines before their phase out in 1970 (Data General 2000). After 1965 computers become increasingly absorbed into the everyday lives of hundreds of millions of people. It is a love affair no less passionate than Jeannie's love for her master.¹⁴

Inside NASA's security perimeter, computers are, like SAGE, icons of command, science and progress. They belong to Captain Tony Nelson's work world of nine to five rationality. Computing is masculine, instrumentalist and scientific. Computers perform logical and mathematical command tasks faster, better and cheaper. They transform orders into actions, summoning up results with superhuman accuracy and speed. They replace mechanical devices with ephemeral, (supposedly) silent electronics (actually the PDP-8 is very noisy). However, computers are also notoriously stupid, prone to errors, bugs and crashes. In the world of *I Dream of Jeannie* NASA commands the most powerful

¹³ <http://www.faqs.org/faqs/dec-faq/pdp8/> accessed February 2000.

¹⁴ It is notable that there is a nostalgia for old computers almost as strong as for old television programs. In February 1989 an email discussion group for 'PDP-8 Lovers' was established at MIT. There are several groups around the world who have restored PDP-8s to working order, and are passionate about preserving them as a significant historical inheritance.

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technology of its time, but day to day life is banal. The romance of the rockets and computers exists in contrast with the mundane routines of work. Even the performance of the actual technologies is patchy, and all operations are ruled by silly office politics.

Outside work, though, technology is more magical. Jeannie personifies the unacknowledged power of irrational desires behind technoscience. Computers echo Jeannie's promise 'your wish is my command'. She has powers NASA and Digital only dream of. She summons events with pure force of will or a mere gesture. She moves things and makes them disappear. Her effortless command over the world mocks the lumbering weight of NASA's Big Science. But her powers are suspicious: tainted with the irrational, the foreign and the feminine. The Jeannie character reflects gender and Orientalist stereotypes: she is dangerously naive and unpredictable.

There is no place for Jeannie's magic in NASA's high-tech bureaucracy, which rigorously polices the Great Divide between science and magic. Tony Nelson constantly has to deny and conceal Jeannie's powers. Tony hides her very existence. Much of the drama (and comedy) come from his attempts to hide her magical actions from the military bureaucracy, and to attribute rational causes to her bizarre actions. In one scene, Jeannie is herself actually mistaken for a computer. In Episode 92 'The used car salesman', Nelson is forced to explain that a car that seems to be driving itself (while it is magically controlled by Jeannie) is actually being driven by an experimental NASA computer (Screen Gems Network 2001). In the fifth season, however, Jeannie comes out into the open when she and Tony are married. As Margaret Wertheim points out, sit coms and other television shows served as cultural preparation for the arrival of cyberspace:

'We who grew up with *Bewitched*, *I Dream of Jeannie*, *Gilligan's Island*, and *Get Smart* — are we not already participating in a vast "consensual hallucination"?' (Wertheim 1999: 243).

The minicomputer (along with time-sharing systems) helps drive a cultural shift by which the dark magic of invocation and its special powers of command begin to become domesticated. High technology begins moving into low culture. Digital is approached by a television station for help in developing a new quiz show, starring the PDP-8. *The Computer Game* will be hosted by a former New York DJ, 'Dandy' Dan Daniels, and pits a panel of celebrities against the computer in a challenging word game. They compete to beat MINI, the minicomputer.¹⁵ The quiz show is hardly fair, since the computer has the entire dictionary loaded and can't lose, but the producers hope it might make great TV. The show opens with a close-up of the machine. As the station announcer starts his banter, the camera zooms out to show the whole machine. Its tape reels start rocking and rolling in time to the cheesy theme music. Dandy Dan leaps out and the show begins (Lasner 1990). Unfortunately (perhaps), the show doesn't get beyond this one pilot.

Domesticating the computer

In marketing the PDP-8 the copywriters try to counter perceptions that computers are depersonalising and useful only for military commanders and scientific boffins. The intimidating connotations of Big Brother, giant brains and military command are barriers these machines must overcome before consumers can feel comfortable with them. Computers have been bound up with the secrecy of the military-industrial complex, the depersonalising

¹⁵ This term 'mini' is credited to the head of DEC's operations in England, John Leng who sent a sales report that started: 'Here is the latest minicomputer activity in the land of miniskirts as I drive around in my Mini Minor' (Jones 2000).

2. Invoking concepts

bureaucratic power of multinational industry, and the post-human threat of super-intelligence.

While the PDP-8 is not yet a consumer device, Digital's documentation shows some effort to 'humanise' the computer. A guide to the FOCAL language, for example, starts with the example of a program that can calculate bank interest rates (Digital Equipment Corporation 1969). This is definitely not a conventional piece of technical writing. The first example program asks, in typically dry terms:

HOW MUCH MONEY DO YOU WANT TO BORROW ?

But the writers offer a rephrased version:

Let's write a computer program which is quite personal in nature and see how the computer could be made to be personal.

This time let's run the program before we explain it:

HI THERE, GOOD LOOKING. HOW MUCH MONEY DO YOU WANT TO BORROW ? :300 (Digital Equipment Corporation 1969: 6).

However, their little joke completed, the writers return to the straight version.

They warn:

One problem though; the computer doesn't know who it is working for — male or female; young or old; pleasant or grouchy; single or married. How would you like a computer flirting with your grandmother? Maybe it really is best to keep the computer impersonal!!

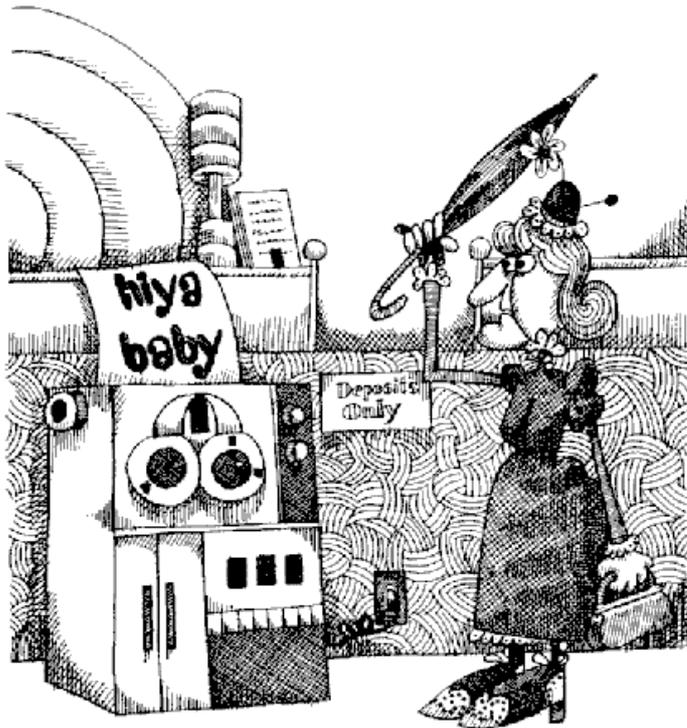


Figure 1: Illustration from Digital Equipment Corporation (1969), FOCAL promotional booklet, p.7.

This friendly style of writing in the brochure, and the attempts at humour in the cartoons anticipate a style of discourse that will commonly be used in popularising computers in the 1970s and 1980s. The style of the presentation reflects the anti-authoritarian mood of the time. Its illustrations look like cartoons from *Rolling stone* or the Beatles' film *Yellow submarine*. The brochure deliberately positions computers as accessible and 'personal' — a long way from the culture of command typical of earlier computers.

Jeannie herself is a very tame version of the Jinnis in the original story originally known as 'Ala al Din and the wonderful lamp'. The story is part of *Arabian Nights*, a group of stories that circulated within oral cultures in the Middle East for centuries, and were finally translated into English, through French, in the late nineteenth century. Modified versions of Aladdin became a favourite in children's books, and Hollywood made several versions of the story.

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By the time the story reaches network television, genie has mutated from 'an Ifrit of terrifying appearance [that surges] out of thin air... his vast black head scraping against the ceiling' (Mathers 1949: 538) into a blonde model in a pink midriff top. Television has transformed the huge, black, male figure of the stories into a petite, pink female. Magic is no longer the dangerous and fearful prospect it once was. America has a confidence that technology can control the natural (and supernatural) world: there is no space left for mysteries. Magic is domesticated, feminised, decontextualised as a fantastic but amusing memory. What remains is a residue of magical desire, embodied in an ideal woman, behind both technology and mysticism. Not only can Jeannie summon up ancient magical powers, but when Tony gets home, she has dinner prepared.

When aired on commercial television, *I dream of Jeannie* is interspersed with advertisements about revolutionary labour saving consumer products. The promises made by advertisers sit naturally alongside Jeannie's magic. In the mid 1960s it seems the world (or the US) is moving towards a state where desires will be fulfilled almost without effort. Futurists talk about coping with the social impacts of increasing leisure. Advertisers promise more and more, and regularly released 'new improved' products. Although the ads are largely fantasy, the viewers are living in a world materially changed by domestic technological devices.

In the-post World War II economic boom in the US it seems there will soon be a product to solve every household problem (if not the war in Vietnam or civil rights). Consumer devices have taken much of the effort out of daily tasks. Fridges with ice-making machines keep drinks cool; microwave ovens cook dinner in minutes. The TV takes central place in the house, transporting whole worlds into the living room. All of these innovations are a kind of magic in themselves. The world of objects is becoming charmed: everyday life increasingly involves using a series of specialised technical devices each of

which requires minimal energy. Everything has handles, wheels, buttons or other controls. Users only have to push, pull or direct these components to complete domestic and professional tasks. Baudrillard points out that in a world where daily life involves dealing with a series of technological controls and readouts, the experience recalls magic:

Something is revived here of the ancient habit, prevalent in a world of magic, of inferring reality from signs... (Baudrillard 1996: 57–58).

Computers are an extension of a broader dream of experiencing a world tailored to convenient manipulation. The process of convergence means ‘common front ends’ are available for more and more activities. The same interface — the same circuits — become the common medium for controlling and experiencing the world.

In the same year that Jeannie and the PDP-8 appear for the first time, the growth in computer power is declared a natural law. Gordon Moore, founder of Intel, prepares a speech in 1965 in which he observes the ‘doubling of transistor density on a manufactured die every year’ (Moore 2000). On this basis he frames ‘Moore’s law’ which asserts that computer power per dollar will double every 18 months. This is not so much a natural law as a marketing plan on the basis of which the industry continues to expand. His prediction becomes a self-fulfilling prophecy which inspires the development of the invocational assemblage over the following decades.

In 1997 the telephone company AT&T revives the Jeannie character by contracting Barbara Eden to make a commercial for their responsive customer service. In this new advertisement, things have changed for Jeannie. At the start she materialises as a help desk operator. She is answering customers phone calls. Her desire to please her master has been transferred to pleasing customers. The camera zooms out to reveal the call centre is inside Jeannie’s bottle. But

Jeannie is not alone. There are dozens of identical desks, with dozens of identical Jeannies answering queries. Jeannie is no longer only in the home: she is everywhere. Invocational media are part of everyday life, no longer secret. Techno-magic has reconfigured bureaucracy. Each operator gives instant satisfaction of customers' desires. Computing is ubiquitous... but before this moment, there's another story.

1984 – Computers for the rest

The broadcast of the 1984 Superbowl between the Oakland Raiders and the Washington Redskins is interrupted by a melodramatic TV commercial. It portrays a totalitarian world in which Big Brother has transformed an entire population into mindless drones. Rows of men march through a futuristic maze-like corridor and into a large auditorium. A huge image in close-up of a grim-faced man stares down from a screen at one end of the hall. The grey, identically dressed figures move into rows of seats, and look back up at the screen.

Intercut with these image is a running woman, bathed in light, coming from the back of the auditorium. She is wearing a T-shirt and shorts, and carries a sledge hammer as she bounds down the central aisle towards the big screen above the stage. A group of riot police gives chase. As she approaches the screen she swings the hammer around her body and releases it. The camera tracks the hammer as it tumbles through the air. The screen explodes, lighting up the crowd. As the camera tracks past rows of stunned faces, text scrolls up the screen: 'On January 24th, Apple Computer will introduce Macintosh. And you'll see why 1984 won't be like "1984"' (Linzmayer 1994: 114–126, Levy 1994: 170).

The good Apple, Macintosh, faces off the evil tyranny of IBM. The woman in the Macintosh advertisement is Jeannie with a sledge hammer. She is Lassie coming home. She is one of the vindictive Muses. She's an angel of information. She confronts Orwell's Big Brother — big government and big business, and most

directly, the computing monolith of IBM. Gender is at stake once again. She also heralds the introduction of the computer as a fully fledged consumer product.

This romantic fantasy introduces a device which tightly integrates actual and virtual machines. It is no longer a general purpose computing machine, but an information appliance. This concept is a leap of faith, which will be gradually vindicated, but never in quite the manner envisioned by its creators. Where computers were previously largely hidden outside popular culture, the Macintosh is saturated in it. New magazines are started to support it. A personality cult starts to grow around the company's CEO Steve Jobs.

As a system, though, it is something different, because it is designed to be accessible. It is a machine that creates its own users, rather than a machine that requires users who are already trained. It is promoted as 'a bicycle for the mind'. It is a media form in its own right, invoking McLuhan's concept of the significance of a new medium.

What McLuhan was saying was that if the personal computer is truly a new medium then the very use of it would actually change the thought patterns of an entire civilisation (Alan Kay in Laurel 1990: 193).

The most significant Macintosh innovation, of course, is its Graphical User Interface (GUI). In command line interfaces like DOS, invocations are typed directly. To copy a text file from a floppy disk onto a hard drive, a user might invoke a command such as '**copy a/ chris.txt c:\docs\chesher /v**'. This would copy an ASCII file '**chris.txt**' into a directory '**chesher**' in the '**docs**' directory on the '**c:**' drive, and verify that copy. This invocation must be syntactically precise, or the invocation will not be effective.

To copy the same file using the Macintosh, users simply need to find the icon for the file '**Chris**', and drag it onto the folder icon '**Chesher**'. When the mouse button is released, the file is copied. The need to make textual commands to

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imaginary logical entities is replaced by an invoked graphical world of desktop, icons, files, folders, alert boxes and buttons. User invocations are no longer made in a machine's language, but performed as gestures towards icons in a GUI Aladdin's cave.

The word 'icon' is more appropriate than programmers may realise. For like religious relics, computer icons are energy units, which focus the operative power of the machine into visible and manipulable symbols. Computer icons also remind us of the use of Hebrew letters in the Cabala or the use of alchemical and other signs by Renaissance magi like Giordano Bruno... such magic letters and signs were often objects of meditation (as they were in the logical diagrams of Raymond Lull); they were also believed to have operational powers. But electronic icons realise what magic signs in the past could only suggest, for electronic icons are functioning representations in computer writing (Bolter 1991: 53).

The magic of the GUI, invoking a malleable world of icons, is followed by software and hardware features that increasingly resemble other electronic media forms. Graphical computers with sound capabilities extend the repertoire of invocable 'multimedia' effects. The term 'multimedia' denotes a mix of text, graphics, sound, animation, and video in seamless presentation. Film-makers are puzzled by the term because they have been combining film, sound, text and animation since the talkies in the 1920s, and to far better effect than any of the day's multimedia presentations.

'Multimedia' once meant orchestrated performances using multiple media (usually tape recording, triggered slide shows, sometimes with lights and even smoke machines). The computer industry commandeers the term to refer to applications which use the computer to deliver entertainment or education content. But in this context, 'multimedia' is a misnomer. The whole point of computer-delivered text is it is *monomedia*. What had required a video recorder,

slide projector, audio tape player, CD player, sampler, synthesiser and whatever, should now be possible with the one device — the computer.

But as a medium, the multimedia computer is both less and more than the deterritorialised media parts converging upon it. On their own, none of the parts approaches the quality of the medium from which it was extracted. But the machine is more than its parts because all the media elements become interchangeable and invocable data types. Computers calculate, visualise, represent and recombine these data when users' invocations call up avocations of programmers and designers.

At this time, though, the principle that is said to define computers as a medium is 'interactivity'. According to this opposition — between passive mass media and interactive media — audience members with an interactive computer become active, individual users. Users direct narratives, explore virtual spaces, call up specific things and so on. Interactivity supposedly distinguishes media technologies which allow users to participate from those that don't. This distinction opposes computers to the dominant forms of mass media such as film, broadcast television and readers of print media, whose audiences supposedly received material passively. This somewhat negative definition defines what computers are not more than what they are.

The problem with this conception is that using mass media is not really a passive experience. Audience members are selective when reading a newspaper, choosing only the stories and advertisements which they find interesting. They watch and interpret films actively, and discuss them with friends. When watching television, they often comment on a program over the top of the sound. Box office returns, reviews, newspaper readership figures, TV ratings, letters to the editor, complaints and so on are all means of interacting with the producers of mass media. Of course these are different kinds of interaction from

those made possible by computers. But the term 'interactive' doesn't really distinguish what makes computers different from other media.

It is more interesting and distinctive that this new media form is *invocational*. The capacity to call up images, sounds and texts is quite different from other media technologies: slot in a floppy disk, a CD-ROM and you can summon up hundreds of previously invisible images or texts. This capacity to invoke will become increasingly evocative as invocational media string together individual invocations to invoke entire environments. If computers are multimedia, then it is in a different sense: invocational media invoke any number of media forms — text generating media, image manipulating media, one-to-one, one-to-many or many-to-many communication media, and so on. In this way, computers are not one medium, but many media. The fact that they are invoked is the only feature that they necessarily share (see Chapter Four).

1989 – Journey into cyberspace

In spite of their proliferation into offices and homes, computers remain hard to imagine. When smokestacks and speeding trains transformed the landscape during the industrial revolution, change was undeniable, even if there was no political agreement on its social value. Futurists celebrated while Luddites resisted, but no one could avoid seeing the change. The 'information revolution' lacks such conspicuous material manifestations. In the 1950s the classic image of the computer in the US was the SSEC, with its huge panels of flashing lights, spinning tapes, and mysterious slots that spat out cards. Part of the institutional computer's ominous presence was its *lack* of presence. It was everywhere and nowhere. The personal computer is a more modest artefact than the SSEC, but equally hard to come to terms with. Its form factor does not correlate with the scale of the changes it brings.

In the late 1980s, artists and designers often create spatial representations of the logical worlds of computers as televisual 3D spaces. These fill the vacuum in the popular imaginary about what a computer actually is. Spatial concepts and images promote computers as mediators of new spaces. Info-bots on surfboards shoot down superhighways that span glowing hallucinatory landscapes. This techno-spatial imagery appears in science fiction, cinema and television, human computer interface design and political rhetoric. Spatial metaphors make technologies more tangible. But these invoked user illusions tend to present particular systems as natural.

Today another frontier yawns before us, far more fog-obscured and inscrutable in its opportunities than the Yukon. It consists not of unmapped physical space in which to assert one's ambitious body, but unmappable, infinitely expansible cerebral space. Cyberspace. And we are all going there whether we want to or not (Barlow 1994A).

Here John Perry Barlow quite uncritically compares cyberspace with a heroic history of westward American expansion and international neo-colonialism. His technological utopian vision presents these developments as a universal good that should be embraced. But this imagery is highly loaded — it is a myth for old white male Americans. Far from liberating everyone, Barlow's rhetoric builds boundaries across the imaginary landscapes, once again forgetting the victims of the heroic colonialism to which he alludes. There is no space for other possibilities: it is coming, like it or not.

Critics draw attention to how the technoc celebratory rhetoric naturalises what is in fact a political agenda in the interests of its proponents. Kroker and Weinsten's theory of the 'virtual class' attacks this new elite (Kroker 1994). The superhighway is not a fast way to get places, but a new means of claiming territory.

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...the digital superhighway... swallows bodies, and even whole societies, into the dynamic momentum of its telematic logic. Always working on the basis of the illusion of enhanced interactivity, the superhighway is really about the full immersion of the flesh into its virtual double. As dead (electronic) space, the digital superhighway is a big real estate venture in electronic form (Kroker and Weinstein 1994: 7).

Virtual reality spaces bear no necessary relation to actual spaces. They reterritorialise virtual spatial relations, but operate according to the lag-ridden dynamics of invocable domains of memory and command. Records in databases are commanded into parallel universes in which events occur outside the usual physical spatial and temporal constraints. Stock markets, libraries, shopping centres and entertainment complexes exist nowhere in particular, visible only through small screens. Text called up on screens replaces physical documents. Data flows stand in for banknotes. Work processes change from embodied practices to more abstracted control (Zuboff 1988). Writing, cataloguing, communicating, interpreting and controlling are now very different activities in their incarnations as computer mediated invocations.

In science fiction, parallel dimensions and worlds through looking glasses are familiar themes, so it is no surprise that advanced computer systems seem often to invoke fantastic universes. The original 'cyberspace' appears in the novel *Neuromancer* (Gibson 1984) and its sequels. These are more contemporary nightmare than utopian projection. The world of the novel invokes mysticism, corporate power, cyborgs, drugs and mental illness in equal measures. In *Count Zero*, the art of 'voudou' is quite a pragmatic image of technology / magic:

"Vodou isn't like that," Beauvoir said. "It isn't concerned with notions of salvation and transcendence. What it's about is getting things done (Gibson Gibson 1987: 111).

In Gibson's world, corporations have taken almost absolute control over life on earth. The 'matrix' is an invoked space that is rapidly becoming a reality of

greater significance than the decaying physical world. It is a space inhabited by warring artificial intelligences and voodoo magicians.

Ironically, sci-fi nightmares of the '80s are a major inspiration for designers of actual systems in the '90s. John Walker at computer aided design software company Autodesk starts a 'cyberspace initiative' in 1989 to build a technology based on Gibson's dystopia (Sherman and Judkins 1992). But the imagined worlds are more pastoral and appealing than Gibson's nightmares. The appeal of the synthetic worlds seems to rely on a perverse high-tech nostalgia for the pre-tech world. The 'virtual reality' dream implies that technology can provide a way of returning to spatial and direct experience. Even though computers are synthetic and non-spatial, VR inverts these limitations by claiming that the systems create a *better* experience and a *new kind* of space (Chesher 1993).

Even architects articulating some of the early designs for cyberspace are inspired by Gibson. In one of the first books theorising cyberspace, architect Michael Benedikt (1992: 119–224) describes a system for creating usable virtual spaces. He proposes principles of dimensionality, continuity, curvature, density and limits. He claims these will create virtual spaces with a reassuring uniformity (132). His cyberspace resembles a neon-glowing urban grid — a matrix of cells, each of which represents an institution. Users can cruise in a 'probe' over the rows of thousands of data cells.

Benedikt's configuration reasserts property relations; each cell is 'owned and maintained in some way, it corresponds to the idea of property, of real estate...' (1992: 202). This shape of cyberspace is unapologetically political: '[j]ust as in the real world, the size of a plot of cyberspace is itself information: about the power and size of the institution that owns and operates it (1992: 203). This ontology is conservative, precluding any possibility that virtual worlds might escape the constraints of conventional spatial dimensions. Benedikt's instinct is to impose

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on cyberspace a phenomenal uniformity which can be controlled, commodified and mapped.

Spatial metaphors are imported directly into public policy, with the rhetorical roll out of the 'information superhighway' in the mid 1990s (Gore 1994). Gore warns of avoiding 'bottle necks', ensuring 'public right of way' and establishing 'road rules'. His historical reference to the 1950s freeway system claims authorisation for the US Federal government's involvement in building computer networks in the '90s. Included in the National Information Infrastructure legislative program is an attempt to implement the 'Clipper Chip', a standard form of encryption which aims to ensure government agencies can tap into digital communications. The automotive metaphor clears the rhetorical path for a virtual highway patrol. However, the attempt to introduce the Clipper Chip fails by the end of the 1990s, and the superhighway metaphor gradually becomes unfashionable.

Three dimensional imagery is more persistent in cinematic and televisual representations of new technology. Computer graphics supposedly represent worlds inside computers and networks. But since computer circuit boards, twisted cables, standard lo-res computer images lack televisual impact, computer animation sequences, which often require days of production for seconds of screen time, are widely used in advertising and special effects. These feed popular images of how computers work.

Computer companies encourage the proliferation of images of computerised wonderlands. The chip manufacturer's 'Intel inside' campaign, for example, features a sequence which takes the viewer on a fantasy voyage down a network cable. A seamless transition finds the virtual traveller on a journey down the canals of Venice.

One of the first films to introduce the conventions for spatialised computer imagery was Disney's *TRON* in 1982. In this film Kevin Flynn finds himself inside the machine, fighting a Big Brother figure: the 'Master Control Program'. He is forced to fight deadly gladiatorial games on the 'game grid', but escapes to hijack a space ship, in a sequence which, of course, resembles a video-game. Similar images reappear in *Lawnmower man* (1992), *Ghost in the machine* (1993) and even the opening sequences in the romantic comedy *You've got mail!* (1998)!. All reinforce the impression that the world inside computers is spatial in a conventional sense. Shiny 3D worlds are appropriate to the narrative and aesthetic conventions of cinema but misrepresent the topology of computers' data architectures.

The other common generator of the impression that computers function in spatial ways are computer interfaces. Designers use spatial illusions to help users manage files, browse through documents and use programs. Playful image manipulation is almost as old as interactive systems. In 1963 Ivan Sutherland created online computer-generated spaces using one of the first graphical computers, the TX-2 at MIT. His program 'Sketchpad' creates precise engineering drawings with a light pen (Sun Microsystems 1994–1999). Not long after, students created the first game, called 'space war'. Games also create 2D and 3D spaces. Over the following years a series of companies will make huge profits from colonising the invoked spaces with video games: Atari, Nintendo, Sega and Sony. The fights over these spaces have high stakes. They claim spaces with research and development, advertising and promotion. They police their invoked territories by controlling proprietary standards and enforcing patents, and copyrights.

In the 1980s and 1990s, commercial software developers realise that there are more potential users than those in the spotty-faced niche. There is money to be made from 'the rest of us' by making computer use itself more like playing a

game. Designers expand their markets by improving the ease of use and 'intuitiveness' of systems. Spatial metaphors become commonplace with interfaces for WIMPs (Windows, Icons, Mouse, Pull-down menus). Macintosh OS and Windows use icons within windows to represent files and logical system entities. Mouse gestures perform commands. Users suspend disbelief by accepting spatial cues (moving items across the screen, layering objects on top of one another). Behind the windows, though, the topology of dataspace always remains non-spatial. Features like user scripting, search and replace functions, and automatic wizards and helpers betray the artificiality of the spatial illusions.

The spatial metaphors chosen by West Coast American developers are heavily culturally charged. The desktop and trash can are office-like spaces. Software primarily supports the goals of its largest group of customers — office workers. People in other forms and places of work must adapt or abandon software that is not designed for their application.

The examples I have just given, in architecture, public policy, cinema and interface design show the ways that spatial metaphors tend to encourage narrow conceptions of cyberspace, and thereby restrict the multitude of potential configurations of invocable domains. *Cyberspace* is misleading because invocable domains are not spatial at all. Networks do not reproduce space but eliminate it. Computer technology retrieves and processes encoded data almost instantly. It allows events to be composed and recovered as data irrespective of where they are located in space or time. Telephones and computer networks compress space to make distance effectively irrelevant within their domains.

Invocational media produce new mediations of space and time. Using a computer is closer to speech than to travel. It is more comparable to a magic ritual practice than to the carriage of an object from one place to another. Data is invoked by a *command*, a *call* or a *gesture* with an icon. Computer invocation is

possible because of the way the technology is engineered: as invocable domains of randomly addressable digitally encoded symbols.

Conclusions: the invoking machine

In only fifty years the invocational assemblage becomes not only several orders more powerful in technical specifications (memory, processor speed), but hugely powerful in its cultural hegemony. The microcomputer subsumes virtually all other mechanisms of command and control and most audio-visual technologies, on top of its conventional data processing functions.

Although by the 1990s the invocational assemblage proliferated to a point where it was ubiquitous in Western society, this growth was rarely planned. As this tropological history has suggested, the invocational assemblage adopts many faces. It is a superhuman brain. It inspires fear as a technology of surveillance and social control. It calls up the magical imaginary in its capacity to bring things into presence through words alone. It inspires the military with its promise of total command. It is domesticated as a consumer's information and entertainment appliance. It becomes a pathway to a new frontier. Every few years the invocational assemblage seems to mutate into a new form appropriate to its times.

The number of faces the invocational assemblage adopts betrays its radical abstraction. It is a technical arrangement characterised by a capacity to become something else. It is the universal invoking machine. However, the invocational assemblage is not outside history. It is abstract, but not so abstract that its components carry no baggage. Quite the contrary. As the following chapters will show, all the components: inputs and outputs, command and memory, and the virtualised user subject, are very much part of the times and places in which they emerge.

3. Ontology of the invocational interval

As the previous chapter glanced through historiographical images of the invocational assemblage, it might seem nothing stood still. Computers were constantly re-invented — as artificially intelligent, Big Brotherly, magical and virtually real. The only thing that stays constant through these transformations is the capacity to invoke something. The previous chapter identified a higher order of invocation, by which invocational media draw up available cultural resources and manifest them as assemblages of technical and cultural components. However, in this chapter I want to examine invocation at a lower, more abstract level to identify invocation's 'genetic element' — a creative force out of which the higher order invocations emerge.

This chapter and the two following it break the invocational assemblage into parts to analyse lower level invocational events in more detail. This chapter looks at input and output devices, which compose and express invocations. It will argue that although the invocational assemblage is based on Von Neumann's rationalist image of the brain, it turns out to look more like Bergson's image of the brain as an 'interval' between perception and action. Chapter Four will concentrate on the CPU and memory devices through which invocational sequences are articulated, and the two clocks which regulate invocational duration. It will show how invocational media function within more extensive machines of memory and command. Chapter Five shows how users become part of invocational assemblages, a process which promotes new forms of subjectivity based around becoming user. As will become apparent, each of these parts has unacknowledged cultural histories as well as technical functions.

Philip Agre identifies two schools of thought in computing: mentalism and interactionism (Agre 1997: 49–65). Mentalist approaches are characterised by metaphors of inside-outside such as are implicit in the terms ‘input’ and ‘output’ devices. In psychology, both cognitivism and behaviourism are mentalist, as both see the problem of the brain as consisting of interactions between an inside and an outside. Mentalist assumptions have driven computing since its inception. They always place central importance on the contents and actions of the inside:

Concisely put, mentalism provides a simple formula that gives plausible answers to all questions of psychological research: put it in the head. If agents need to think about the world, put analogs of the world in the head... The tacit policy of mentalism, in short, is to reproduce the entire world inside the head (Agre 1997: 51).

The alternative approach according to Agre is ‘interactionism’ (Agre 1997: 52–65). This approach (or set of approaches) tries to avoid the dichotomy of inside/outside by concentrating on the machinery and dynamics of actors within complex environments. Rather than analysing formal symbolic events inside the machine, interactionism looks at how actants perform within given situations, and how they relate to each other over time.

The theory of invocational media is broadly in the interactionist camp, although it does not overlap entirely with all interactionist approaches. An invocatory device (a light switch, a lever) triggers an immediate event. A switch is flicked, and light reveals something that was in the dark. In the invocational assemblage, which operates with programmed sequences of invocations, each switching is less determinate. This complicates the interactionism of invocational media. Unlike the simple switch, computers create a gap — an interval — between events of input and events of output. Inside this gap are the

invocational functions of memory and command, but outside are the micro-politics of that place and moment.

The invocation is not the possibility of a decision, but a singular moment of decision itself. In linguistic terms, it is not a phrase or a proposition, but a statement (Deleuze 1988A: 1–22). An invocation completes a set of circuits, over a specific duration, performing a discrete, single, or compound, transformation. A compound invocation ties together a series of related operations, either simultaneously or consecutively. Although each invocation is similar to uncountable billions in the past, every one is unique.

An invocation is not a circuit, an algorithm or a section of compiled code, but a multi-layered event that folds through hardware and software components in the machine, and through components beyond the machine. An invocational event that folds is quite different from the dominant conception of a signal that is transmitted (Deleuze 1993). Invocational media are richly layered, registering vibrations in one layer that become vibrations in a different medium in another layer. A sound passes into a microphone and becomes an electric current; the current passes into a converter, and becomes a stream of bits; the bitstream passes into a hard drive to become a pattern of magnetic fields on a spinning platter. What remains through all these transformations is the ‘fold’, or the pattern that began as a sound. Within the invocational interval, the folded data can be re-layered and re-folded indefinitely. Invocations can copy and transform these folded events, adding simulated echoes to the sound, shifting its pitch, or bringing it back once again as a sound that the user can hear.

The general purpose re-programmable digital computer is a specialised set of components — the famous Von Neumann architecture — that produces these events of compound invocation on folded data. This chapter deals with the components which connect the command/memory system with the world:

input devices which compose invocations; and output devices, which express the consequences of invocations. The invocational input/output system is distinctive because it deterritorialises data by composing invocations and reterritorialises data by expressing invocations.

Von Neumann first publicly describes this assemblage in 1945 in the 'First draft of a report on the EDVAC'. In it he discusses the 'structure of a *very high speed automatic digital computing system*, and in particular... its logical control' (Von Neumann 1973 [1945]: 383. Italics in the original). He summarises some of the significant capabilities of this machine (operating automatically according to stored instructions; temporarily holding intermediate results; recognising errors), and weighs up comparative advantages of different components (opting for vacuum tubes over mechanical relays (388)). But more important than all of these is the invocational architecture — central processor, inputs, outputs and memory/storage.

Before ENIAC, human computers — often women — in large institutions undertook routine mental tasks delegated by more senior scientists and engineers. These orders started to be diverted to computers as invocations, articulated as electronic signals through carefully selected and arranged components, and expressed as computer outputs (see the next Chapter). But Von Neumann's documents which propose to transfer a function from women onto machines make no reference to the social changes the proposal requires. Instead he presents a purely formal proposition about how to perform complex and rapid logical and algorithmic functions with a machine. He pays hardly any attention to the pragmatics of events in which computers will participate. This reflects his instinctive mentalist bent. It is systematically blind to the dynamics of invocational media as devices which operate within wider cultural and social assemblages.

The analogy with the brain

Throughout the 'Draft' paper Von Neumann compares the computer design with the human nervous system.¹⁶ He expands further on this analogy in the book *The computer and the brain* (Von Neumann 1958). While he was writing these works he was involved in the Macy series of conferences on cybernetics, where he and others, including Norbert Wiener, discussed feedback loops in a wide range of natural and technical systems. Their work compared mechanical thermostats with the human sense of balance, since both operate by systems that oppose sensors and motor organs (Hayles 1999: 7).

In using the brain analogy, Von Neumann is part of a long tradition of conceiving and designing automata — machines that mimic living systems. However, his approach reflects a hard determinist rationalist ontology. It assumes that it will ultimately be possible to create a perfect simulation of a brain, because he believes brains are themselves discrete state machines (Von Neumann (1973)[1945]: 387–389). Discrete devices, as Turing proved in 1937, are more versatile in their capacities for representation than devices that use continuous variations. Digital devices are also potentially interchangeable. Any Turing machine can simulate any other Turing machine (Turing 1965). It is significant, though, that Von Neumann claims that, like his design for a computer, human nerve cells operate as discrete state machines:

...neurons of the higher animals are definitely elements in the above sense [with discrete equilibria]. They have an all-or-nothing character, that is two states: quiescent and excited (Von Neumann 1973: 388).

¹⁶ J. Presper Eckert and John W. Mauchley, who designed ENIAC, did not agree with Von Neumann's brain analogy (Eckert 1982). However, as last chapter showed, this analogy has regularly been applied in popular literature and the field of artificial intelligence since (Berkeley 1949, McCorduck 1972, Juback 1992). This was discussed in Chapter 2.

His analogy makes two mentalist assumptions about the brain — first, that neurons are discrete state machines, and second, that the brain operates symbolically. His formal model of mental processes proposes that brains operate, at their lowest level, using some system of symbolic representation like mathematical symbols. Hence, the brain is literally a very very sophisticated Turing machine, and therefore could, in principle, be simulated perfectly.

Von Neumann's later work on automata extends his approach of modelling thought and other complex events as complex interactions of simple primitive objects. Although he acknowledges these are oversimplifications, he sees them as only *quantitatively* inadequate, not as qualitatively different from the events they model. He makes one of the classic rationalist assumptions about thought — that it works with mental entities that stand for objects in the world (Winograd and Flores 1986). This approach oversimplifies the relationship between the symbolic simulation and what it stands for.

At the same time, Von Neumann's model down-plays the significance of the sensorimotor system in thought processes. He sees the 'sensory or *afferent* and the motor or *efferent* neurons' as lower order elements, not involved in significant ways in abstract thought (Von Neumann 1973: 385). He has little concern for the body's role in mental events. It is the furthest thing from the rational core of his interest:

The very last stage of any memory hierarchy is the outside world—that is, the outside world as far as the machine is concerned, ie. that part of it with which the machine can directly communicate, in other words the input and output organs of the machine (Von Neumann 1958: 36).

Von Neumann has even less concern about how humans, or computers, engage with their immediate surroundings. He invariably privileges the transformative power of the 'central control' and 'central arithmetical' elements (Von Neumann 1973: 384). Perhaps this omission is because he was mainly interested in

designing a functioning machine. He expected this machine would be used mainly by mathematicians, and some businesses. Was he such a specialist that he had no concern for the social implications of his inventions?

It is not true to say that he was disinterested in the social dimension of his work. Quite the contrary, in other work he advocates game theory for modelling economics, social dynamics and geopolitics (see Chapter Two and Five). Moreover, he acted on these in his extensive involvement in developing government policy early in the Cold War, vigorously advancing a very aggressive approach to dealing with the Soviet Union:

If you say bomb why not bomb them tomorrow, I say why not today. If you say today at five o' clock, I say why not one o' clock? (Slater 1987: 30)

Von Neumann was confident that all kinds of problems could ultimately be resolved with logical and technical solutions. He seemed to see ethics and politics as reducible almost entirely to mathematics and logic. For example, while he acknowledged that there is no universal system of economics, he approached that discipline as a task of enumerating factors involved, and creating dynamic games models to determine the most effective policy strategies (Von Neumann 1944).

It is generally agreed that Von Neumann was wrong in his assumptions about the activity of nerve cells. The structural analogy between computers and brains is not supported by biological evidence. Nerve signals are never simply all or nothing. Their states involve much more complex chemical and electrical changes. It is an oversimplification of the action of individual and groups of neurons to describe them as a binary system (Dreyfus 1972).

No arguments as to the possibility of artificial intelligence can be drawn from current empirical evidence concerning the brain (Dreyfus 1972: 74).

Von Neumann's image of the brain also implies that processes of thought stop at the boundaries of the organism. Rationality is all in the head. Following this model, the computer is seen as creating a mathematical mirror world which can be read off as a workable, if not entirely true, representation of the phenomena it models. Even in his time, Von Neumann's assumptions were under question. Godel's incompleteness theorem, proposed in 1931, found that 'any formal system of symbolic reasoning required postulates or propositions for which the system itself did not have proof' (Hobart and Schiffman 1998: 199). This showed that all invocations of formal models stand on foundations of faith.

In spite of Von Neumann's problematic assumptions, the image he had of the brain did inform the design for invocational devices (although he had an extended legal battle with Eckert and Mauchley over who should get credit for that design). His reductive determinist epistemology, which draws a direct formal analogy between the brain and computers, does not take into account the pragmatics that would emerge in the relationship between observers (users) and model (computer simulations). The invocational assemblage fulfills some of his needs as a mathematician, but he has not rebuilt a human brain. He has invoked a brain that behaves little like the human being on which it is supposedly modelled. But it does something. The question is, what does it actually do?

Von Neumann's work, then, raised a fundamental question: even if you do build a functioning brain, how do you know if you have succeeded? Turing avoided the whole question of structure by proposing his famous imitation game (Turing 1950). If something functions as intelligent, he says, it is intelligent. The Turing test does not entirely abandon the analogy with the brain. However, it no longer models the brain of the self, but the brain of the *other*. His pragmatic measure of intelligence is based on the subjective impressions an interrogator would have. The test succeeds if the difference between a human and a machine is indiscernible. As it turns out, Turing

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underestimates the difficulty of processing natural language. Even fifty years later there is no application that gives a convincing automatic impersonation of a day to day conversation.

However, Turing's own observation in this essay is easily passed over: computers were already passing a less rigorous version of the same test:

The reader must accept it as a fact that digital computers can be constructed, and indeed have been constructed... and that they can in fact mimic the actions of a human computer very closely (Turing [1950]: 438).

Users were already inputting mathematical and logical problems into their computers, and the computers were giving them results. It made little difference to the mathematicians whether the results came from humans or from machines. In fact, machines were often faster and more reliable. It wasn't conversation, but within limits, it passed Turing's test. Users 'spoke' to the machine only in invocations — commands, switch settings, punch cards etc. Computers responded by expressing results as unfolded, partly programmed, invocations of their own — print-outs, dial read-outs, etc. While they failed to mimic natural language conversation, they were quite satisfactory in creating working relationships of delegation or command, and gave almost immediate and acceptably reliable responses.

Over the following decades computers performed admirably in a whole range of invocational Turing tests. While AI itself was bogged down in mimicking human behaviour, other scientists and artists built more and more apparatuses based on the invocational diagram. Computers did even better once software developers established hierarchies of avocation — languages that made composing invocations increasingly simple for programmers and users (see Chapter Five on designing users and software). By the 1990s, computers were responding to billions of invocations every day: automatic teller machines,

personal computers, information kiosks, web servers, video cassette recorders and so on presented invocable faces.¹⁷

Invocational assemblages like personal computers function pragmatically, irrespective of whether they have 'real' intelligence or not. All users care about is the transaction, and what is manifest on output devices in response to the invocations they compose on input devices. Notice, however, that these events don't originate in the CPU and emanate outwards. Events begin as vibrations outside the invocational assemblage (keystrokes, video camera inputs, mouse movements) that are folded up as data and instructions. Computers create delays between these events of perception and events of action. At some later moment, they express unfolded invocations with output devices. Looking at computers in this way decentres the CPU, and puts far more emphasis on the functions of input, output and memory devices in the invocational event.

This invocational model of the machine matches Henri Bergson's description of the brain in the first chapter of *Matter and memory* (1991 [1908]). He argues that the key difference between living and non-living things is the interval between an action upon their bodies and their body's reactions. He distinguishes living or non-living systems based on how they respond to actions upon them. Von Neumann's invoked brain presents a new complication to Bergson's living/non-living categories. On closer inspection, though, Bergson's brain offers a better conception of the invocational assemblage.

A non-living object typically reacts to outside forces in a manner that classical physics can predict. Any action faces an equal and opposite reaction. An animal's nervous system, on the other hand, creates delays between the moment

¹⁷ Jaron Lanier makes a similar argument in a *Wired* Column: 'Real though miniaturised Turing tests are happening all the time, every day, whenever a person puts up with stupid computer software' (Lanier 2000: 164).

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its body is touched from the outside, and the moment that it reacts with a motor action. When a hand senses pain, the nervous system and muscles in the arm almost immediately move the hand away from the source of that pain. The reflex reaction is almost immediate, with a loop that causes a reaction directly from the spinal cord. In many cases, though, the body makes no apparent response to perceptions at all. Vibrations pass into the brain, which selects an appropriate response, which may be no apparent response at all. The sensation is absorbed as memory and experienced as affections. In the brain, immediate perceptions of the senses mingle with memories to allow the brain to select from a wide range of possible reactions in any given situation. The brain complicates the relationships between input and output, although perceptions are always tuned to possible actions.

In this, Bergson anticipated the foundational analogy of connectionist cognitive science — that the brain is like a big switchboard with no creative power of its own:

In our opinion then, the brain is no more than a kind of central telephonic exchange: its office is to allow communication or delay it (Bergson 1991: 30).

A switchboard doesn't create anything new, it just delays and processes what comes in and gets sent out.

Von Neumann's invocational brain device may not be alive, but it does create delays between input and output. Invocational delays are not simple cybernetic loops. Analogue devices like thermostats maintain a single circuit in a constant, immediate relationship of homeostatic balance between input and output. The signature of the digital machines, by contrast, is a matrix of circuits which switch from off state to on state according to instructions stored in invocable domains. The current that flows through the electronic circuits is regularly interrupted by the CPU, which swaps one circuit for another, thousands or

millions of times each second. Consequently, like the human sensorimotor systems, inputs register outside events, but don't necessarily create immediate corresponding outputs.

The traces captured by input devices are translated into data. For the input pattern to be expressed again requires a separate invocation of output devices. Within these circuits there is more scope for the emergence of virtual components. The term 'virtual' is most familiar in computers with the concept of 'virtual reality'. This meaning suggests that virtuality is equivalent to illusion, which is not the sense in which I use it here. Virtuality is real, but not actual (Deleuze 1991 [1988]: 91-113, Lévy 1998). Systems with virtual components include human memory, social relationships, reproduction of living things and media technologies. Each of these has different mechanisms of virtuality.

Think of the moment when two people first meet. The situation can be described accurately as a physical event in which two bodies come into a particular spatial relation. The utterances each person makes can be recorded and analysed as linguistic variables. The peoples' facial expressions can be recorded on video and analysed. These are the 'actual' components. Yet there is always a dynamic in play that can not be captured. Their behaviours are not predictable, because there are virtualities at work — human perceptions and affections.

There are words for these virtual dimensions in social situations: friendliness; hostility; openness; guardedness; calmness; agitation. These do not so much capture the virtuality as 'tune in' with it, or evoke it. Some forms of analysis of the participants' behaviour can provide statistical or descriptive evidence of operation of the virtuality. In fact, these virtualities could be described indefinitely.

All technologies have virtual dimensions. The virtualities in prosthetic technologies such as binoculars or spectacles are actualised when these artefacts

are attached to a user's body. Hermeneutic technologies such as clocks, thermometers or sextants are actualised when users read them (Ihde 1990). The process of reading unleashes a virtuality that only emerges with the interplay of writing and reader (Iser 1974).

Computers have a special form of virtuality which is actualised in events of invocation. Part of the invocational machine always remains virtual. This brings to mind another term in computing discourse — the 'virtual machine'. This term is most commonly used to refer to a software system that emulates the characteristics of hardware. A software virtual machine allows other programs to run 'within' this virtual machine layer. In effect, though, all modern operating systems are virtual machines. Operating systems and applications are virtual machines. When a 'general purpose' computer invokes a virtual machine, the system becomes something particular. A new program (or even sub-program) effectively makes it a new machine. The term 'virtual machine', therefore, is quite appropriate. In its standard sense, it simulates another machine — often one that never actually existed before. In an extended sense, every software avocation summons up a virtual machine, each with its own rules and behaviours. In a more philosophical sense, the virtual machine is a machine that folds and unfolds virtuality.

The 'virtual machine' also relates to another concept: the abstract machine. This is a philosophical concept referring to what defines a technology (or in fact any deterritorialisation of assemblage), in the broadest sense, abstracted beyond its manifestation as substance and form (Deleuze and Guattari 1987: 141–2). It is the virtual element that distinguishes *this* technology from *that*. It is the intangible thing that all digital computers have in common that makes the virtual machine

the invocational order-word machine.¹⁸ While a modern computer shares no components with the 1950s machine UNIVAC, what it does and how it works in the most abstract sense is remarkably similar. They belong to the same technological lineage. The abstract machine of the virtual machine produces a distinctive immaterial architecture.

Virtual machines are not built, but invoked. Their design is not constrained by the physical tolerances of material engineering, but by the logical tolerances of code. They are not pieced together as *structures*, but with *instructions*. The incantations that produce them must be uttered with precise attention to syntax or their incorporeal form will break with a crash! As they are as much ‘written’ as ‘built’, virtual machines are invoked not only with mathematical functions but also with a wide range of symbolic cultural resources — metaphors, concepts, images, sounds.

An invocation is an articulation in both senses — an utterance, and a joining together of elements. An invocational machine is all joins, with many virtual elements. Its instructions articulate data through a series of foldings. They pass through fold upon fold of layers in hardware and software. As patterns with no permanent material expression, invocational entities have a quasi-magical fluidity. Invoked simulations are liquid architectures: ‘a landscape for rational magic’ (Novak 1992: 226).

The virtuality of the invocational medium comes partly from its capacity to be programmed. The program dictates in advance a series of invocations that the device will articulate. In this way, computers perform more sophisticated sequences of actions than other machines. However, this is a limited form of the virtual. When a program runs internal to the machine, it will create regular and

¹⁸ Historians can’t agree on which computer was the first because they can’t agree on which definition of computer to use. See for example, Gries (1973) pp.1–7.

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reliable repetitions of the same logical states. When invocational media interface with things outside themselves, their operations become less predictable, and more virtual. As the ratio of 'live' inputs to memory goes up, the degree of virtuality invoked increases.

In these interactions, the CPU becomes less important, and the peripherals become pivotal. How does this system with all its computing power, extract meaningful patterns or folds from its surroundings? How does it reterritorialise this liquid data as perceptible images, sounds and texts? Again, although the assemblage is modelled roughly on the abstract machine of biological systems, there are significant engineering problems with how to build invocational media that remain open to their surroundings.

Bergson observes that the human biological sensorimotor system perceives changes around it, but these sensations mingle with affections in human memory. Over a life time, these processes form an internal evolution of affections that comes to define that person. These are how humans relate to time, and to duration. Every human individual's nervous system develops by autopoietic processes — it grows itself, based on genetic code and engagements with its environment (eating, sleeping, perceiving etc).

Computers are produced in quite different ways. They are allopoeitic: 'machines that have as product of their functioning something different from themselves' (Maturana and Varela 1980: 135). They are created to be used by humans, so most of their functions are geared towards pragmatic applications. They inherit not genotypes and cultures, but traditions of manufacturing techniques, media technologies, processes of social organisation, means and modes of production. They capture change according to engineering principles, and more distantly, philosophical assumptions about the nature of change. Each component in the assemblage has its own histories. I'll start with input devices.

Inputs

Computer inputs include devices such as keyboards, microphones, mice and scanners. At a technical level, these simply function as sources of data and instructions to the machine. However, each of these has its own history beyond its technical efficacy. Input devices are typically based on analogue devices of magnification or surveillance: telescopes, microscopes, security cameras, X-ray machines, motion sensors, metal detectors and any number of other devices which enhance powers of the gaze. Each of these apparatuses is sensitive to particular vibrations, extracting perceptible changes in the environment, and folding them up as possible invocational events. Inputs serve to make some things visible to the invocational assemblage.

The devices that were the progenitors to computer inputs were most often used within bureaucracies — typewriters, filing cabinets, tape recorders, cameras, fingerprint pads. Bureaucracies are a cultural form also motivated by the imperative to make things visible to states and corporations. Pre-computer bureaucracies tended to apply a range of technical apparatuses, techniques and systems of communication to subject people to surveillance. They were proto-invocational assemblages of humans and artefacts which combined to constitute the types of records that are typically entered into computer inputs. The Hollerith tabulator, used in the 1890 US census, was a pre-computer database that also functioned as a magnifying technology. It translated each citizen's details onto an index card (Shurkin 1996: 66–92). Through a combination of technical devices and techniques, bureaucracies make their subjects more visible, in the interests of making it possible to act upon these subjects more efficiently.

Foucault, the pre-eminent theorist of surveillance, illustrates how 'a state of conscious and permanent visibility... assures the automatic functioning of power' (Foucault 1991: 201). His theory of panopticism gives an account of how

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modern societies collectively manage fields of vision. Regimes of visibility make people, events and objects visible to agencies of power. Institutions manage subjects by arranging them to be observed easily, using 'all-seeing' technologies (Foucault and Gordon 1980:146–165 and Foucault 1991: 195–230). Hospitals arrange beds in wards to allow doctors to see patients efficiently, while separating patients to avoid contagion (Foucault 1963). Schools and workplaces handle students and workers as a group by distinguishing them individually according to attributes (enrolment or employment status, grades or work performance measures etc.).

Input devices are mutated surveillance technologies. They still engender unease or paranoia. Facing a camera, or even sitting in front of a keyboard especially for a novice user, can be uncanny or intimidating. Input devices compose objects and user subjects to make them visible in specific ways. A keyboard positions its user in front of the computer screen. A database tracks a customer's purchasing history. A face-recognition system invokes an image of the user's face.

Invocational surveillance assemblages systematically regulate access to the means of invocation. As Chapter Five will explore, invocational assemblages incorporate modes for virtual or implied users, and segregate these groups of users according to their levels of privilege.

On the other hand, invocational input devices are often tamed and made friendly. Input devices are the only means by which users can articulate invocations. They are the components that grant users the powers that these assemblages mediate. While input actions can bear witness, or betray invokers, they are also the only means of access to invocable universes. People take up invocational media because of the powerful liquidity of invoked environments. Users can automatically call up traces of formalised traditions and stored up decisions: not only from decision theory, but from a wide range of cultural histories and vocations.

When I strike a single key on this word processor, I invoke not only a letter on the screen, but a whole set of frozen histories. The event begins in an industrial designer's space, conditioned by the ergonomic principles of key sensitivity, wrist positioning, visual design and choice of material. My invocation folds over into an electrical engineer's territory. The keyboard singles out that key from a matrix of relays. From there it flip-flops into digital electronics, and the clean-rooms of chip designers and manufacturers. In software the virtual foldings become even more intricate. Typographers are responsible for the font that the character invokes to display itself. The operating system manages the overall transaction, while the word processor application organises the virtual work space around the character. At the end of this event, the letterform is rendered on screen, which, if it is a cathode ray display, draws mainly on the engineering tradition of building television sets.

At a more abstract level, input devices work with two distinctively different ways of capturing changes and variations around them: switches and samplers. While other technologies apply these principles separately, none has applied both together to the same degree.

Modern and ancient modes of capturing change

Input devices are built from materials and components selected for their singular sensitivity. Some devices are sensitive to specific wavelengths of light, others to sound frequencies, and others still to types of physical contact. Each reliably extracts meaningful patterns from its surroundings: images, sounds or other phenomena. In fact, virtually anything that can be measured to mark a difference can become a form of invocation.

Input devices can be divided into two families: switches and samplers. Switches create discrete values, while samplers create bitstreams (which are actually sequences or arrays of discrete values). Keys on a computer keyboard are

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switches. Each corresponds with a discrete and singular value. When the user hits the letter 'A', the computer registers the ASCII value '01000001' every time. A sampler, on the other hand, digitises modulations of an analogue signal. So, for example, a microphone captures sounds and converts them into electrical modulations, which are digitised and stored as computer sound files. The individual values of the bits captured in this way have little meaning on their own, but in combination constitute digitised analogues of signals that can be played back at random, or, analysed with algorithms.

The difference between a switch and a sampling device is not an essential property of the device, but how it functions in invoking events and creating data. A switch articulates an invocation precisely and distinctly. Programmers enter code in a programming languages with keyboards because this task requires unambiguous and syntactically correct information. Even a microphone can function as a switch. In a security system it could trigger an alarm if the sound level reaches a certain threshold. How inputs function is determined partly in software: the 'device driver' is a specialised code sequence written specifically for each individual peripheral. It mediates the processes that extract switching or sampling invocations from that device.

While switches capture singular events, samplers capture extended events by measuring a sequence of changes over space or time. They capture slices out of their surroundings by laying down grids, and capturing as data any changes in the intensity of signals that come in from sensing devices. This is how scanned photographic images, samples of music and digitised video are recorded into computers. Sampling captures analogue phenomena: gestures, colours, sounds.

Invocational systems often integrate sampling and switching. The computer mouse is a good example of how they work in combination. The mouse button is a switch that sends a discrete signal. It has two states: mouse-up and mouse-

down. If the button state changes from up to down and immediately up again, it records a *click*. The computer also receives continuous signals corresponding to relative mouse movements back to forward and left to right. A mouse movement adds to or subtracts from the coordinates that position an on-screen pointer.¹⁹ Most mouse systems operate in a bit-map environment, the output-side equivalent of a sampler. The pointer moves across this bit-map according to the user's hand gestures. While at any moment the pointer is *at* a precise position on the x and y axes, the user experiences the movements as a fluid flow. In combination with the mouse button, this assemblage invokes a wide range of actions, including mouse-over, mouse-down, select, drag, drag and drop and so on.

The techniques of switching and sampling continue long histories of capturing movement in Western science and philosophy. Change in general, and movement specifically, has long puzzled philosophers. Nearly 500 years B.C.E., Zeno of Elea articulated a series of paradoxes that seem to prove that change is actually impossible (Bergson 1998 [1911]: 308–311). One of his famous paradoxes of motion uses the example of a runner who aims to run to the other end of a stadium. Before he reaches the end he needs to run half the distance of the stadium. At this point he has halved the distance remaining. Now he *still* needs to pass the point that halves the remaining distance to the other side of the stadium. As he approaches the other side of the stadium, half the distance to his destination gets smaller and smaller, but, according to a logical infinite regression, he can never reach the other end.

Undeterred by the paradox that it is logically impossible to capture movement, physicists, engineers and running coaches since have looked for useful ways of

¹⁹ The mouse senses relative position. Other input devices sense 'absolute' position, such as the lightpen, or the graphics tablet. The joystick also senses relative position, but is often used to signify relative velocity (more than position) and direction of a movement.

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measuring motion. They typically capture it by taking ‘snapshots’ of objects before and after a change in position. Henri Bergson describes this as the cinematographic illusion (1998 [1911]: 306), which reconstructs movement by taking a series of stills. Each image is static, but in combination they create a picture of the movement. Observers try to calculate the speed, direction and vector of movements from these stills, but, according to Bergson, never capture the movement in itself.

Bergson notes, though, that ancient and modern methods of capturing movement are distinctively different. The ancients (Plato and Aristotle), and the moderns (Galileo, Kepler, Descartes) have quite different strategies. While both try to comprehend mobility by measuring the change an object has undergone between immobile points, the two traditions choose their points differently.

Wherein consists this difference of attitude of the two sciences toward change? We may formulate it by saying that ancient science thinks it knows its object sufficiently when it has noted of it some privileged moments, whereas modern science considers the object at any moment whatever (Bergson 1998: 330. *Italics in the original.*)

Ancient science defines movement by capturing ‘privileged or salient moments’ (330). If ancient observers want to track a falling object they would choose the moment the object is released, and the ‘culminating point’ at which it hits the ground as salient moments (331). The object would be observed to follow a curved path between these two points. They see this particular event as an instantiation of a universal Ideal curve. Even if it is blown off course a bit, this deviation represents only a degradation of a mathematically true geometrical path. This Ideal curved path is like Plato’s Forms — universal Ideas (Ross 1951). For Plato everything in the physical world is an imperfect instance of the Forms (Plato 1974: 305–325). In this conception, movement takes place through a transition from a privileged point, through a series of ordinary points, to

another privileged point. As Deleuze paraphrases, ancient movement progressed from ‘pose’ to ‘pose’ (Deleuze 1986: 4).

Switching input devices continue in this ancient tradition of defining movements by capturing poses. A click on the mouse button defines a salient moment — it strikes a pose. In a ‘draw’ graphics program like MacDraw²⁰, users draw lines by clicking at one privileged point and dragging to another point. They draw circles and squares by choosing an appropriate ‘tool’ (the oval tool and the rectangle tool) and again, click-and-dragging.²¹ That these are said to draw ‘perfect’ figures (Naiman 1989: 549) recalls Forms in Platonic philosophy. The object in memory is mathematically defined and perfect, but what appears on the screen is an imperfect low-resolution rendition.

Modernity never entirely replaces ancient methods. The two coexist in contemporary Western culture. Students study both Euclidean geometry and Cartesian geometrical principles. They read about Plato’s Forms, as well as Newton’s gravity and Einstein’s relativity. Mathematician Roger Penrose explicitly acknowledges his philosophical allegiance to Plato (Penrose 1989: 552–555). Phil Agre traces the influence of Platonism on the conceptual structures of many programmers, especially in the field of AI (Agre 1997: 49). Even those who don’t directly study ancient philosophy, the methods and concepts are part of the Western cultural and technological toolbox.

²⁰ MacDraw was one of the first popular Draw graphics programs (although the Apple Lisa incorporated a similar program called LisaDraw).

²¹ More sophisticated packages define more complex curved lines using Bezier curves. The Bezier curve was developed by an engineer at Renault, Pierre Bézier in the 1970s. His technique defines a curved line by positioning on a Cartesian grid two endpoints and two ‘control points’ outside the curve. The result is an efficient but versatile way of defining a wide array of complex curves. The technique is only practical with the computer, so Bézier curves are an invocational form of geometry. See <http://muldoon.cs.ucdavis.edu/GraphicsNotes/Bezier-Curves/Bezier-Curves.html> accessed May 2000.

Vector graphics programs recall the ancient Greek world view. The vector-based animation program *Macromedia Flash*, for example, has several features with an ancient heritage. For example, 'symbols' are stored in a 'library'. Like 'intelligible' entities in Plato's *Republic*, these symbols themselves are never seen directly by viewers of a final multimedia work (Plato 1974: 312). Only 'instances' of the object appear on the 'stage' (Ulrich 1999: 167–190). The Instances on the stage are like Plato's 'visible' entities — lower order instantiations of the original Form, which remains unchanged in the library. Changes made to a library object are 'inherited' by all the instances.²²

However, *Flash* models graphical objects in a more Aristotelian manner. They are not pure forms, but composites. Lines are made up of points linked to other points. A line that meets itself creates an object that can be filled with a colour or pattern. The objects are stacked in hierarchical layers. Any object can be sent to the back or brought to the front. Objects may be grouped to form a higher order composite object.

Flash also models *movement* in a classical way. A feature called 'tweening' moves an object from one 'key frame' to another 'key frame' — between 'privileged moments' (Bergson 1998: 330). The program calculates the movement that takes place during the 'In-between' frames in order to render the movement (Ulrich 1999: 212). It invokes a 'regulated transition from one form to another, that is, an order of *poses* or privileged instances, as in a dance' (Deleuze 1986: 4. Italics in the original). The program smoothly transforms objects, not only in position, but

²² Michael Heim relates cyberspace to a modern Platonism:

Instead of emerging in a sensationless world of pure concepts, the cybernaut moves among entities that are well formed in a special sense. The spatial objects of cyberspace proceed from the constructs of Platonic imagination not in the same sense that perfect solids or ideal numbers are Platonic constructs, but in the sense that inFORMation in cyberspace inherits the beauty of Platonic FORMS. The computer recycles ancient Platonism by injecting the ideal content of cognition with empirical specifics (Heim 1993: 89).

in scale, rotation and even colour, as the playback head that marks 'now time' passes between the two key points.

An object approach is not unique to graphics. The philosophy of object-oriented programming also reflects this construction, where objects are instances of classes. Subclasses inherit features from their parent classes, and further objects can be based on these. Objects send messages to other objects. This mode of representation is a concession to a particular philosophical conception and modelling of objects and their relationships. When object oriented code is compiled it becomes procedural. That is, once it is translated from the human-readable program into an executable application, it returns to a more sequential form.

Samples and any-instant-whatevers

Sampling input devices, such as digital audio recorders, scanners and cameras, apply a more modern technique for capturing objects and their movement. Taking a series of measurements of their surroundings, they capture 'any-instant-whatevers' (Deleuze 1986: 3). They take samples at a set rate in time to map numerical points of relative extension across a calibrated grid. Sampling converts analogue signals like microphones, light/colour sensors and mouse rollers into an array of numbers. It transforms modulations into bitstreams, and bitstreams into arrays. This technique is relatively expensive in terms of processor and storage resources when used as a source of data because it quickly produces very large, 'dumb' files. Unlike the highly hierarchically structured system of classes, objects and methods implicit in object oriented data structures, a bitstream is just tabulated binary bits.

Digitised signals need not be delivered in highly invocational ways. An audio compact disk, for example, is not an efficient random access device. Although the laser can track to any point on the disk, it is engineered to work most

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smoothly when it plays a single continuous bit stream from beginning to end (from the inside to the outside of the disk). Digital Audio Tape is even less invocational, even though it works with signals as digital bitstreams. The tape runs from one spool onto another. While players often have advanced indexing features that speed up the process, different points on the tape are always relatively near or far from the current point of the tape.

Scanning input devices are more subject to noise than switches. In a way, this is their very purpose — to capture samples from the noisy and unpredictable detail of physical events like environmental sounds, images and movements. In direct contrast to the overdetermined systems of meaning in objects and their poses, bitstreams are chaotic. Input devices open onto the world with a sensitivity to specific types of variation — sound waves, optical frequencies etc. In the data-capturing mode input devices extract, or subtract, from their immediate surroundings, a single slice of the movements around them and convert them into a string of discrete values.

Bergson sees both ancient and modern scientific methods for capturing movement as illusions (Bergson 1998 [1911]: 272–370). Like Zeno's paradoxical runner who never reaches the other end of the stadium, neither the poses nor the any-instant-whatevers capture change in itself, only static snapshots on either side of it. Change is the 'open', which always takes place in between the immobile sections, no matter how finely spaced. It is pure duration, an 'infinite multiplicity of becomings' (Bergson 1998 [1911]: 304).

Deleuze qualifies Bergson's critique of the cinematic illusion in developing his own approach to cinema that borrows heavily from Bergson's concept of

duration.²³ In the two *Cinema* books (Deleuze 1986 and 1989), Deleuze carefully negotiates around Bergson's rejection of the cinematographic illusion, and uses some of Bergson's concepts to talk directly about how cinema in fact does present images of change in itself. Deleuze develops a systematic theory of how the cinematic apparatus creates not an illusion, but an immediate image of movement. Much of the cinematic image's impact is virtual — something apparently between the frames. The cinema image is 'not the photogramme (but) an intermediate image to which movement is not appended or added; the movement on the contrary belongs to the intermediate image as immediate given'. The cinema image is not a series of stills, but a 'movement image' (Deleuze 1986: 2).

The invocational assemblage is not cinema. However, it can invoke cinema. Cinema captures pure images of time. Invocations capture pure samples of change. The samples of 'any-instant-whatevers' that input devices collect use a similar cinematographic method to cinematic movement images. Both the film camera and the computer input device capture 'blocs of space-time' (Deleuze 1986: 61). Samplers apply a similar principle to cinema's regular 24 frames per second, but in a far more rapid and more abstract process: sound samplers typically capture 5000-44,000 samples per second. Video samplers capture thousands of pixels for each cinematic frame.

Cinema is also different because of what it captures within an image. The cinematic frame holds a whole world in its mise-en-scene; it distinguishes 'saturated' and 'rarefied' regions; it manifests a point of view; and it defines an 'out-of-field' (Deleuze 1986: 12–18). In contrast to this richness, individual samples are meaningless. Each sample carries only a discrete value, significant

²³ Deleuze's conception of cinema is an application of a conception of art as a particular type of activity. A work of art is a 'bloc of sensations... a compound of percepts and affects' (Deleuze and Guattari 1994: 164).

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only relative to preceding and following samples, and to an analogue continuum it maps. Any single sample in a sound, or a pixel in an image, on its own, unlike a cinematic frame, makes no meaning at all. It is not a movement image, but a *change sample* — a pure sample of change.

The meaninglessness of the individual change sample gives the bitstream its abstractness and versatility. Sampling not only captures temporal phenomena like sounds, but spatial forms like ‘still’ photographic images. An invocational image is captured by sampling pixels (picture elements) one row at a time from top to bottom, and left to right. Each pixel records red, green and blue values on a scale from saturation to rarefaction (usually 8 bits or 256 values). This spatial data is captured and translates into a bitstream or digital signal, and stored in the form of a matrix, or array, in memory as a bitmap. These various foldings of sampled and switched invocations, all working with traces of invocations, create highly versatile and abstract entities in invocable domains. Invocational systems are a meta-medium that invokes not only single images, but entire media forms.

Invocation is the genetic element in digital computers like cinematic *montage* is the ‘genetic element’ in Deleuze’s conception of cinema (Deleuze 1986: 83). A genetic element is a basic force from which more complex compounds are created. It is the dynamic that remains constantly immanent to invocational media. Once invocational media capture changes on input devices, they become indefinitely reconfigurable with further invocations. The invocational event captures in circuitry something which was previously an intense manual process. It automates practices from mathematics and logic which capture formalised images of change. But more than analyse these samples, it reconstitutes these change samples through outputs.

The captured bitstream of change samples becomes snap frozen as data in a bitmap array. In this form it is invocable, outside its reference to time or space.

In invocable domains the undifferentiated series of samples becomes as malleable and invocable as any other piece of data. The limitations are no longer so much spatial, as economic — based on the costs of memory, storage and network devices. Slower *storage* devices are always cheaper than faster *memory* devices. The main constraints for media forms such as the early world wide web relate to relative file transfer rates and storage costs.

Within these constraints, bitmaps of all modalities are subject to invocational manipulation. Sound files can be processed with analogue effects like echo, reverb or frequency discrimination (high pass and low pass filters), or with entirely mathematical processes like ‘aural exciters’, ‘bass enhancers’ and ‘intelligent noise reduction’ (Digidesign 1996-1999). Images can be blurred and enhanced, or salient regions selected and positioned or processed individually.

The most dramatic changes for media practitioners working with digitised material come with the invocational applications that combine ancient and modern modes. Programs that call up any sample whatever from bitmaps, irrespective of where it is spatially or temporally located, constitute a different medium to linear analogue systems. Sound designers invoke sections of audio with non-linear audio editing programs like *Pro Tools*, which represent sound levels and frequencies across time with live-updating graphs of soundwaves. These programs present artists with new materials: they work with a graphical image rather than using the tactile physical form of spliced audiotape (Potts 1995). The MIDI standard combines ancient with modern modes by positioning sequences of switches, which invoke sampled or synthesised sounds. Invocational musical genres like drums ‘n’ bass, techno and trance emerge from these invocational composition/performance environments.

Image manipulation uses a similar mingling of switches and samples. Graphics and desktop publishing software often combine bitmap images (scanned

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photos, video frame grabs, 3D rendered images) with vectors (geometrical paths; shapes etc.), and type (text with font and style values associated). These combinations use the strengths of each format to create hybrid documents in total digital environments. The collection of elements, held as files in invocable domains, remains open to manipulation and output in various forms. Unlike viewers of cinema, users of invocational media are regularly offered spaces for decision within the invoked simulations. The invocational interval remains open.

It is clear that the invocational organs of perception open onto the world in quite different ways to the human nervous system, and also in different ways to other technical assemblages such as cinema. Computer input devices sense external events as invocations. Inputs compose invocations with samples and switchings, and fold them up as traces in memory and storage devices. The arrangement of input devices depends on the rest of the invocational assemblage — it prepares invocations that can be held in memory and expressed on output devices.

The invocational interval recalls the film editor's point of decision, constantly and automatically. It maintains a state of indeterminacy, so that what is invoked is never only repetition. The computer is constantly re-drawing the next screen. Like a folded up and automated operator in Bergson's telephonic exchange, the CPU is constantly called on to decide what to connect next from a range of possible events. What is invoked moment by moment is conditioned by automatic transformations in the current state of the digital machine based on what is available in memory, storage or on networks (invocable domains), and what vibrations are recorded on input devices.

Unlike cinema, computers remain open through inputs and conditional branching to unlimited variation from moment to moment. In cinema the final work is frozen once the film editor and director have sequenced all images

together into a whole. In invocational systems, users control the flow of what is revealed moment by moment. User input devices are the privileged force for change in most invocational systems. Users determine what will happen next. This privilege is granted because the computer designs incorporate spaces for virtual users: pauses, stand-ins and sensors opening onto the world to detect users' manifest intentions. In fact, computer applications also have to be completed — debugged, tested and released — before they are safe for users to invoke (see Chapter Five). Simulated environments have to be secured, maintained, kept clear of viruses and errors.

Outputs and faces

Cinematic spectatorship, though, belongs to a different set of cultural practices, relating more closely to the 'peripheral' devices at the other end of the invocational interval: the outputs. In the brain analogy, they are the limbs, or the motor systems. Outputs articulate the centrifugal, expressive forces, amplifying and extending invocations. They articulate material effects, transforming invocations into actual actions in the world. However, it was some time before outputs came out on a large scale.

Output events escape the implicit Platonism of data entities internal to the device, but in the process open themselves to judgement by articulating statements (Deleuze 1988A: 47–69). Output devices generate proof, manifestations, evidence of the secret invocations inside the machine. When students create works for assessment, their documents must pass through an output device (a printer, or possibly a screen) if the student is to pass the degree. Output devices unfold the invocation to present it in a form that will make someone accountable. Even images presented purely for aesthetic pleasure make artistic statements. Everything invoked on an output device functions as a statement.

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In the early days of computing, only those at the tip of hierarchies, or within the sanctified spaces of laboratories, could make invocational statements.

Invocational media in bureaucracies kept outputs out of general view. With the domestication of personal computers, and real time multimedia machines, though, output devices created a proliferation of cyborg entities. Video arcades, personal computers, laser printers and so on presented an ever expanding array of invocational images. Once they moved into the open, invocational output devices took on a new face.

Commodified output devices express statements by drawing on technological lineages associated with other media forms: printers, speaker systems and computer monitors. In this, they are less characteristic of surveillance, and more of spectacle. Invocational outputs miniaturise the 'mass' media assemblages of newspapers, radio, television and cinema. Mass media forms tend to mechanically reproduce certain privileged images and voices on a large scale. They mix commands (general mobilisations, the 'order-to-buy' of advertising) with collective memories (documentary cinema, the daily news) (see Chapter Four). By contrast, invocational outputs can customise what is output. Where every listener to radio news hears the same words, every user invokes what are apparently original statements articulated through output devices. In close connection with input devices, outputs make spectacles invocable.

Output devices, then, are based on the modern technologies of the spectacle: printing devices, loud speakers and screens. Guy Debord (1990) argues that late capitalist culture is characterised by spectacle. The spectacle creates 'a world that is no longer directly perceptible'. Instead it can only 'be seen via different specialised mediations' (Debord 1990: 17). If capitalism has transformed human experience from *being* to *having*, the society of the spectacle supplants *having* by *appearing* (16). The mass media, advertising and tourism increasingly present the world as pre-constituted images. Debord argues that this process makes people

into spectators, and converts their experiences into separated, packaged commodities. Spectacle is performed with technologies of amplification that extend and enhance events of authorised and commodified articulation.

Invocational spectacles are not the distant spectacles of the cinema screen, but customised, privatised and intimate. Computer screens more often function as surfaces than windows. Invoked objects have a tactility that is brought to life by the invocational interplay between input and output. This dynamic emerges clearly only when the assemblage operates in real time. Until they enter into the same temporal phase, inputs and outputs remain distinct and separate. To become present to the user, command, memory and decision must synchronise with human duration. Real time functioning implicates user actions directly in events around them, and not in the nostalgic time frames of cinema. Unlike television viewers, users are directly engaged and accountable.

The commodification of invocational assemblages changes how outputs operate. Sometimes outputs are limbs that do users' work (robot arms, bombs). More often, though, outputs invoke faces. In the early days of video games and microcomputers, invoked faces began to appear on outputs everywhere. PacMan's 2D face slid back and forward, up and down a maze in a manic munching frenzy (Poole 2000: 190–195). The 'Happy Mac' face greeted users when the Apple Macintosh started up. Later, electronic mail smileys apologised for the absence of f2f (face to face) contact. The obsequious cartoon helper in Office 98 offered advice to helpless users. A grizzling, battered and disembodied face in *Doom* stared defiantly back out of the frame at computer game players. These faces are redundant, because they only make literal the function the screen is already performing.

Deleuze and Guattari discuss the 'abstract machine of faciality' as a mechanism through which subjectivity and signification work together (177). The face is a

'white wall/black hole system' (180). White walls — screens and surfaces — are a mechanism of the signifier. The black holes — regions of shading and distinctive patterns — work with subjectivity. In combination, the face emerges as something recognisable: as both a meaning and an identity. When a computer screen invokes patterns of dark and light, it is already functioning as a face, in more than just resemblances. It works to capture meaning and identity.

Approaching an airport counter, you hand over a ticket and a passport. The attendant checks your ticket, which signifies your right to a seat, and your passport, which verifies your identity. The screen of the computer is a third face that joins together identity and meaning. Your booking is complete only when this third face has given its approval.

In the dominant Western culture, faciality operates as a system of domination by eliminating all meanings that are not facial (Deleuze and Guattari 1987: 167–191). The white wall of signification translates all meanings into images on the wall, and the black hole positions the subject as autonomous and isolable holes: 'you will be pinned to the white wall and stuffed into the black hole' (181). Faciality emerges after a generalised 'collapse of all heterogeneous, polyvocal, primitive semiotics in favour of a semiotic of signifiante and subjectification' (180). There is no space for other possible meanings: 'there must not be any exterior' (179).

A computer monitor functions as a domesticated facial system. Personal computer screens are mutations of the cinematic close-up, the instrument panel, and the mirror. They are where the internal affective states of command, decision and memory are invoked and expressed. The screen becomes a surrogate machine mirror face. This has implications that are both affective and micropolitical. Commodified invocational faces tend to personalise and differentiate mass spectacles, complicating conventional relationships of

domination from the outside. Invocational screens reflect images of users themselves. Mouse pointers, digital cameras, sound samplers offer people their own avatars (see Chapter Five). The image or text that appears on screen is usually something the user has just requested. Although audiences are always to some extent co-producers of any artefact or performance, users constantly implicate themselves by what they call onto their screen, even though they only have a limited degree of control over the dynamics of that process.

Interfaces also present landscapes, which are also faces. Computer screens create live world-views. Unlike portraits, newspapers or personal letters, which distance the event of composition from the event of reading, computer screens offer a sense of (almost) liveness. Stock prices updating in real time, e-mails arriving or web pages loading create an impression of an event that is occurring simultaneously in two places. This face is different from cinematic or televisual faces, which are usually framed, and exist beyond the screen itself. As Heim observes, the facial systems of invocational media recall the ancient Greek interface, *prosopon*, where one face faces another face:

Two opposite faces make up a mutual relationship. One face reacts to the other, and the other face reacts to the other's reaction, and the other reacts to that reaction, and so on ad infinitum. The relationship then lives on as a third thing or state of being (Heim 1993: 78).

This, at first, uncanny opposition between human and inhuman faces, though, becomes increasingly normal. Computer-based media production and delivery systems, which began as magical curiosities, become conventional by the end of the 20th century. They are sometimes referred to as 'virtual realities' or 'cyberspaces', but 'invoked environments' is a better term. While some of the more outlandish claims about their importance are little more than marketing ploys, the emergence of invoked environments is more than an introduction of a new set of tools. They shift the ground underneath many kinds of activity.

Generic invocational literacies such as composing search queries, managing file hierarchies, editing images and texts in digital environments and basic problem-solving become necessary life skills (Gilster 1997). More than this, like other technological/ cultural forms, invocational statements, faces and environments start to change the world.

Intervals cinematic and invocational

Cinema has given rise to its own particular signs, whose classification is specific to cinema, but once it produces them they turn up elsewhere, and the world starts “turning cinematic” (Deleuze 1990A: 65).

In the early 20th century there was a significant cultural shift as populations became cinema audiences. The world started ‘turning cinematic’ (Deleuze 1990A: 65). The world view of cinema insinuated itself into the broader world of the audience, and even bled across into science and philosophy. Leni Reifenstahl and Marilyn Monroe, Chaplin and Hitler mobilised cinema in ways that altered the courses of events. The proliferation of cinema transformed how viewers saw and experienced the world. Events increasingly became media events, taking place first as newsreels, and later as television programs. Media events not only reported on what was happening, but changed the dynamic of the events themselves.

Later in the century invocational media began transforming space and time, not only in terms of perception and textual production, but also in the dynamics of events. Computers came into a culture already over-saturated with space and time shifting media. Not just cinema, but the telegraph, typewriter, gramophone, radio, television, telephone, and so on. Computers, and later, computer networks, added even more layers of complexity. These innovations were not spread evenly across the world. Like every aspect of society, the spread of computers was mediated through already highly developed and

interwoven economic, military, political and cultural systems which differently empower and constrain groups and individuals.

Invoked virtual machines are not rationally calculated representations of a world outside, but dynamic and incomplete maps that function in the world to direct, explain and expose parts of the world in particular ways. Virtual machines most often map worlds that are already overcoded — money and economic relations of debt and credit; legal relations of criminality; biological codings of genetic structure; epidemiological codings of disease patterns and so on.

In summary, then, the invocational modes of deterritorialisation and reterritorialisation synthesised three cultural formations which, until the development of the computer, operated as inter-related but relatively independent machines. These can be classified as:

- Media technologies such as the gramophone, telegraph, cinema, radio and television which automatically measure, capture, transmit and /or (re)play traces of change over time;
- Scientific symbolic or semiotic systems such as mathematics, physics and engineering that develop and apply abstracted formalised maps of spatial and temporal processes. Two abstract approaches explored here were the classical system of poses and the modern system of any-instant-whatevers;
- Social systems of power and knowledge that operate by regulating fields of vision, and modes of articulation. Input devices were based on surveillance technologies, where output devices reflected the society of the spectacle.

Where this chapter's emphasis has been on input and output devices, the next chapter will concentrate on the CPU and memory devices. It will look directly into the interval between input and output that this chapter has revealed. Inside

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this interval, control circuits call up instructions from memory addresses. A command structure interprets instructions, and executes them on the basis of data in memory and variations sensed by input devices. Most of these invocations are stored back in memory or storage, but some are expressed using output devices. The invocational interval will help change the dynamics of more extensive machines of command, machines of memory, and machines of decision.

4. Command, memory and decision machines

All human communication works through machines of command and machines of memory. Command machines extend the reach of a voice and reduce the duration between an articulation and the effects it produces. Memory machines extend the duration between when an articulation is made and when it disappears from trace. They hold a pattern through time, allowing it to be somehow re-produced later. Invocational media are characterised by a tight integration of these two machines: memory commands, and command memorises. This chapter explores in detail the dynamics of command, memory and decision.

The invocational assemblage supposedly centres around the central processing unit (CPU). But as last chapter showed, the CPU is a mediator rather than originator of events. However, the CPU really is remarkable in its capacity to mediate both command and memory functions, and to combine the two to produce decisions. This chapter will address these three distinctive features of invocational media — command, memory and decision — and the implications of these capacities for the spatial and temporal sense of users and others.

In his pioneering work in medium theory, Harold Innis surveys media technologies through history (Innis 1950; Innis 1951) and distinguishes them according to their bias towards space or time. He argues that different transmission and storage media technologies have different inherent biases in mediating culture.

We must appraise civilisation in relation to its territory and in relation to its duration. The character of a medium of communication tends to create a bias in civilisation favourable to an overemphasis on the time concept or on the space concept (Innis 1951: 64).

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Contrasting the mediums of clay and papyrus, for example, he shows how clay favours preservation over time, while papyrus, extension across space (Innis 1951: 6). Inscriptions in technologies of memory like fired clay or stone last longer than those written on technologies of command like papyrus and paper, but they are more difficult to transport across a large empire. The printing press and paper represent dramatic and well documented cultural and technological changes that extend both temporally and spatially, but centralise command and control (McLuhan 1964, Eisenstein 1980; Ong 1982).

Innis is disturbed by a trend in new media forms since the 19th century to extend centralised command and control over territories, and to neglect time-binding functions. For example, the invocatory medium of the Morse Code telegraph dematerialises information by carrying invocations composed by a sender's gesture to be 'read' by a receiver's ear. While it accelerates the transmission of messages across space, its persistence through time depends on an older technology — writing — or adding on another new invocatory technology — the typewriter. The proliferation of the 'mass' media of radio and television continues the trend towards space-binding media.

Innis's work is important because it addresses how media forms influence not only how meaning is created, but how cultural practices, ways of life and even existence itself are affected by changes in media technologies. Similar questions are later explored by McLuhan, Ong, Carey, Meyrowitz and Kittler, among others (see later in this chapter). The concept of invocation demonstrates, however, that medium theory analysis is reversible. Cultural practices are themselves presupposed and embodied within new media. The digital computer inserts itself into an already existing cultural practice of invocation.

Invocations are distinctive because they command to memory. The myth of the Muses provides the archetypical diagram of the invocational relationship. As

the daughters of Zeus and Mnemosyne, the Muses inherit the traits of both command and memory. Humans have only imperfect access to both, and invoke the Muses and other deities to remember and to command.

Technologies of command and memory are always somewhat unreliable. There is no technology which extends voices over territories or durations with absolute fidelity. The human voice and memory are already imperfect. People can never quite articulate what they desire. People forget. When objects are co-opted to create machines of command or memory, the emerging assemblages do more than faithfully amplify or record the original voice. Each new machine of command or memory creates its own universe with its own tendencies, gravities and implicit rules.

In non-invocational media, a sophisticated connection between command and memory usually requires direct human intervention. Invocatory devices like doorbells or levers give command over particular named events, but only in the presence of a user. Memory technologies like writing require human readers for a message to do anything. Without a reader, the message does nothing.

Archiving systems involve complex arrangements of humans and non-humans: librarians, indexes, indexing systems and carefully arranged and labelled storage spaces. Non-invocational forms of automation are also limited in their degree of autonomy. Mechanical automata invoke a series of instructions as mechanical movements, but can't vary their own instructions. While some invocatory devices can invoke memory or command, the effects they can produce are limited.

The invocational assemblage integrates command and memory into the same circuits. The invocational sequence mobilises a sequential interplay between central processor and memory components (in a modern PC that means a CPU and RAM). In this way, invocational sequences interweave command and

memory. If the buzzword 'convergence' has any meaning, it is in how invocation brings together these events. The social practices of command (passing sentence, instructing workers, sending e-mails, launching missiles) are automated by the integration of memory functions (recording databases of verdicts, logging working speeds, archiving documents). Meanwhile, social practices of memory (record-keeping, ritual performances, interpersonal and 'mass' communication) are transformed when they come to operate on command (databases, real time online chat, news groups). More critically, invocational assemblages mediate decisions — not only carrying commands across space and time, also but operating as agents or daemons that take decisions themselves.

This chapter will show how invocational cultural and technological assemblages emerge together. Invocation draws on existing cultural histories, but also builds new practices. It echoes the military and bureaucratic chains of command within which the command/memory assemblage develops. It also invokes the command over materials developed by medieval alchemists and magicians. The discourse of magic recurs in the discourses of computer innovations. However, the incessantly repeated commands become more religious than magical. Network communication generates new modes of interaction that invoke oral forms, creating what I will call *n*th oralities. Invocational archival technologies generate a desire for universal access to a universal library, but this desire is always frustrated.

Delegation and invocational media

As I showed in Chapter Two, the immediate model for invocational media was the relationship of delegation from human to human. The precursors to automatic computers were human computers: people who typically worked in large institutions during the first half of the 20th century with the sole job of

performing simple but time-consuming calculations and research tasks. These bureaucratic systems of command and memory had numerous functions: managing customer or citizen records, creating artillery and insurance tables, providing research services, typing pools and so on. In each case computers were arranged in teams of largely interchangeable workers to whom routine tasks of both memory and command were delegated.

In the large scale wartime facilities in which electronic computers were first installed, mathematicians, scientists and engineers were accustomed to delegating their laborious manual calculations to halls full of people in the computing department. Human computers did the laborious work of decoding encrypted German and Japanese messages, helping mathematicians and physicists in the Manhattan Project, and working for engineers in ballistics labs. These humans were asked to behave as mechanically as possible:

The idea behind digital computers may be explained by saying that these machines are intended to carry out operations which could be done by a human computer. The human computer is supposed to follow fixed rules; he has no authority to deviate from them in any details (Turing [1950]: 436).

In spite of Turing's choice here of the masculine pronoun, this 'mental' work was more often delegated to women (especially in war time). A wide range of routine administrative tasks in bureaucracies had been feminised over the previous century. Kittler observes that in the 19th century 'the typewriter inverts the gender of writing' (Kittler 1999: 283). Typing pools, research and filing departments, telephonic switchboards and reception were spaces where women and technologies operated together to respond to the requests, commands and dictations of men. Women's work tended to be boring, and of low status (Plant 1997: 144–151).

Within formalised relationships at these military facilities, automatic computers initially substituted directly for some of the human computers. When

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COLOSSUS was installed at Bletchley Park near London in 1943, it slotted into the place of the WRENS who were doing the same calculations by hand. It automated part of the work of decrypting German messages (Randell 1982A). The displacement of people by devices was only another move in strategies to accelerate command and control.

Often the attempt to install invocational command structures was resisted. The 1956 film *Desk Set* portrays another instance of this highly gendered pattern of conflict: the research office of a television corporation (a group of 6 women librarians and researchers) face the sack when management decides to install a computer. This film illustrates the general process whereby orders are diverted from people to computers. It rehearses some of the anxieties about the dehumanising effects of this change, and ultimately reassures the audience that these changes are all for the best.

At first, then, invocational assemblages displaced women in certain chains of command. They were remarkable devices because they did mental rather than physical work: 'electronic brains' which helped give answers to complex mathematical problems. Yet this was hardly the first time non-human elements had been involved in thought. The technologies of writing, the slide rule, the diagram, the automated card reader and so on all involve different ways of thinking with technology.

However, the invocational assemblage was different because it could delegate delegations themselves. It was not only their capacity to follow stored instructions, nor only their capacities to store up and recall data, nor only their capacity to perform calculations, but their capacity to do all of these in indefinitely extended sequences that made invocational media so magical. As the previous chapter showed, the developers co-opted technologies of surveillance and spectacle as inputs and outputs. They also needed to identify

materials through which delegated commands, memories and decisions could be reliably articulated.

When objects or materials are co-opted into a chain of command, they must be transformed into forms that will reliably 'hear' orders from above. Designing such systems requires some expertise in understanding the properties of natural materials or compounds. Again, command over materials itself tends to rely upon complex social arrangements of hierarchy, specialisation and delegation. Command over objects emerges alongside command over people (Latour 1993). However, the two cannot be reduced to each other. The network of relationships between human and non-human grows more and more extended and complex.

Invocational media are a good example of the interplay between cultural and technological change and continuity. The acceleration in speeds at which invocational media operate was achieved by exploiting singularities in silicon, germanium and related compounds during the 1950s and 60s. Using the semi-conducting properties of these elements in transistors, it became possible to switch voltages without using mechanical relays or switches (Riordan and Hoddeson 1997). Where a valve can switch possibly 10,000 times per second, transistors can switch 1,000 million times (Reid 1985: 14). Microchip manufacturers since the 1960s have exploited these singular properties to build faster and cheaper microprocessor and random access memory chips that far surpassed earlier components like valves, mercury delay lines and cathode ray tubes (Reid 1985).

However, many invocational capacities — command over the physical world, generating illusion, enhancing perception — have their genesis in other cultural histories. Among the forms of expertise organised as science are some that emerge from another history: magic. Magic articulates its own commands in spells and incantations. Command ideally fuses perception, will and action into

a single circuit. The magician or the commander's will is ideally imposed instantly across his territory, and his objectives should be virtually achieved already, just by his formulating them as a spell or a command.

The command of magic

Between fantasy and exact knowledge, between drama and technology, there is an intermediate station: that of magic. It was in magic that the general conquest of the external environment was decisively instituted (Mumford 1963: 36).

Magics were significant as pre-modern techno-cultural practices which anticipated and prefigured functions that were later organised as invocational media.²⁴ In Europe from the 1600s onwards, magic was a historical predecessor to 20th century technologies. It set the conceptual grounds for technics by giving some people the motivation and confidence to try to exert their will to control the physical world. Magic focused on achieving instrumental goals through procedures that, as they became more rigorous, connected with the development of scientific method. Magic rejected the Aristotelian hegemony, which insisted on trusting only what could be perceived through the senses. It also took a more active interest in the unexplained than organised religion, which largely left mysteries alone (Thomas 1971).

Invocational media in the twentieth century fulfil some of the social functions of medieval magic. Magicians and cunning men in the middle ages applied magic in dealing with day to day problems such as retrieving stolen goods, telling

²⁴ Two books from the late 1990s give detailed and specific accounts of the connections. Erik Davis's *Techgnosis* (1998) explores in encyclopedic detail how the history of technological developments, particularly information technologies, was bound up with magical practices and beliefs. David F Noble (1997) traces a historical connection between the emergence of Western technology from medieval times and the 'religion of technology' which connected technological innovation with spiritual redemption.

fortunes and healing illness (Thomas 1971). Crime, business modelling and medicine remain among the more common applications of information technology. Where people lack control over their lives, magic has a practical value, which magicians themselves cultivate. When people fall ill or natural disasters occur, magical forces are often the only explanation. Magic answers a desire for some sense of command over unexplainable things. Modern science and technology have more effective techniques than magic, but, for most people, their modes of operation are no less mysterious.

Technology's historical heritage in magic is more than symbolic. Electronic, electromagnetic, cryptographic and imaging techniques that are commodified as modern technical objects were the domain of Natural magic during the Renaissance and of mysticism in the nineteenth century. These traditions looked for exploitable patterns and mechanisms in the properties (singularities) in the physical world. They were particularly driven by a will to achieve command over distance. The concepts of telepathy, communicating with spirits, and the ether coexisted and mingled with the forerunners of technological devices that later solidified as recording, broadcast and invocational media.

In 1600 Sir William Gilbert identified the important distinction between magnetism and static electricity. He compared magnetically polarised lode stones used in navigation with the fields of attraction around a piece of amber that has been rubbed (the 'amber' effect). However, his explanation of these phenomena sounds like pure fantasy to the modern ear. He proposed the 'doctrine of the magnet', by which magnetic fields supposedly open up the possibility of telepathy, magical healing and action at a distance. Gilbert saw the world as alive, vibrating with invisible effluvia. He supported the possible effectiveness of the weapon salve, where wounds could be healed by treating the weapon that caused them (Thomas 1971: 224). While his explanations now appear absurd to modern science, the forces he identified have become the

foundations of many of the modern technologies that mimic the magical effects he predicted. Radio and infra-red transmission, radar, x-rays, radiation therapy, magnetic data storage and so forth, are meaningful manipulations of the very invisible effluvia that Gilbert found, but could not understand or control.

Modern techniques for selecting materials are not substantially different from pre-modern ones. Modern engineers exploit traits of materials in a way that is strikingly similar to the metallurgists of the middle ages: they experiment to find distinctive and predictable properties and exploit them. As Latour argues, there is no Great Divide opposing alchemists, magicians and metallurgists on one side to silicon chip factories on the other, only variations in scale (Latour 1993).

Medieval metallurgists followed the traits of hardness and weight of metal to make a true blade. Designers of invocational hardware exploited various magnetic and conducting properties of metals and other materials (silicon).

They selected materials and components by collective properties of invocationality: fast-switching semiconductors, reliable and fast memory components, high resolution displays. While silicon chip makers may have used complex formal calculations, they still relied, as did alchemists, on a combination of trial and error and intuition.

It is no surprise that magic often resurfaces in computer discourse (including, of course, the term 'invocation'). Many computer designers use magical concepts to talk about something new they have made. While 'ether' was scientifically discredited, a networking protocol developed at Xerox in the 1970s carried invisible signals in a way that was quite sympathetic to Gilbert's visions of action at a distance. The engineers called on the magical precedent to convey this to users. They had succeeded in capturing Gilbert's effluvia, and gave him some credit by naming the technology 'Ethernet'.

Invocation is magical rather than metaphorical. In the 1980s interface metaphors become particularly fashionable. Apple's Macintosh is based on a 'desktop' metaphor. PageMaker is a metaphorical layout table. Hypercard is like a stack of cards. The idea is that the user's knowledge of a task domain with which they are already familiar can be transferred into the new metaphorical environment. However, it becomes apparent that direct metaphors have limited usefulness (Laurel 1991: 127–132). A rigid one-to-one correspondence between an original object and a simulation is not only impossible, but also restrictive. It misleads users when it doesn't fulfil all their expectations, and it systematically diverts them from discovering features that work in a different way from the original object.

Alan Kay prefers the concept of user illusion: '...it is the magic — understandable magic — that really counts'. He sees magic as a better concept than metaphor. For example, it is better to present a new graphics program as 'magical paper', than 'metaphorical paper'.

Should we transfer the paper metaphor so closely that the screen is as hard as paper to erase and change? Clearly not. If it is to be like magical paper, then it is the magical part that is all important and that must be most strongly attended to in the user interface design (Kay in Laurel 1990: 199).

If magic introduces new and powerful commands, religions impose faith in, and devotion to existing standards. As applications become more standardised, the significance of the innovative powers of new features decreases, and the power of standards becomes more important. What goes out as command returns as ritual.

Standards: invocational religions

The general historical tendency with computers has been to move from magical innovation towards religious hegemony. The cultures around computers

become more like religion when software and hardware standards are patented, institutionalised, regulated and black-boxed. Computer religions emerge when programmers and users develop allegiances to particular systems. Magical commands become proprietary rituals. Several times in the history of invocational media, this tendency for faiths to emerge recurs on a large scale.

Unlike pure research or hacker innovation, religious product development systematically polices a particular set of standards. Acolytes adopt ritualistic rites of fetishism, fealty and devotion around these. There are economic forces that encourage standards to stabilise. Standards and 'installed base' are especially critical in invocational media, but do not happen only in this field. Marx notes how a first version of an innovative technology tends to be substantially more expensive than those that follow. This encourages development to follow standards that have already been developed (Marx 2001 [1867]). Thomas Kuhn identifies a conservative tendency in the cumulative advances of 'normal science', which resists innovations (Kuhn 1996).

However, there are also forces which encourage radical changes in standards, particularly as existing markets become saturated (Flamm 1988). There are often also cultural pressures for change from those excluded by the priestly vested interests. In their early days, time-sharing systems, minicomputers and microcomputers appeared to be a form of resistance to the religious rigidity of IBM corporate and military systems: 'Guardianship of the computer can no longer be left to a priesthood' (Nelson 1974: 2). Rebels in T-shirts rose up against a white-cloaked ministry of the mainframes. After MITS released the Altair in 1974, a string of competing but incompatible microcomputers were released: IMSAI's 8080, the Commodore Pet and Amiga, Atari 400 and 800, Tandy's TRS-80, Texas Instruments' TI99/4, the BBC Micro, Apples I, II, III, Lisa and Macintosh (Freiberger and Swaine 2000). A decade later, though, personal computers developed their own 'religious wars' between competing platforms.

Competition stabilised again by the late 1980s, when the IBM PC and compatibles and the Apple Macintosh became the two dominant competing systems. Apple was among the first companies to employ people whose job title was 'evangelist'. Their job was to spread the faith about the system. Apple designers were expected to follow the Macintosh religion by building their software in ways that followed the Mac conventions (Levy 1994).

Invocational religions are often subject to interfaith conflict. Umberto Eco famously compares Mac and PC believers with Catholic and Protestant faiths:

Insufficient consideration has been given to the new underground religious war which is modifying the modern world... the world is divided between users of the Macintosh computer and users of MS-DOS compatible computers... the Macintosh is Catholic and... DOS is Protestant. Indeed, the Macintosh is counter-reformist and has been influenced by the 'ratio studiorum' of the Jesuits. It is cheerful, friendly, conciliatory, it tells the faithful how they must proceed step by step to reach — if not the Kingdom of Heaven — the moment in which their document is printed. It is catechistic: the essence of revelation is dealt with via simple formulae and sumptuous icons. Everyone has a right to salvation.

DOS is Protestant, or even Calvinistic. It allows free interpretation of scripture, demands difficult personal decisions, imposes a subtle hermeneutics upon the user, and takes for granted the idea that not all can reach salvation. To make the system work you need to interpret the program yourself: a long way from the baroque community of revellers, the user is closed within the loneliness of his own inner torment.

You may object that, with the passage to Windows, the DOS universe has come to resemble more closely the counter-reformist tolerance of the Macintosh. It's true: Windows represents an Anglican-style schism, big ceremonies in the cathedral, but there is always the possibility of a return to DOS to change things in accordance with bizarre decisions; when it comes down to it, you can decide to allow women and gays to be ministers if you want to...

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And machine code, which lies beneath both systems (or environments, if you prefer)? Ah, that is to do with the Old Testament, and is talmudic and cabalistic... (Eco 1994)

Another religious conflict was fought in the 1990s between Netscape Navigator and Microsoft Internet Explorer—the ‘browser wars’. In early 2000, Microsoft’s tactics in this evangelistic battle for the desktop were ruled anti-competitive by the US Department of Justice (US Department of Justice 2000). This trial discussed the significance of the ‘installed base’ of users to a company’s future profitability. In invocational economics, power accumulates to those who control avocational standards:

A software product with a large installed base has several advantages relative to a new entrant. Consumers know that such a product is likely to be supported by the vendor with upgrades and service. Users of a product with a large installed base are more likely to find that their products are compatible with other products. They are more likely to be able successfully to exchange work products with their peers, because a large installed base makes it more likely that their peers will use the same product or compatible products (United States of America v Microsoft 2000).

The stakes in the browser wars were even higher because the explosion in the use of the Internet had moved the computer into the domain of general communications media.

Invocational religions are ultimately more powerful than magics. When commands are repeated constantly, they become incantations. Proprietary invocations become daily rituals and virtually disappear. They become so familiar that they are no longer noticed, so offer an almost natural income stream for the company that owns them. Their mainstream position in the regular flows of cultural life assures them of steady returns. New media become increasingly ritualistic as computers are domesticated and commodified.

The tendency towards ritualistic practice draws attention to the other side of the Muse's ancestry: memory. Beyond the command that invocational media maintain over present and future, they are also notable for their capacity to call up things from the past. Invocational media belong within a technological lineage of collective memory that includes not only record-keeping technologies, but subconscious beliefs and habits.

Commands become rituals: invocations and *nth* oralities

By the end of 1990s many people had access to powerful invocational assemblages without any connection to hierarchical systems of delegation, although their powers were subject to religious avocational standards. Personal computers were being used for many things, from managing finances to playing games. The global military and academic Internet had become publicly accessible, even if it had quickly been captured by e-commerce. General access to invocational media forms started creating new modes of social interaction: electronic mail, online chat, database queries, search engines, news groups and mail lists. These developments are significant enough to ask what the implications of these changes are for the dynamics of culture. What is the significance of invocational rituals?

Marshall McLuhan sees a resemblance between new electric media forms (television and radio) and ancient oral/aural cultural forms (McLuhan 1962). He draws a grand historical arc beginning with oral traditions, passing through a period of rigid print culture, and culminating in electric media with a renaissance of culture that returns to the oral tradition. A classics scholar, McLuhan particularly admires Ancient Greece, seeing it as the exemplary culture that maintained cultural continuity through individual memory and oral ritual performances. Narratives and songs held the civilisation together. At this

end of the arc, McLuhan argues, electric media return to this heritage of myth and oral culture:

Electric circuitry confers a mythic dimension on our ordinary individual and group actions... Myth means putting on the audience, putting on one's environment... putting on a whole vesture, a whole time, a *Zeit* (McLuhan 1967: 114).

McLuhan argues that specialist technologies, like writing, 'detrribalise' (1964: 24), and generalist technologies, like television, retribalise. While computers in McLuhan's time were large and expensive, he emphasises their significance as a medium that extends the human nervous system (McLuhan and Zingrone 1995: 295–297). In some cases he seems extraordinarily optimistic about their implications. In an interview in *Playboy* in 1969, he claims computers in the future may have almost transcendent powers:

The computer thus holds out the promise of a technologically engendered state of universal understanding and unity, a state of absorption into the Logos that could knit mankind into one family, and create a perpetuity of harmony and peace (McLuhan 1969 *Playboy* interview in Marchand 1989: 205).

McLuhan's writing itself is like spoken language, more rhetorical flourish than precise exposition. His style of work — he calls it sending out 'probes' — also creates concepts, even if they are embedded in Romantic narratives (Coyne 1999: 271). Although his probes go in and out of favour (see Moran 1994), his legacy persists because many of these probes — the global village; the medium is the message; hot and cold media — still have some momentum, if not clear direction. *Wired* magazine consider him as their 'patron saint'.

Some who follow McLuhan's legacy claim that the personal computer has in fact become a 'generalist' and 'retribalising' device. Paul Levinson says '[b]y the end of the twentieth century, McLuhan's global village was turning, year by year,

into a more fully fledged reality' (Levinson 1999: 69). Along with radio, television and newspapers, Levinson claims, the Internet is creating a stronger sense than ever of a simultaneous global community. Moreover, the net makes possible *ad hoc* connections between local and local, escaping the mediation of large media organisations. Websites, chat rooms and news groups connect individuals with individuals, irrespective of where physically they are logging on.

The Internet certainly has established platforms for a range of new forms of cultural expression: virtual communities; virtual spaces; synchronous chat; asynchronous discussion; one-to-one email; one-to-many websites; many-to-many news groups and e-mail lists. These have almost the same reach as the voice telecommunications system, but use a more heterogeneous range of technical and cultural forms. Where do they fit in the mediascape? Are they a return to oral culture, as some claim? (Fowler 1994) Are they a threat to literate culture as others claim? (Birkerts 1996) In many ways these forms fit neither the picture of oral nor literate culture.

Invocation is not a 'return' to primary oral culture. For one thing, sound, which is essential to the music of oral performances, is less important. Invocational memory and archival machines supplant the functions of human memory, which is central to how oral cultures persisted. Print forms themselves create written archives alongside memory, but computers automate memory even more powerfully. The way they organise data into categories is often even more rigid than written lists because they must also adhere to technical constraints.

In his rigorous work on the historical transition from oral to print forms, Walter Ong (1989) develops a grounded analysis of change and continuity in media. Ong shows how different media forms support totally different ways of life and mentalities. Following McLuhan, he suggests that there are some ways in which

modern electronic media create new cultural/media forms of 'secondary orality' (Ong 1989: 136–137). Television news and advertising jingles are examples of oral modes that exist within a culture that is primarily print-based. Although news readers and musicians rely heavily on written scripts, their work is expressed as speech. The reassuring voice of the announcer, the politician's voice in a debate or a memorable jingle are cultural performances that are both like and unlike traditional oral modes.

Secondary orality is both remarkably like and remarkably unlike primary orality. Like primary orality, secondary orality has generated a strong group sense, for listening to spoken words forms hearers into a group, a true audience... (Ong 1989: 137)

There are some language forms unique to computer media, such as online chat and discussion forums, that are reminiscent of oral traditions. Although postings to these forums are typed, the discourse in e-mail and chat is closer stylistically to spoken language. Electronic text allows a fluidity of composition quite unlike the permanence of ink and the rigidity of print (Lanham 1993). 'Debates' in electronic discussion forums like USENet newsgroups allow a number of geographically dispersed speakers contribute to on-going 'threads' of argument. Writing teachers experiment with collectively created texts that don't have a single author, but multiple contributors (Murray 1997). Automated e-mail lists and specialist websites dramatically accelerate the circulation of new research in global academic communities.

Invocational social conventions, such as 'netiquette' and mobile phone etiquette, develop around new media technologies. They determine what is acceptable when you are invoked out of context and what kinds of invocation are perceived as polite. Invocational media produce new positions for users: sender, respondent, avatar (see Chapter Five). They require new competencies or invocational literacies (Gilster 1997).

Some writers have compared such invocational interactions with ancient cultural forms. Jay David Bolter compares Homeric discourse with the electronic writing space (Bolter 1991: 57–59). He argues that both are highly associative. The pattern of connections is as important as the elements in themselves. Both forms are dynamic and their outcomes depend on audience or user participation.

Janet Murray (1997) also sees similarities between the Homeric tradition and interactive texts in online environments. Both oral literature and online discussions are incompatible with print conceptions of authorship. Oral literature is comprised of ritualised fragments of stock phrases and formulaic narratives, quite different from the originality of the individual print author. Interactive narratives have the opposite character: not authorship, but agency in a highly plastic multiply authored text (153).

Rhetorician Richard Lanham (1993) sees the computer as quite unlike writing. Compared with the static codex book (which is 'set'), electronic text (which 'flows') has a fluidity with radical potential consequences. Where print is serious, uniform, frozen and conservative, electronic text is playful, ever-changing, dynamic and liberating. In other ways it is a return to an earlier tradition, says Lanham. It is a return to the tradition of rhetoric, which had been displaced for three centuries by the dominance of criticism of canonical texts (51).

So are invocational media another example of secondary orality? Stephen Talbott (1997) strongly rejects the comparison cybertheorists such as Richard Lanham (1993), John December (1993) and John Perry Barlow (1994B) make between electronic textual forms and secondary orality. He argues that electronic communications tend more to remove people from face to face oral contact with each other. He says cybertheorists tend to ignore Havelock's

analysis of oral culture in *Preface to Plato* (Havelock 1963) which emphasises how oral cultures are highly conservative because of the perpetual repetition of standard figures and myths. By contrast, the Internet promotes a culture of disposability that tends to forget its past. Talbott argues that the significance of sound in oral culture is clearly not replicated in the silence and isolation of the computer user. Another objection is that the Internet's ethos of personal expression is quite unlike the oral culture, which had no notion of the individual. Overall, Talbott sees Internet culture as dramatically unlike oral cultures. Rather it is an extension of the increasingly abstracted and socially atomised culture of print rationality.

However, Talbott's conclusion that invocational media simply reinforce print forms fails to account for the dramatic ways that these media forms differ from typographic forms. Even the Internet is not one, but several media. Websites, for example, are a form of publishing: the proprietor of a web site usually offers content to a large number readers, but controls the content. By contrast, news groups are public notice boards, open for many people to send and read messages. Some systems including IRC, MUDS and ICQ operate in real time, resembling phone party lines in text. Although all these applications use the same substrates (the TCP IP protocol and Internet hardware), each has quite different textual and social conventions, and provides quite a distinctive user experience. Each has its own technical and social configurations within the TCP IP invocations.

Invocational media forms — databases, online discussion lists, news groups, websites — are not secondary orality, but *n*th oralities. Invocational media create *any number* of new forms of cultural mediation and ritual. Each new configuration of invoked environment — text chat room, digitised video conference or whatever — effectively creates a new social context. While each of

the *n*th oral forms produces a change not nearly as dramatic as that from oral to print culture, the overall result is an increasingly heterogeneous mediascape.

The proliferation of *n*th oralities is significant because new media technologies tend to help produce new social situations. Joshua Meyrowitz combines what he calls 'medium theorists' like McLuhan and Ong with sociologist Erving Goffman's analysis of social situations to show how a new medium effectively also creates a new social space (Meyrowitz 1985).

For media, like physical places, include and exclude participants. Media, like walls and windows, can hide and they can reveal. Media can create a sense of sharing and belonging, or a feeling of exclusion and isolation... (Meyrowitz 1985: 7)

With the development of virtual machines, there are as many invoked social situations as there are computer programs. Meyrowitz shows how broadcast television creates a relatively small number of very public (virtual) spaces, which position producers and audiences in quite asymmetric relations to each other (73–92). There are many barriers to moving from being a viewer to becoming a producer of television content. Broadcast TV stations operate by the principle of the 'least objectionable programming', avoiding content that would put off sections of the audience. By contrast, invocational media can define a wider range of finely differentiated communities of speakers and listeners. Invocational *n*th oralities are qualitatively different communicative formations from print media. They are also different from media of secondary orality such as the gramophone, radio and television. These heterogeneous modes of mediation suggest that the simple binary division of oral and print culture may be reductive.

*N*th orality *invokes* other cultural forms (including oralities), rather than repeating them. Like speech, invocations operate in the present. They work in 'live' invoked simulated environments. Although 'programmed', invoked

events unfold in the indeterminate flow of 'real time'. Invocational media can be 'interactive', sometimes creating pseudo-conversations or mediating real time or delayed connections between speaking subjects. Invocational modes such as database queries, online arguments in discussion lists ('flame wars') and real time chat often have more in common with spoken language than with printed books. Each has its own way of mediating invocational voices. These voices are expressed in different modalities (numbers, text strings, sound samples, images, etc), as well as being positioned in a specific relation to a set of implied speakers and listeners.

One example that shows the paradoxical position of nth orality is the database query. This invocation to memory might be compared with invocations to memory in oral cultures. The most well known ancient invocations are those that poets made to the Muses. Homer presented his epic poems as invocations to the Muses, reinforcing one of the most enduring conventions in the genre. McLuhan describes Homer's work as the 'cultural encyclopedia of pre-literate Greece' (1967: 113), but it was of course a spoken encyclopedia, with its custody attributed to the Muses. The Muses were part of the techniques of memory, song and narrative upon which oral cultures relied to preserve cultural memories through time.

Homer's *The Odyssey* begins with an invocation to the Muse Calliope:

Tell me, O Muse, of that ingenious hero who travelled far and wide after he had sacked the famous town of Troy (Homer 2000B).

Database reports are also invoked, but from automatic electronic oracles, using a query language such as SQL. Database queries have a strange inhuman resemblance to Homeric invocations. If a postmodern Homer wanted the same story today he might submit the following SQL query:

```
open database muse;  
select hero, travels, victories  
from heroes, adventures  
where heroes.hero_iq="ingenious"  
and adventures.exploits like "sacking of Troy"  
and adventures.year >= -1180  
and heroes.hero_id=adventures.hero_id;  
printall; (Wiggins 2000)
```

In some ways, this fictional, but syntactically correct database query is reminiscent of oral culture. The results of a query are conditioned by the specific and immediate needs of the invoking user. The database outputs a 'report' which appears at a different time and place and in a different form from where and when it was entered. Database reports are subject to the dynamics of recall. Epics begin 'in the middle of things' because of the psycho-dynamics of memory and oral performance. A database report also appears 'in the middle of things', because it depends on arbitrary choices about which parts of a data set are invoked. Both epics and database reports are effectively authored collectively rather than individually, because they are both composed of fragments created by many people over long periods of time. The database report tells a new story each time, depending on the search criteria and the changing body of data. The results it produces in any one report cannot be entirely anticipated. It is a collective product of all those who have entered the data, the author of the query, and the programming of the system. Many of these characteristics: content conditional on immediate circumstances, beginning in the 'middle of things', collective authorship, seem to share something with oral forms.

By contrast with the epic, though, a database relies on an archive of highly structured records. The technology of recall in databases is delegated to the invocational assemblage, actually displacing human memory, which is so critical in oral cultures. While both databases and epics function to maintain

cultural continuity, they do so in quite different ways. Epics tell accounts of past events in the community, functioning more like television soaps by providing stories for the collective to share. Databases help conduct censuses, keep tax records, track customers and suppliers and so on.

In the twentieth century, databases began challenging narrative as the dominant mode of organising cultural memory. Lev Manovich argues that a database is distinctly not narrative (Manovich 1999: 80–99). Where a narrative ‘creates a cause-and-effect trajectory of seemingly unordered items’ (85), the ‘database represents the world as a list of items which it refuses to order’ (85). A database doesn’t have a moral — not in the same way as a narrative, although in some ways it does implicitly say ‘these entities are similar to one another, and have some importance and validity’. A report offers dynamic interpretations of the overall meaning of the data, with automated visualisation and summary tools. The data that a query invokes, and how it is ordered present a meaning that transcends the components. A database report has no natural beginning or ending. It does not impose the teleology or sense of closure that is expected from narrative accounts of a series of past events.

The pragmatics of *n*th orality

The database query is a good example of the pragmatics of invocation. In making queries users articulate their wills to power. In any event of *n*th orality, the pivotal question will always be ‘what is at stake?’ When a company puts up a website it does so because it expects to improve its profits somehow. A businessman uses a spreadsheet to write a business plan because it increases the force of his argument. Computer game players get an affective charge and sense of mastery when they win part of a game (Turkle 1984: 58–89). Whether the invocational event connects with economic machines, enunciative machines, or percepts and affects, any invocation has some kind of force.

In speech act theory a statement is said to be ‘illocutionary’ when saying that statement *does* something. Austin distinguishes locutionary acts (what is said — making sounds, writing a text), illocutionary acts (what is performed in the act of saying — promising, threatening) and perlocutionary acts (the virtual effects achieved — giving reassurance, generating fear) (Austin 1975: 94–120) (see Chapter Seven for a more detailed exploration of invocation and speech act theory). Statements articulated using computers are another class of speech act: the *invocatory act*.

The invocatory act is a statement which functions both as an instruction directed at the machine, and at the same time as a social form of address. Syntax and semantics are important, but not in the same way they are in natural language. Invocatory acts of command and instruction demand absolute syntactical precision (they must have no syntax errors). Invocatory semantic systems mingle human meaning systems with machine-readable codes. A doubled technically mediated pragmatics is infused into each expressive event.

To choose an example that will be familiar to most people, think of the process of composing and sending an email. To start composing an email you might invoke a mail client application and choose the menu option ‘File > New > Mail Message’. Interface designers make menu options pronounceable, so that they make some sense when an instructor needs to speak the procedure in a class. It is an abbreviated imperative form, not grammatically correct in English, but clear as an invocatory statement.

The next step is to enter the email address in the address field to invoke the user/person you want the message to get to. The email address has both machine semantic and human semantic significance. It functions as both name and address. It is memorable for the user who told you their address, and unique in the Internet’s address space.

There is another choice relating to the address: whether to put receivers' email addresses into the 'To:' or 'cc:' (carbon copy) field. This makes no technical difference, but signifies the relationship of the message to receiver (whether they are the addressee, or just getting a 'copy' for their information). The 'Blind Carbon Copy' (BCC) field, on the other hand, has technical and social significance because recipients in the 'To:' field get no indication that the message has also been sent to addressees of BCCs. How the message is addressed is part of the meaning of the message itself. I will answer a message *to* me, but usually treat a CC: message as information only.

After composing the message you press 'send'. This is a particularly forceful invocation, because in most systems it is irreversible. It transforms the message that was a personal draft in local memory into a message in the public domain. Once sent, it can be virtually impossible to erase. Messages are often archived on the servers through which they is sent. Sending an e-mail can create powerful evidence (quite unlike oral records). Some of the anti-trust litigation against Microsoft relied on subpoenaed evidence of internal e-mails (US v Microsoft 2000). A subsidiary of Chevron settled a law suit for \$2.2m after an employee was accused of sexual harassment. The key piece of evidence was an e-mail message with the subject 'Why Beer is Better Than Women' (Siegel 1999). Although it is very easy to write, an e-mail is a remarkably permanent mode of transmission/storage.

The electronic mail metaphor suggests that the message is going to travel over space. It will be broken into packets that follow the pipes of the network until they are reconstituted as the message that 'arrives' in the recipient's mailbox. This is an appropriate but misleading analogy for the communication of electronic mail. It is more accurate to say that the message is sung through the network. The sing-song sound of modems negotiating a connection through a phone line hints at a better conception of the process (Levinson 1999: 44–54).

Messages are not carried through space as physical objects, but transmitted as inhuman songs, through time. The modems negotiate a rate at which they will communicate. This is like musicians establishing a rhythm. Performers have to be in tune (using the same protocols) and in time (using the same data rate) before they can make music together. The score is provided partly by the user's invocatory statements, and partly by avocational standards.

Whether an event of *n*th orality connects with another person, or a software robot, an invocational performance always executes some transformation. This is most often not a physical change to bodies, but a change of status that is attributed to bodies. An invocation is always in some way a mobilisation of power. To be effective, this act must be backed up by some relationship of authority. Most invocations change the immediate invocational system itself — viewing a list of files, erasing, altering or copying files from one location to another, bringing something to memory. Many invocations, though, extend beyond these internal tasks to connect with other social and technical assemblages. An email at work invokes someone else to do some work for the sender. An electronic transaction debits one account and credits another.

Invocational memory

As well as mediating the new modes of *n*th orality, invocational media have a dramatic effect as archival technologies. As Derrida argues in *Archive Fever* (Derrida 1998), a change in archival technologies — changing the medium of inscription — changes the future. Today's archiving techniques determine how the future will see the present. In spite of the strength of the archival dream, there is no transparent or total technology of memory.

Invocational media put memory on command by storing instructions and data in the same mechanism, and liberally combining them. Invocational memory dramatically diverges from previous methods of human record-keeping.

4. Command, memory and decision machines

Records are no longer stored as permanent marks on a surface that are read directly by the human eye. Instead records are inscribed into invocable domains using a range of mechanical, magnetic and optical media. Records are not indexed by spatial relations (pages, shelves, filing cabinets), but by virtual memory addresses. In this form they are invocable with queries.

In physical record-keeping systems, each object is located *at an address* (a particular place which is relatively distant from other places). In invocable domains, virtual objects are located *with an address* (invocations to a memory or storage address within a medium restricted by protocols and connection more than distance). Records can be browsed, sorted and re-sorted. Because the records are effectively immaterial, it is increasingly irrelevant where physically a particular image or text is captured or stored. The logical connections of relations become more powerful than physical connections in the world (Poster 1990).

Invocational database systems are often used as indexes to track physical objects in space (customers, library catalogues). More and more, though, invocational systems become the complete record itself. They offer the 'full text', rather than indexing a physical location. Networking infrastructures that were originally created to share computing resources (printing, file transfer) become invocational communications media in their own right. The speed of invocational access encourages more and more records to be put online. Parts of the general cultural record become available on command.

A generalised ambition emerges to have '[a]ccess to all human knowledge — anytime, anywhere' (Universal Library 2000). An invocational aesthetic develops, which values random access, real time responsiveness, elegance, seamless interconnectivity and modeless operation (Gassée 1985)(see Chapter 6). Businesses develop 'just-in-time' manufacturing processes that rely on

invocational infrastructures to track the flows of raw materials and inventory (Voss and Clutterbuck 1989). Robot search engines on the Internet constantly index web pages, following link to link in the Sisyphusian task of making every page invocable.

The promise of universal access, however, is highly constrained by intellectual property rights, limited by incompatible standards and decelerated by hardware limitations. Invocational standards often impose strategic and accidental barriers to universal access. The collective advantages in interchange and open standards are often compromised by the advantages that rights holders gain from restricting access. Some commands and some archives are protected for reasons of confidentiality: their invocation is restricted by using techniques of encryption and authentication (see Chapter Five). Commercial software manufacturers tend to develop proprietary formats that tie users to using their products. It happens in hardware as well. Removable storage devices tend to be built using shifting standards that sustain a cash flow by requiring users constantly to upgrade and buy more.

Although invocable domains almost eliminate spatiality for users, there is a residue of the physical in technical and economic limitations of components. The cost of memory and archiving hardware is determined by a combination of storage capacity and access speed. There is an informal economic and technical hierarchy of memory and storage components. The fastest devices are the memory registers and caches close to the central processor. At around 10 nanoseconds, random access memory (RAM) is the next fastest. Mechanical hard disks, with an access speed of around 10 milliseconds, are not as fast, they have far greater capacities for the price. Hard disks are usually known as storage rather than memory devices, partly because they are magnetic rather than electronic, so hold data without power. Linear devices like tape drives are cheaper still, but less invocational.

The delays created by differential access speeds of storage mechanisms are only a part of the impact of the invocational assemblage on users' sense of time. User temporality is more fundamentally regulated by two sub-components within the invocational assemblage: the clocks.

Two clocks

The constant interplay between CPU and memory in the invocational interval is regulated by time-keeping components. There are in fact two clocks inside most computers. One keeps the time in years, months, days, hours, minutes and seconds. The other regulates the rhythm and rate of processor operations. These two clocks, with different histories, generate complementary and contradictory mediations of time. The real time clock sustains and extends the standardised global time system established in the late nineteenth century. The processor clock brings into prominence a new time sense: the 'just in time' invocational temporality. It is *now time*, creating a platform always in a state of openness.

Technologies that measure time play as important a part in regulating social dynamics as techniques of spatial differentiation. Lewis Mumford famously argues that '[t]he clock, not the steam engine, is the key-machine of the industrial age' (Mumford 1963: 14). The machinery of the clock extends beyond cogs and springs and into the whole world it regulates. In industrial capitalist society clock time sets an increasingly precisely defined temporal structure. It keeps a standard universally calibrated scale on which to schedule the future and chronicle the past, and becomes a fundamental point of comparison against which all events can be mapped.

The processor clock accelerates past the daily and hourly time of real time clocks. Where the real time clocks privilege the future and the past, the processor clock privileges the present. Invoked events take place at a maximum speed set by the processor clock. The necessity for this clock, which gives all

invocational operations a regulated duration, was part of the compromise of choosing digital over analogue computer designs. Switches — relays, valves, transistors or integrated circuits — take different lengths of time to open and close. In a digital computer, this uncertainty is a problem, because every invocation must be read clearly as either one or zero. Synchronising the instruction cycle overcame the ‘hazards’ of these ‘propagation delays’ (Taub, 1985: 139). However, this design ties the speed of invocational events to the speed of the central processor’s clock.

The rate of processor clocks is measured in millions per second (megahertz) to give speed ratings of microprocessors, which becomes a big selling point in the 1990s (Howe 1993). Over the 1980s and 1990s standard speeds accelerated from below 10 to approaching 1,000 megahertz (the so-called gigahertz chip) (Goldberg 1998). The processor clock is a metonym for the emergence of an invocational time sense in cultures that adopt computers. It presupposes clock time’s ubiquitous synchronisation, but transcends it by bringing everything towards virtual presence.

The processor clock marks time into discrete slices, but the slices are heterogeneous and fleeting. At one pulse the processor might execute a word processor instruction, and the next a graphics application. The software techniques of multi-threading and multi-tasking break up operations so that several events can take place as though they were simultaneous. These operations represent nothing. They are their own simplest explanation. They simply provide a platform on which invoked events take place.

What is becoming critical here is no longer the three spatial dimensions, but a fourth, temporal dimension — in other words the present itself... technologies of the real time... kill “present” time by isolating it from its presence here and now for the sake of another commutative space that is no

4. Command, memory and decision machines

longer composed of our “concrete presence” in the world, but of a discrete telepresence whose enigma remains forever intact (Virilio 1993:4).

Invocable domains are available on call at approaching (but never achieving) absolute speed. Communication and representational vectors link to the past and to the distant. Delay or lag is intolerable, but inescapable. Invocational time moves everything toward the present, but never reaches it. Software engineers have to work within the bounds of the invocational aesthetic, which relates largely to duration (see Chapter Six).

Invocation as decision

The fundamental idea is the message... and the fundamental element of the message is the decision (Wiener in Hayles 1999: 52).

When invocation brings command and memory together under the regulation of the two clocks, the result is decision. Decision is an invocational ‘order-word’ in miniature (Deleuze and Guattari 1987: 84). It is both a death sentence and a call to flight.

...the order-word is a death sentence... even if it has been considerably softened, becoming symbolic, initiatory, temporary, etc... But the order-word is also something else, inseparably connected: it is like a warning cry: a message to flee (107).

Decision is the ultimate killer application of the invocational system. It is the 0 or the 1. It is the open or closed circuit. Invocation deterritorialises what used to be the almost exclusively human capacity for decision.

Every step executed on a digital computer invokes a decision. Flows of bits in logical flip-flop circuits are essentially a series of choices — 1101 means true, true, false, true, or yes, yes, no, yes. Every invocation marks a tiny binary judgment. Whereas analogue media operate through flows of variation (modulations), invocational media operate by articulating sequences of

decisions. Decisions are events that unfold the data that was folded into memories. Decisions also fold new things back into memory. Decisions express events on output devices. Users contribute to decisions through input devices (see Chapters Three and Five).

In most modern computers, which operate serially by sequential logic, the most common decision is not a decision at all. The program counter is incremented by one, and the next instruction in a programmed sequence is invoked.²⁵ Often, though, a program encounters a point of branching, when the next event is determined by states of other variables. In many instances a key stroke, or a signal from an input device, provides that decision. In most cases, though, a virtual 'agent' which is pre-programmed with conditions and 'preferences' makes the decision immediately. The program automatically 'chooses', based on data in memory and storage devices.

Traditionally, invocations to the Muses come at a moment when a protagonist has reached the point of despair trying to make an important choice. In desperate need of inspiration or guidance, he cries to his Muse. Classically educated poets, artists and scientists credit Muses as the source of their originality. Muses function, in a broad sense, as a technology in their own right. For a poet giving an oral recital, they personify the elusive inspiration for their performance. Muses give him leave to pause, bring some stories to memory, and choose where to start. If this inspiration fails to come, he projects this failure onto the reluctance of his Muse.

²⁵ These principles of sequential instructions and random access were established early. For example, Burks et al (1947) write:

It is clear that one must be able to get numbers from any part of memory at any time. The treatment in the case of orders can, however, be more methodical since one can at least partially arrange the control instructions in linear sequence. Consequently the control will be so constructed that it will normally proceed from place n in memory to place $(n+1)$ for its next instruction (401-402).

The first parts of this chapter showed how memory and command regularly overlap and bounce off one another. Commands depend on knowledge from the past. Memories are commanded into the present. These generalities are true in particular ways with information technology. Within the computer itself, the fetch-execute cycle oscillates perpetually between memory and command. This is the most distinctive feature of the invocational assemblage: combining memory with command to create decisions.

In the first chapter (p.7) I said that invocational media are a sophisticated upgrade of the invocatory device. An invocatory device like a switch summons a commanded event immediately (turning on a light or starting a motor). The invocational assemblage folds the invocatory device into four parts and regulates the connections between the segments with a clock. Users make their invocation to the central processor, which separates them from making the invocation directly. Instead users use input devices (like keyboards and mouse buttons), and await the delayed and transformed results expressed as outputs (on screens, speakers etc).

The invocational assemblage gravitates around a rhythmic cycling between a central component of command and invocable domains of memory. The CPU is a critical set of circuits which articulates invocations by directing current through matrices of addressable circuits. The lowest order invocational event is known as the fetch-execute cycle, a characteristic sequence of simple electronic switchings that support everything invocational media perform. Each fetch-execute cycle is a doubled invocation. The first invocation calls up the next instruction in a series, according to a program counter. The second invocation is different each time, because it interprets and executes the instruction that has just been fetched.

Electronic invocations produce decisions which are quite different from human decisions on which they were supposedly modelled. Decision in general is one of the most mysterious events in philosophy and logic. The modern computer belongs within a long tradition of thought about this event. However, it manifests only one narrow section of this tradition: formal decision theory. In a sense, electronic invocations also invoke concepts from this Western tradition: Pascal's wager, Boole's universe, Maxwell's demon and Von Neumann's games. Each of these figures established one of the conceptual foundations for automating events of decision, and each is remembered in computing discourse.

A collection of inventions by Blaise Pascal (1623-1662) helped establish the possibility of simulating the human faculty of decision-making. He invented an early calculating machine which mechanised addition and subtraction. He also developed a theory of probability, which extracted regularities from collections of past decisions to guide future decisions. More philosophically, he outlined a strategic approach to deciding on belief in the existence of God. His famous 'wager' argues that in the absence of proof, belief in the existence of God is the most rational course — the best bet. If you choose not to believe in God, and it turns out that He exists, the cost is eternal damnation. On the other hand, for the minimal cost of believing in God, if He does exist, you go to Heaven. Faced with these conditions, the only rational course is to believe (Goldstine 1972). In these ways Pascal puts forward the conception that decision-making could be an objective and formal procedure. At the same time, though, decision relies on a measure of faith. In 1970, it was appropriate that Niklaus Wirth invoked Pascal's name for a structured programming language.

Writing in the early 19th century George Boole defines the total parameters of formal decision-making. Boole puts the null set on one side, and the universe on the other. He labels these 0 and 1 — nothing, and all things. From this point on, every logical equation can work between these two poles, and use these two

symbols. In fact, Boole claims that unlike previous mathematics, the symbols aren't as important as the structures in the universe to which they correspond (Boole 1951). The principles of Boolean algebra are later manifest not as symbols, but as variations of voltage across sets of transistors and diodes in microprocessors. Each transistor conducts a current or not, depending on the state of the other components connected at that moment. All data transformations are invoked by algorithmic combinations of basic logical gates. Decisions are made by combining (AND), excluding (OR), not combining (NAND), not excluding (NOR) — and a number of 'exclusive or' conditions (XOR or EOR). (Dowsing and Woodhams 1985). End users are most familiar with Boole when they invoke his name in generating Boolean searches for databases.

Maxwell's 'demon' demonstrated the type of power that summoning up decisions would bring. For mathematicians and physicists decision is a crucial response to the problem of entropy. According to the second law of thermodynamics, there is a general tendency towards noise and disorder. The universe is slowly, but inevitably degenerating towards a homogeneous state of disorganisation. James Clerk Maxwell's classic thought experiment starts with two vessels, both filled with gas, but in one the gas is hotter than in the other. If a connection is opened between the two, by the principle of entropy, the hot and cold molecules will mingle until the difference between the two is cancelled.

Maxwell claims that entropy can be counterbalanced by introducing a mechanism of decision into the system. He introduces a notional molecule-sized decision-maker — a demon who will allow only certain molecules to pass, thereby countering entropy. Decision will introduce negative entropy.²⁶ A century later, cyberneticists expanded on Maxwell's themes. While computers

²⁶ This is where the extropian movement gets its name — extropy is the opposite of entropy.

never create decision systems that break the laws of thermodynamics (Maxwell was eventually proven wrong on this), invocational media simulate decision-making to give order to simulations of such a system.

The decision theory figure closest to computers is, once again, John Von Neumann. In the 1920s he wrote a paper that established the field of game theory (Von Neumann 1959 [1928]). Game theory sets out to calculate mathematical proofs that determine the optimal strategies for each player in a logically defined game. It always starts with a strict set of assumptions about the situation. There are two (or more) opponents who want to beat the others. The initial conditions are finite. All possible moves are defined. All goals are measurable. Most of the early game theory work dealt with 'zero-sum' games, in which if one player wins, the other loses. In the original 1928 paper Von Neumann mathematically proves that the best strategy is to follow the 'minimax' principle of minimising losses and maximising gains. He later applies games theory not only to parlour games, but to biology, economic and geopolitical situations.

Abraham Wald generalised Von Neumann's approach with his work on 'decision theory' in 1939. This synthesised game theory principles with statistics and weighted risk functions (Beniger 1986: 52). By the mid 1940s, decision theory was being applied at a high policy level to deal with a wide range of problems. Wald and Von Neumann's formalist approaches applied mathematical models to any and every complex phenomenon. In classic rationalist determinist style, they reduced all change to cause and effect events of bifurcation, and subjected them to logical analysis and explanation.

Von Neumann is also famous for his pivotal role in developing the design of the digital computer (1982 [1945]), as discussed in the previous chapter. In developing its basic architecture he applies the analogy that the computer is like

a brain (Von Neumann 1958). He also argues that economics, social policy and nuclear strategy should be subject to statistical and logical analysis with this organ. His principle of mutually assured destruction is the foundation of cold war strategies (Air Force Command 2000). It is almost as though Von Neumann created computers specifically for this kind of game theory calculation.

Von Neumann, who was wheelchair-bound and dying from prostate cancer during the 1950s, is rumoured to be a model for the title character in Kubrik's *Dr Strangelove* (Myhrvold 1999). The plot revolves around the ultimate fusion of invocation and commanded destruction: the doomsday device, a Russian bomb which will destroy all life on the surface of the earth if the Americans attack. As *Strangelove* explains, the designers removed the possibility of 'human meddling' by delegating the decision to trigger it to a computer program.²⁷

Computers are decision machines. They operate with sequences of decisions made on the basis of known variables, generating automatic expressions of formal rational calculations. Users invoke Pascal when they ask their computers to predict the best bet in business modelling, weather forecasting, computer aided design or picking horses. They invoke Maxwell's demon when they program their video recorder to tape *Buffy the vampire slayer*, or when they set and forget a sprinkler system. Their searches continually choose between nothing and everything in Boole's database universes. They play Von Neumann's games when playing war strategy games or modelling financial plans.

²⁷ Unfortunately for the Americans (and the rest of the world), the Russians have not yet announced the existence of the device, so its deterrence function in this game is not effective. And in spite of its sophisticated command and control infrastructure, the military can't contact the rogue B-52 bomber which is on its way to bomb Russia, and thereby destroy the world.

One way to work with invocational decision is to define variables and algorithms carefully in advance, and use the machine to work through a problem that the user has already conceived. In doing this work the invocational assemblage is effectively performing exactly the same work as human computers, only faster and more cheaply. The invocation provides precise values, but little that could not be anticipated.

More unpredictable results are achieved by invoking simple primitives and establishing rules for their interaction, and watching complex behaviours emerge. Von Neumann himself experimented with this kind of application with cellular automata— one of the inspirations for the field of artificial life. Artificial life researchers see themselves as practising ‘synthetic biology’ by generating models of natural systems and experimenting with invoked organisms within these environments (Langton 1993). In such experiments complex behaviours emerge from simple elements.

Connectionist computer programmers take approaches which abstract invocations even further from users’ intentional control. They abandon Von Neumann’s symbolic methods for more chaotic, fuzzy invocations that work with distributions of ‘weights’ rather than manipulations of symbols (Gurney 1997). They build ‘neural nets’ that simulate complex nervous systems by invoking thousands of nodes, each of which is supposedly modelled on a human neuron. Each node has connections with other units in the net. The net is then ‘trained’ in tasks of recognition or pattern matching, during which these connections become stronger or weaker through ‘experience’. Neural nets are often used to analyse images in order to ‘recognise’ features. They work much more effectively than formal logic in working with context-sensitive information. It could be said that they invoke a sense of intuition. These approaches have had considerable success, especially improving on other approaches in situations where there is incomplete information.

In neural nets, though, users never really know what they have trained the system to do. Such a system may work well, but there is no way to explain with any formal specificity what it is actually doing. In this process, users have subjected themselves to the invocational interval. This invocational relationship recalls the ancient relationship with the capricious Muses. The user really might not know in advance what the system is about to call up. In practice, though, what really matters in invoking a decision is not the means of creating it, but that it is believed. Once it is believed, the question is how the decision is applied.

Guidance, mediation, simulation

The limitation of decision in the abstract returns to the problem of pragmatics. Once a decision is made, how is it expressed? How does a machine-mediated decision connect with the human social world? To what extent should people rely on these decision? Should it be a guide that offers advice, a carrier that passes decisions on to others, or should the machine carry out the task autonomously?

Computers are more or less formalistic decision-makers which perform commands on the basis of data and instructions in memory to provide predictions, mediations and simulations. They are the modern Muses who inspire, announce and enact decisions. While they don't approach the goals of perfect simulation of real events or thought, they have been inserted as formalised models into cultural events in three broad ways: prediction, mediation and simulation.

Predictive invocational decisions offer users strategies and scenarios to inform their future actions. They allow users to generate formalised, automated, but asynchronous models of a task environment. Starting with a finite, quantified data set, a program creates a representation that tries to predict how a complex

series of events might play itself out depending upon the permutations of choices human and non-human 'players' involved make. The best example of this application on personal computers is the spreadsheet.

The spreadsheet gave business people a new kind of predictive power. *Visicalc* was the first 'killer app', which enormously boosted sales of the Apple II. Only a couple of years after the spreadsheet arrived, Steven Levy (Levy 1986) observed that it had done more than speed up the work of accountants. It allowed a new style of business planning, introducing an invocational 'what if factor' (322). Users could experiment with how small variations in input data might effect the overall outcome of a business model. The attraction was as much affect as rationality: 'Spreadsheet models have become a form of expression, and the very act of creating them seems to yield a pleasure unrelated to their utility' (323). It turned office workers into 'gurus' and 'power users' (323).

The second category of invocational decision does not use the machine to make decisions, but to store and transmit decisions. The majority of the forms of *n*th orality already discussed operate at this level. They include electronic mail, news groups, real time chat and so on. These mediating infrastructures carry decisions across space and time. They provide platforms for a range of social situations that escape the physical and temporal bounds for face-to-face interactions. Many such systems operate reasonably transparently, although there is always a politics underlying the conventions by which their discursive events take place. Mediating applications sometimes work along invocational chains of command that record and recover decisions. For example, invocations can track promises that customers and sellers make in a commercial transaction.

The third category of invocational decision is the simulation. Simulations invoke real time modifiable worlds with their own frames of reference. They are made up of a set of entities with defined properties and behaviours. They usually

allow one or multiple users to exert some control through inputs. Invoked simulations are animated worlds that model environments in which economic, political, legal and other transactions (incorporeal transformations) can take place (without taking place). Like predictive applications, simulations model complex inter-relationships and behaviours of entities. And like mediating applications, they often transmit these across time and space.

Simulations may or may not have outside referents. Missile tracking systems and space invaders video games are both real time simulations, but they have quite different impacts on actual events, bodies and states of affairs. Mediating applications can easily become real time simulations, and vice versa. The 1983 film *War games*, in which video game-playing kids almost start World War III by challenging a defence computer to a war game, explores the blurry border between invocational simulations and realities. Baudrillard sees the Gulf War as an indication that the real world is fading with the rise of simulacra (Baudrillard 1995).

By the 1990s, most invocational system had themselves become simulations. The 'desktop' simulation was the standard operating system convention. Real time databases of the military, businesses, police and global commodity markets created invoked universes which worked as much according to the dynamics of invocation as by their own rules and traditional modes of operation. Work in media production moved into the simulated environments for sound and vision editing, document production and graphics and animation.

A simulation makes discrete events of memory, command or decision indistinguishable from one another. Operating in real time, simulations function at an indecipherable level of complexity. They become black-boxes (or beige-boxes). Users take on faith the details of the invocational decision paths that invites their invocations, and expresses the results that the user requested. So

beyond command, memory and decision, another layer of invocation remains. It is how the assemblage creates users.

The next chapter deals in more detail with the nature of the cyborg relationship between users and invocational assemblages. As this chapter has shown, the processes by which individuals and social/technical assemblages are co-produced through machines of command (becoming ritual) and memory (becoming archives) are always interwoven. Individuals simultaneously create and are created by the world around them. The computer forms the user as much as the user commands the computer.

5. User design

Great! Great! Perfect! Perfect! Perfect! Perfect! Great! Miss. Miss. Miss.

A crowd encircles Sam, who is staring downwards, stomping his feet on the dance floor, building up a sweat. The chants of 'Perfect!' come not from the mystified passers-by who have stopped to watch, but appear as animated text flashing on the screen of the video game, *DanceDance Revolution*.²⁸ The game rates how well Sam is dancing by electronically measuring each foot stomp to the millisecond. The game is in an arcade in the middle of the city, but Sam is indifferent to the world around, and stares intently at a relentless stream of arrows (←↑↓→←← ↓↓) flowing from the bottom of the screen. He has to match the arrows by stepping on four footpads, marked with similar arrows. Each time he misses the beat he loses points and shortens his game.

Meanwhile, across town, I am about to write another chapter in this thesis, and I am greeted by a paperclip. It says 'Type your question here and click Search'. It's the Microsoft Office Assistant, an animated software agent that predicts, with uncanny imprecision, the help I need at this moment. It asks again, 'What would you like to do?' I click the close box to try to get rid of it. It waves goodbye and disappears to leave me in peace with my cursor.

There's now just a cursor flashing at the top of a word processor's invoked blank page. It patiently waits for me to start typing. It is the most intense point in my field of action. It marks a gap where my words are about to appear. The flashing cursor hails me as a prospective user and a writer. Perhaps the call of

²⁸ *Dance Dance Revolution* was released by Japanese game manufacturer Konami in October 1998. Korean company Andamiro released a clone machine *Pump it up* in 1999, prompting Konami to seek an injunction for breach of copyright. Konami website:

<http://www.konami.co.jp/press/2000/03/050/r.12.03.31-e.html> accessed May 2000.

the cursor reaffirms Althusser's (1972) concept of interpellation, discussed in Chapter One. Microsoft Word quietly asks me to type. In fact, I have been hailed continually since I started up the computer and the words 'Welcome to MacOS' appeared on the screen. What else can I do but start typing?

As my fingers start typing the cursor slides across the page, a vanguard ahead of my emerging words, a compact but powerful on-screen avatar giving birth to sentence after sentence. Its flow marks my presence and activity, increasing the word count, increasing the file size, recording my inspiration. As long as my inspiration comes, it is alive. I pause again. The cursor flashes. It waits in untiring subservience. I continue writing, and once again it is the centre of my power over this emerging text. It gives me power, but only within certain prescribed limits. My desires and intentions are constrained and directed through the narrow space that the cursor cuts into the computer-invoked world.

When a computer addresses users, it doesn't speak as an authority like a school teacher or dance instructor. The cursor doesn't demand obedience so much as make an offer. It addresses me individually, but only because I personalised the system myself. It asks: 'Where do you want to go today?' (Microsoft 1999). The cursor is not telling me something, but indicating that it is listening for my command. It doesn't demand that I write, but offers support if I want to write. 'Dance Dance Revolution' doesn't command Sam to dance. It's not like my primary school teachers who circled around me and my 8 year old classmates and told us to dance the 'Pride of Erin'. Instead, it offers him constant depersonalised feedback — praise and warnings. It asks only for another \$2.

As users we have special hailing powers — powers of invocation. Sam's magical feet build up an impressive high score. My dancing fingers summon words onto the screen. And I have other powers, too. When I demand a printed document it slips out of my laser printer. I connect to the Internet and call up a reference on a

library catalogue. I e-mail this document to a friend. In magical and technological senses, the computer is the *medium* through which we call into presence new daemons: charmed dance floors, writing environments, databases, electronic mail systems. Each of these daemons has a logic and an economics of its own.

Different invocational daemons address users in different ways. Computers inside institutions speak with a voice of authority. The early microcomputers (and games systems) offered invocational powers directly to private individuals. PCs connected to the Internet seemed to spread invocational powers even more democratically. Compared with print and broadcasting, a medium like the Internet seems more socially and personally liberating. It is relatively decentralised and polyvocal. It has low barriers to entry and, in many of its applications, there is no distinction between producers and consumers.

All that computers ask in return for the powers they offer is that we become users: that we take up positions as invoking subjects. User subjectivity is difficult to define because it is based on taking up the capacity to invoke. Unlike churches, prisons, schools and factories that position individuals as subjects in relation to institutions (Althusser, Foucault), computers don't necessarily make users subservient to a 'big Other' (Zizek 1998). However, this does not mean computers have no impact on relations of forces that constitute social power.

Invocations, avocations and vocations

The paper clip and dance floor daemons call Sam and me away from our regular paths. I am not a specialist programmer, and Sam's not a dancer, but we are called away. Like any computer system, *DanceDance Revolution* and *Microsoft Word* both have their own conventions and standard rules for operating. While some systems require substantial training for users, the ideal 'user friendly'

system is 'intuitive'. It requires no tuition. It is immediately apparent. It speaks for itself. This 'speaking for itself' of software and hardware is the avocation.

Every invocation that a user makes is anticipated, or prehended, by one or several avocations.²⁹ Every call to the machine answers its own quiet callings. Every key on a keyboard is an avocation. Each software feature is an avocation. They provide the platforms on which invocations are made, and the vectors along which they are articulated. Computer platforms are built and stabilised in avocational layers — hardware, operating system and application layers. Avocations are visible as 'affordances' — controls for which 'the method of operating it would be apparent — to most people in the culture for which it is intended — by merely looking at it' (Raskin 2000: 63). Affordances call directly to users. Each layer of affordances presents a cohesive set of avocations. If a user tries to utter a command not supported by the platform, it will have either no effect at all, or, worse, produce an unanticipated result.

Avocation in its general sense is a minor form of vocation. Vocation mediates between individual and collective wills. It was first a theological concept — a sense that someone was chosen by God to perform religious work. The term was secularised to refer to an individual's sense of being called or particularly suited to a profession. For Weber secular vocations are significant as forces of predestination in the modern professions typical of rational bureaucracies. At the same time, office bearers' vocations legitimate their actions. Their authority is invested in their position and their profession, rather than in their own personal gravitas (Weber 1946B).

²⁹ Deleuze applies Whitehead's concept of prehension in *The Fold* (Deleuze 1993: 78–81):
Everything prehends its antecedents and its concomitants and, by degrees, prehends a world. The eye is a prehension of light. Living beings prehend water, soil, carbon and salts (Deleuze 1993:78).

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An avocation is more a distraction from one's central path than a final calling. Avocations don't replace vocations, but begin to redistribute power. Weber uses the term 'avocation' in the essay 'Politics as a vocation' to distinguish those who occasionally engage in politics from those whose entire vocation is politics (Weber 1946A).

In the theory of invocational media, though, the term avocation refers to the structures that make invocations possible. These include command sets, software environments and hardware components. Avocations in invocational media divert users from the path that they would otherwise take to solve a problem. Faced with a series of numbers, rather than resorting to mental arithmetic, or to a pen and paper, the user enters the problem as invocations into a calculator. Users make pragmatic judgements about the most efficient means of approaching a task. The success of invocational media is built on the range of avocational offerings that calculators, personal computers and all other computers have made. While each of these events are individual choices, the outcomes of the millions of tiny choices are dramatic for entire social collectives.

Many software applications assemble a whole set of avocational features to constitute themselves within a broader vocation. A desktop publishing application gathers together and integrates a set of avocations for the vocation of the graphic designer or typographer. The avocations offered by financial packages suit accountants. Where individual features (search and replace; cut and paste) are generic avocations, entire applications reach a threshold of supporting a whole set of practices associated with a single profession. Since the 1980s both accountancy and design have been transformed by the invocational vocational systems. Graphic designers' and type-setters' work is now performed as invocations, rather than the traditionally more heterogeneous mechanical, chemical and photographic processes.

Avocations are not reducible to a form of calling Althusser dubbed 'interpellation' (Althusser 1971: 121–173). An interpellation is part of a social system that calls subjects into an entire ideology. Individuals constitute themselves as subjects to that ideology by recognising these calls. This was important for Althusser in trying to account for the consent of those who are subject to class oppression. Avocations don't necessarily call a subject to an ideology. The invocational assemblage itself is relatively ideologically agnostic. Avocations are minor; interpellation is major.

Although they are minor, every avocation connects with mechanisms of legitimation that extend beyond purely technical efficacy of the invocation. A software feature not only has to work technically; it also performs some socially significant function. Each software feature slightly modifies users' work procedures, requiring users to adapt their activities to fit the invocational standards.

The game Sam was playing is at the far end of the scale of hard user avocation, or special purpose machines. It offers a limited range of functions, and special dedicated input and output devices. At the same time, it is a machine for play, and the social force of its invocations are not generally substantial. The PC of the early 2000s, on the other hand, remains a system with relatively soft user avocations. It is a general purpose machine, although its avocations are biased towards business, document production, records keeping, network communication and home computer games. When a PC is situated within social machines, it becomes capable of mediating more powerful functions: economic transactions, recording personal details of others, and so on.

Some writers claim that the computer is intrinsically politically liberating. Because it is supposedly a universal machine — programmable and connectable — some see it as a harbinger of democracy and freedom (Green 1997). However,

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in most cases, invocational media change only the ways that power is exercised. Avocations become part of tactics by which institutions mediate their social power. Avocational tactics are most apparent with systems that control access to physical spaces. Users with a swipe card are admitted or excluded from particular spaces depending upon logical flags in the system. In these cases power relations are unambiguous.

Even something as apparently simple as web page design, though, can also exercise a less coercive power. When designers make links to some things and not to others, or even make some links more prominent than others, they are effectively encouraging users to 'choose' certain courses of invocational action. While users 'choose' to do everything they do, the choices they make are provided by the avocations.

These practices are both symptoms and reinforcements of broader changes in social power in overdeveloped capitalist societies in the second half of the 20th century. Users are creatures of the *control society*, where operators belong to what Foucault called 'disciplinary' societies. Deleuze (1990: 177–182) diagnoses a move from 'disciplinary societies' with their prisons, hospitals, factories and families towards 'control societies', characterised by rapidly shifting control, a service economy, and moves towards meta-production mediated by computers.

In control societies... the key thing is no longer a signature or number, but a code: codes are *passwords*, whereas disciplinary societies are ruled (when it comes to integration or resistance) by *precepts*... We're no longer dealing with a duality of mass and individual. Individuals become 'dividuals,' and masses become samples, data, markets, or 'banks' (Deleuze 1990B: 180).

Disciplinary society forms developed in the 19th and early 20th centuries. They put in place strategies that controlled masses of individuals by distributing them in space. Workers in a factory were handled as a mass, moulded into a shape by their position on an assembly line. By contrast, control society operates by

'continuous modulation' (179). In control societies businesses offer incentives and bonuses, and encourage staff to identify with the company as rivals to other companies. Hence, users are empowered by a capacity to invoke, but this power is conditioned by the dynamics of avocation — which defines what is invocable.

The user/computer assemblage is never only an interface between a user and a device. Users are already at home, at work, at a museum or in a cybercafé. They have at least partly predefined identities to perform, and tasks to accomplish.

The computer *supports* users in performing these tasks. It is a platform on which they do their work, and gradually come to depend upon absolutely. These emergent dependencies on avocational structures, or invocationary refrains, are the key to how invocational media transform power relations. Hardware and software standards position users in relation to invocational events. The topology of invocational environments enables, structures, and constrains what users can do and how they do it. These forces are not violence or intimidation, and not quite coercion. Users produce themselves by taking up the power of invocation.

Social semioticians argue that natural language is always a social, not an individual phenomenon. In a sense, language speaks you, you don't speak language. What you say only borrows words that circulate within a community of speakers. The meaning of any statement you can make is possible only because it makes sense to others. The structure of any individual utterance is determined by the immediate social situation. An utterance is not an isolated event.

Any utterance, no matter how weighty and complete in and of itself, is only moment in the continuous process of verbal communication. But that continuous verbal communication is, in turn, itself only a moment in the continuous, all-inclusive, generative process of a given social collective...

(Volosinov 1985: 62)

When a user invokes an event on computer, who is the source of the consequent event? Users delegate commands to a technical apparatus. Like language, an invocation is not simply generated from within the individual. An invocation arranges an available repertoire of avocations.

But is that the same as language? In some ways it does seem to be like communication between humans. Natural language requires that both speaker and listener speak the same language. This requirement seems to be repeated in invocational media, because when computers transfer data they must use the same protocols.

On closer examination, language and computers are not equivalent, but distinct and complementary. Data moves through its own layers that don't duplicate the linguistic level, but add to it and remain largely independent from it — the invocationary act. When there is a problem with a data transfer, that is not the same as a human misunderstanding. Where computer failures are black and white, human misunderstandings tend to be shades of grey. On top of these differences, computers open up a range of 'natural language' situations — *n*th orality — that would otherwise not be possible or practical, such as e-mail, online discussion and live chat (see Chapter Four).

Another difference between natural language and invocational standards is their political and economic status. Many avocations are proprietary — copyrighted or patented as commercial intellectual property. Unlike natural language, entire systems of avocations are owned and protected by patent and copyright laws. They are both social conventions and private property. Furthermore, many invocations on computers aren't language as such, but algorithms, images, simulations and other symbolic activities. Theories of language won't easily map across onto theories of users' relationships with computer events.

Usergenesis

The layers of avocations in computer hardware and software carry strategies to create users. In learning to invoke, users respond to the avocations of the machine. In this way, invocational media come to function as machines that generate users. This process of usergenesis involves entire assemblages — users, machines, social situations around it. It includes official and unofficial regimes of training, reference materials, advertising, apprenticeships, architectural changes etc. Usergenesis is apparent at a number of levels in relation to the invocational assemblage itself, none of which provides a complete explanation.

Guattari's work on the machinic processes of subjectivation helps draw out the significance of usergenesis (Guattari 1995A). He extends Freudian and Lacanian concepts of psyche by emphasising the multiplicity of forces that create the self. The psyche cannot be reduced to a single Conscious/Unconscious opposition. The forces that produce subjectivity are not only in the self, but connected with 'collectives'. These collectives are machines of all sizes, from tiny to global. They tend to emerge from affective as well as logical, social and political connections. Particularly crucial are 'refrains', a term Guattari borrows from music, but extends to all manner of regularities and rhythms, repetitions and continuities. This approach privileges events over objects, processes over essences.

the refrain is not based on elements of form, material, or ordinary signification, but on the detachment of an existential 'motif' (or *leitmotiv*) which installs itself like an 'attractor' within a sensible and significational chaos. The different components conserve their heterogeneity, but are nevertheless captured by a refrain which couples them to the existential Territory of my self (Guattari 1995A: 17).

In processes of usergenesis, then, users do not robotically follow the scripts written as computer programs. An avocation is an arrangement of forces that participates in a user's generation of invocations. Users' invocations are not

simply technical events, but refrains that draw on the user's desires and intentions, affects and obligations. Invocations makes connections with other users and with worlds outside, but always need to pass along the lines of force provided by the avocational systems.

If I want to add page numbers to the bottom of every page of this document, I can use the word processor's automatic page numbering avocation. The programmers chose to include this avocation because page numbering is a cultural convention in document production. This avocation will save me the work of adding numbers manually. However, it requires me to negotiate the 'Header and Footer' avocations, calling me away from my task of writing, and forcing me to try to understand the avocational structures of document sections, page layout and page number formats. Over time, my work practices become bound inseparably to this word processor. I can't write the same way without it.

Invocational media always include avocations in the form of software features with spaces or intervals that users fill. Avocations incorporate implied users of a system. There are four distinctive kinds of user-avocation: material interfaces; invoking languages; user modes; and user avatars:

- the industrial design of the physical spaces around computers are a more subtle way to encourage the user to take up certain physical positions in relation to the machine. Users come comes face to face with the *material interfaces* like keyboards and screens;
- *invoking languages* are the linguistic and quasi-linguistic formations and standards that constitute the virtual language system (*langue*) with which users perform. These define the power of and constraints on the statements users can make in specific programming languages and environments;

- *user avatars* are the logical and physical entities like the cursor that stand in for the user in invoked environments. User identities are constituted at each of these levels simultaneously;
- and finally, the logins, passwords and other strategies for securing the identity of the user are the strongest way of making sure users are who they claim to be. These relations are enforced within the software by *user modes* which protect the authorised speaking positions.

Even within an apparently simple invocational relationship such as writing a document on a word processor, there are several different levels in play — bodily, linguistic, political and psychological — each of which is affected by the mediation of the computer. Picture me again writing this document. There I am, a user in-the-world, sitting at a desk typing and waving a mouse around. There I am again, a reader/writer working with several symbol systems including English, MacOS and Microsoft Word. And that's me playing the student, employee, author, citizen, customer, and probably some other roles. Here I am once more, thinking about this, as a rational thinking subject, or a bundle of subconscious urges ruled by desire and Oedipal dramas. In each case, the presence of the computer complicates the picture. It is not a question of how computers change the user, or how users change the computer, but how invocational assemblages emerge from invocational refrains between users and avocations.

Material interfaces: the physical machine

At one level, all computer use involves an interplay between computer hardware and bodies. The human is the interval between computer output and input devices. The configuration of a computer requires that users literally take up certain positions in front of the machine. Like many technologies, computers are engineered to suit the capacities of human bodies. The PC mouse fits users'

hands. The screen displays images for a users' eyes: refreshing at 60 to over 100 times each second. The keyboard is the width of two hands, with pads for users' fingers. Users internalise QWERTY key positions until typing is second nature. In all these ways, the computer presents a world to the scale of the human body. It is in tune with how users perceive, learn and act.

The design of the modern conventions for interactive computing is based not only on designs for the machine, but designs of the augmented human. Doug Engelbart is the most prominent proponent of the vision of augmented human.³⁰ He has based his technological life's work on a vision for humanity. From the Second World War he proposed that the computer should *augment* institutions and humans, and that it offered 'huge potential gains for mankind' (Engelbart 1988: 188).

Metaphorically, I see the augmented organisation or institution of the future as changing, not as an organism merely to be a bigger and faster snail, but to achieve such new levels of sensory capability, speed, power, and coordination as to become a new species — a cat (Engelbart 1988: 188).

His thirty year 'framework' for computer development began as a humanist vision of social evolution. Faced with exploding complexity after the Second World War he believed that 'mankind' was 'in trouble', and he hoped to find ways of '[b]oosting mankind's ability to deal with complex, urgent problems' (189). The solution came to Engelbart in a flash of inspiration:

Ahah— graphic vision surges forth of me sitting at a large CRT console, working in ways that are rapidly evolving in front of my eyes (189).

This vision drew from his experience as a radar operator during the war. It became a more general vision of an entirely screen-based world view. The

³⁰ Licklider (1960) is the other key progenitor in the goal of using computers to augment humans.

dream took shape in the Online System (NLS), which was demonstrated at a famous conference presentation in San Francisco in 1968. The demo was the first public appearance of the mouse, and introduced the germ of the conceptual framework that would become the standard computer-user system.

At one moment during the demonstration, the computer text and images were directly superimposed over the user's face. Here was not only a vision of the computer of the future, but a vision of the cyborg human. While the human was ostensibly at the centre, in command, simply augmented by the machine, this image told a different story. The dynamic text and images ran over the user's face. The human face mingled with the invoked face of the machine. The augmented human was not simply empowered by this relationship, but transformed by it.

If human and machine were to coexist, though, they needed to function at some juncture at the same speed. Invocational systems became *present* for users only once they achieved the speed to generate simulations in real time. Users have limited tolerance for delays in what they invoke. They quickly become frustrated at losing responsiveness. There is a threshold passed when the invocations are fast enough to give a sense of 'presence'. When it is fast enough, the computer gives a feeling of open-ended possibility. The capacity to invoke virtually instantly through the interface is primary in the user experience.

Computer game players' 'twitch' is an archetype of this time sense (Delacour, Heyward and Polak 1996). Playability is the primary aesthetic, and centres on the sense of engagement within a field of play, both spatial and temporal. Players respond to system events at speeds at the boundaries of human reaction time. The best games give a seamless illusion, where players' actions and their awareness of their actions merge. The subjective experience of this timescape is

one of losing touch with clock time. Players talk about not noticing the hours pass. Invocational time is a perpetual present.

Software designers develop avocations that deliberately manage the user's sense of time. The progress bar, now a standard interface element, indicates the probable duration of the current process. Similarly, the spinning hour glass of Windows, or Mac's watch cursor signifies a suspension of the power of invocation, but promises imminent relief from that pause (Apple Computer 1992). The obsession in human interface design with 'intuitiveness', which promised to reduce the time for the user subject to learn to use the system was symptomatic of the present-centrism of the technology. The mobile phone and personal digital assistant started taking the place of the pocket watches and diaries. People are constantly on call, as well as being on appointment.

All these innovations needed to be designed and built. Avocations are generated through social and technical processes of design and production. When teams built personal computers they incorporated avocational spaces that embodied strategies or programs for creating users. Steve Woolgar (1991) describes this process as 'configuring the user'. During the 1980s he observed the development process of a new series of 286-based personal computers. His ethnographic study traced the design of the product (known only by the acronym 'DNS') from inception through to release. He watched the dynamic interplays between different sections of the company, all negotiating over images of the ideal user.

In configuring the user, the architects of DNS, its hardware engineers, product engineers, project managers, salespersons, technical support, purchasing, finance and control, legal personnel and the rest are both contributing to a definition of the reader of their text and establishing parameters for readers actions. Indeed the whole history of the DNS project can be construed as a struggle to configure (that is define, enable and constrain) the user (Woolgar 1992: 69).

Among the design teams there were a range of conceptions of the user. Technical support staff, who had direct experience of the problems that users had with poor designs, were scornful of hardware engineers' disregard for the simple problems that came from poorly conceived design. One of the technical writers said she was surprised at the Marketing department's unsophisticated conception of the profile of future users (70). An overlapping, if not entirely shared image of the ideal users was negotiated during the processes of collective decision making and usability testing.

Throughout the process the image of the user was highly fluid. Neither the user (who was inexperienced) nor the machine (which was incomplete) was settled or established until quite late in the project. Woolgar interprets the entire design process as a struggle to capture, fix and control the user, and to define the computer as a distinct object in relation to that user. He compares designers' objectives with a writer's desire for seamlessness. Designers wanted to create the impression that the computer was an object with its own integrity, and not just a collection of components. He notices how the engineers delayed the usability trials until the machine had a proper case. Although they themselves regularly worked with the boxes open, the engineers perceived it to be important for end users that the box be sealed. It defined the boundaries of the machine, like a book's covers distinguishes one work from another. This was part of 'black boxing' (or beige-boxing) by which much scientific and technical work becomes invisible (Latour 1999:304).

Using a computer is an active process, which Woolgar compares to reading. Different users can have different readings of the same text, but their reading paths are guided and constrained by the writers' strategies and embedded assumptions. The success of the text is measured by how many different readers find uses for the text. The historical timing of Woolgar's research was significant because it was during the late 1980s that many of the standard user conventions

were being established. At the time, responsibility for designing user interfaces was shifting from engineers to designers. The work was shifting from scientific to artistic. Managers came to recognise that designing user experience was about creating percepts and affects more than working with avocational functions. That is, while the computer had to work as an engineering system, it also had to work as something that was sensed and acted upon.

Software changes at a faster rate than physical hardware of computers. Virtual machines made the beige-boxed machines simultaneously more and less 'black'. They became less black because software allowed users to customise the machine in apparently unlimited ways. Computers are very versatile consumer electronic devices. They became more black partly because of this power. Any picture of the innate limitations of the invocational medium was obscured by the perpetual promise of the next version of software... the next hardware upgrade... the next generation of machines... These deferred judgement on contemporary systems indefinitely, overlooking the limitations built in to the very nature of the invocational assemblage.

Invoking languages: writing users

In *Computer lib* Ted Nelson promises that the computer will be 'a completely general device, whose method of operation may be changed, for handling symbols in any way' (Nelson 1974: 10). This is certainly the opinion of Von Neumann and Turing. The early developers underestimate how complex programming would become. The promise of complete generality turns out to be true for users in only a very limited sense. Much of Nelson's book concentrates on programming skills. In practice, the vast majority of users never consider learning FORTRAN or even BASIC, but choose instead to use commercial games and office software like the spreadsheets, word processors and databases.

Users never invoke the CPU directly in its own language (machine code), but through the mediation of several layers of hardware and software. It could be said that everything experienced on a computer is already written.

Programmers have already conceived and written every avocation, every behaviour, every function that a user invokes. Like the reader of a piece of writing, users unleash and actualise a virtuality written into the work. Also like writing, programs can be designed to encourage certain conceptions of reality. If the book is 'a machine to think with' (Richards: 1960: 1, 1924 in Iser 1974: 45), the computer must be a supercharged instance of such a machine.

But as the comparison with social semiotics above showed, invocational codes and utterances have an ambiguous status as language. The existence of computers requires a new distinction between 'natural language' and 'computer language'. Programming languages like FORTRAN or C++ are not languages in the usual sense at all. They are systems of mnemonic machine instructions with only a distant resemblance to, or overlapping with, human languages. The process of using the computer is a kind of reading, but users don't read programming languages. Before programs can execute, they are 'compiled' into machine language. Users read the behaviours of the executing compiled applications — a double separation from the program code. What users read includes not only written components of 'user dialogue', but a full range of behaviours in the invoked environment. Users *read* invocations as they appear on outputs, not the avocations that make those events possible.

There is a paradox, or trade-off, as users move away from the fine avocations that programmers use to end user avocations. Programmers invoke with absolute precision using machine code. Each command in a processor's command set, or even commands in assembler languages, correlate with circuits inside the machine. By contrast, users invoke programs written by other people. In using software applications, users take on faith most of the detail of the

commands they make. Old time hackers hold 'lusers' in contempt (Barry 1993: 158). They see graphical user interfaces as a form of pandering to the unworthy and incompetent.

But even the most low level programmer is a user. They rely on the chip and hardware designers as much as the users rely on them. Everyone relies on beige-boxed engineering techniques, components and infinitely extended technological traditions. Every invocation answers avocations. The outputs remain always literally behind a screen. Invocations are always articulated in the voices of others. Users are always also being used. In these ways, invocations are alienating, which is why so much work is put into designing them not to seem to be that way.

Once again, relationships that resemble delegation are pivotal to invocational media. Delegations pass as folds through layered structures of software and hardware architectures. An operating system typically sits *on top of* hardware; applications sit *on top of* the operating system. Users perform their work in another layer again. Each of these layers is itself layered — an operating system might handle file management, networking, printing, device control and so on. Because each layer is logically separated, black-boxed from the other layers, it is (at least in theory) possible to insert new components into any level. As long as that layer does its delegated and delegating jobs in relation to other layers, the system will keep functioning. Over time all the components in the entire system could be replaced, but it remains the 'same' system.

This strategy of layering dramatically accelerated the processes for developing new machine logics. Software transformed engineering into a kind of writing. Hardware developers could also work independently to build new generations of general purpose equipment which sped up (quicker access) and expanded the capacities (storage, resolution, reliability) of the generic invocational medium.

At the same time, software developers refined techniques for procedural, logical, algebraic, arithmetical and other transformations of data.

Platforms added higher levels by folding invocations together into compounds. Each layer worked with a higher order of abstract entities and events. The development of the string and the integer established a capacity to invoke numeric and text variables by name instead of memory address. The use of arrays allowed groups of similar variables to be held together as a logical table, which can be looked up easily. Sequences of invocations were named as a function, which could be used and re-used with different variables. Even these generic abstractions embodied certain conceptual assumptions and started to apply mathematical systems.

The need for layers relates to divisions of human skill and responsibility as much as to technical imperatives. Over time, the job of adding new features within a layer became more specialised, and the human roles associated with each layer were formalised as vocations in themselves. Programmers developed not only applications and operating systems, but also meta-tools like compilers and other development tools that assist programmers to create applications. Computer science gradually differentiated into specialised sub-fields.³¹ These

³¹ A report by the ACM Task Force on the Core of Computer Science (1989) defined nine sub-areas that the authors thought defined the field:

- Algorithms and data structures
- Programming languages
- Architecture
- Numerical and symbolic calculation
- Operating systems
- Software methodology and engineering
- Database and information retrieval systems
- Artificial intelligence and robotics
- Human-computer communication

sub-disciplines formalised the tasks involved in creating and managing avocational structures, virtual machines and invoked environments.

In trade-offs of precision for power invocational systems tend to build higher and higher layers as they mature. While using a word processor concedes many choices to Microsoft or another software company, for practical purposes a writer has no other choice (any more than there is for building one's own car). Powerful features that appeared as magic become stratified as invocational religious standards. Some standards are set by official standards organisations like the ISO (International Standards Organisation), but more often they emerge by the force of 'installed base'. If enough people come to rely on the stability provided by proprietary layers, they become the *de facto* standard — the 'reference platform', or just the 'environment'.

Between the 1950s and 1970s, IBM held the dominant position in controlling standards, while during the 1980s and 1990s, it was Microsoft. Invocational religions provided seamless, consistent 'userly' environments. These were always to some extent a deal with the devil. They offered users comfort and power, but at the same time tied them in to dependence on the developers of the system and those who controlled the standards.

Avocational systems achieve a totalising, interpellating force when they combine to form larger structures like operating systems, programming languages and applications. There is a certain threshold at which a set of avocations constitute a complete invoked universe. These higher level strata invariably make connections into social institutions and vocations in the wider sense. FORTRAN (FORmula TRANslator) is for scientists who already know mathematical equations. COBOL (COMmon Business Oriented Language) is for business. It is more suited to handling large quantities of data with relatively simple algorithms. COBOL programming standards strictly separate data from

procedures, and require clear statements of authorship (see upcoming section on user modes). BASIC and LOGO, by contrast, are less structured languages designed to be easy to learn and rewarding for users (Walter 1993, Appleby 1991, Biermann 1997).

Seymour Papert's LOGO language was designed as part of a humanistic project to make creative use of computers in education, providing a softer alternative to drill and repeat or instructional paradigms (Papert 1980). However, Papert's vision was unapologetically a strategy to produce users in a certain image:

computers can be carriers of powerful ideas and of the seeds of cultural change... they can help people form new relationships with knowledge that cut across the traditional lines separating humanities from sciences and knowledge of the self from both of those (Papert 1980: 4).

The conventional view of users shifted after the 1980s, once computers became 'information appliances' rather than an obscure form of deep magic. Hackers became outlaws (Sterling 1992). A term that once meant 'inquisitive and independent-thinking technical genius' came to mean 'anti-social outcast bent on wreaking havoc on legitimate system users'. At the same time 'power users' gained a bit more respect. With visual tools, using became more like programming. Faster hardware and more 'mature' software gave users capacities to perform more and more work on their desktop machines. The most dramatic shifts came when software companies began realising that their task was not so much designing the machine in hardware, but designing the user in software.

Ben Shneiderman's book *Designing the user interface* sits in the middle of this transition in computer design that helped bring users into the world (Shneiderman 1986). He starts by summarising much of the scientific empiricist work on user interfaces from ergonomics, cognitive science and computer science. Much of this research concentrated on human capacities rather than on

the machine. It measured perceptual abilities (19), human 'central processes' and 'factors affecting perceptual motor performance' (22). It took measures of short and long term memory, problem solving, decision making and time perception (22). It defined the tolerances within which the engineers were working with human components of the system.

As the book progresses, though, Shneiderman develops more qualitative 'theories, principles and guidelines' (41–81) about designing for users. He emphasises principles of consistency, informative feedback, easy reversal of actions and reducing short term memory load (61–62). Shneiderman's most celebrated contribution is the principle of 'direct manipulation' (180–223), which he says creates 'the really pleased user' (180).

The central ideas seem to be the visibility of the objects and actions of interest, rapid reversible incremental actions, and replacement of complex command language syntax by direct manipulation of the object of interest (Shneiderman 1986: 180).

Direct manipulation is one of the distinctive features of the WIMP (Windows, Icon, Menus and Pointing Device) interfaces that became the dominant standard for computers by the mid-1990s. This directness is, of course, only possible by a radical move towards something indirect: the creation of a 'user illusion'. Graphical user interfaces allow users to generate computer commands without writing direct invocations. Commands are replaced by gestures and menu selections.

In the 1980s a global market for commoditised general purpose hardware and 'shrink-wrapped' software grew. The conventions of graphical user interfaces stabilised as the dominant standard. What was known as 'human factors' research came more to be called 'human-computer interface design' or 'usability research'. Rather than studying human or machine capabilities independently, it concentrates on emergent dynamics between the two. Research also moved

towards interdisciplinary approaches. Interface became an art more than a science (although user testing often continued to quantify the merits of different design decisions).

User friendly invoked universes provide stable platforms upon which users perform higher level work. Their features are (relatively) integrated and consistent. They give users an appropriate choice of abstract entities and functions for the tasks at hand. An animation package such as *Macromedia Flash* offers a drawing environment to create sprites (animated elements), a layered timeline environment in which to position objects on the screen and across time, and a basic scripting environment in which to create conditional events. This designed environment is not only a software design, but a user design.

The move toward 'user friendliness' establishes a range of consistent conventions about how users command the invoked worlds. Among these practices are new ways to represent and perform the self that function as forces for cultural transformation.

Avatars

Avatars are entities within invoked environments which function as the grammatical subject in invocational statements. They represent users within computer simulated spaces. Avatars can take on a range of forms. Sometimes they appear as visible sprites, or as fully 3D modelled bodies, while at other times they are only implied by a point of view. In other cases they are logical entities: names, numbers or placeholders within simulations. Avatars perform as a special category of actor in the chains of human and non-human actors in invocational systems (Latour 1991: 110). Users' bodies manipulate hardware devices that they use to control data avatars, which act as the user stand-in within the invoked environments.

The archetypical instance of user avatar is the cursor, which marks the text insertion point. First used in command line interfaces such as DOS and UNIX, it also features in word processors and text editing software. The term 'cursor' is of Latin origin (OCED). It means 'runner', but it is also applied to mechanical slide rules. The cursor position marks the results of a calculation. The computer cursor is a placeholder or progress mark in a position within grided rows and columns of text.

The user directs and controls the cursor as an on-screen token or agent. The cursor functions as a virtual tool with powers to perform the specified set of tasks proscribed by user modes. Its shape as well as its position has significance: in one mode it inserts text, in another it types over text and replaces it. The trained user and cursor perform as a singular cyborg assemblage, jumping across the screen, transforming its textual landscape.

The graphical user interface transforms the relationship between user and avatar. The pointer and mouse parallel, but go beyond the cursor/keyboard assemblage. Mouse users use relatively rough gestures rather than precise discrete decisions to invoke effects. By mobilising the modern method of scanning, the computer follows the arc of the user's gesture. This change provoked a prolonged controversy during the 1980s over whether command line interfaces were better than graphical user interfaces (CLI vs GUI).

The so-called 'interface wars' represented two sets of values on user subjectivity: a precise, rational, masculine CLI against the fuzzy, bodily, feminine GUI. It was not just that the Macintosh's 'cuteness' that was perceived as 'unmanly' (Gelertner 1998: 36). The Mac's implied user was quite different to the PC's. A mouse seemed to bring back everything that digital electronic engineers had worked to eliminate — imprecision, ambiguity, embodiment and analogue meaning systems. Ultimately the war was not won by any side, because

graphical interfaces support visual modes of thought, where commands and keyboard shortcuts support more verbal modes. Some tasks (working with images, grouping objects, mapping relations) are better handled in tactile/visual modes using invoked images, while others (defining conditional instructions, editing text) are better articulated as verbal invocations.

The most diverse range of avatars is found in computer games. As with other forms of play, computer games invariably entail taking on roles — invoking the identity of others. Game avatars take on more culturally specific personae than cursors. They borrow from science fiction, sport, military forms, games and puzzles, and even dance. The space ships in *Space war*, *Space invaders* and *Asteroids* are relatively simple to render, but capture a cultural imaginary of radar screens and science fiction laser battles. A game scenario creates a world in miniature, with physical and ethical boundaries, and proscribed roles for avatars to play. id Software's *Doom* gives players a first person view down the gun barrel of a warrior-hero's weapon. Its science fiction scenario invokes a moral universe that justifies slaughtering anything that appears in front of your gun.

The identification between player and avatars can be quite complex. Each game genre has its own special mode of connecting players with the games world. Some simulate sports players, or parts and multiples of players. As I will show in the next chapter on invocational aesthetics, the bat in Atari's *Pong* operates as part of a player: a metonymic table tennis paddle. In the virtual soccer arcade game *Virtua Striker 2*, on the other hand, there is a projected shifting user identity that floats around as control over the ball jumps from on-screen player to player. The system selectively charms players so that the one closest to the ball is always under the user's control. An arrow shifts from player to player, mimicking a television viewer's capacity to find a collective affective identification with a whole team as play progresses.

A new pedagogy of the user emerged with the avatar. It requires substantial training to learn to use command line computers. Users have to memorise complex syntax and vocabularies of invocations. The GUI users of the 1990s were different. They were more active, creative and self-directed. Once again, though, this freedom came at the some cost. Users faced a new set of constraints, based not on physical coercion, but effectively based on implicit but invisible control over their avatars through user modes.

User modes and the individual

Invocation simultaneously differentiates and aggregates users. Users perform invocations to fulfil their own immediate personal desires and needs. Every invocation is singular, marking a discrete point of individual decision. At the same time, invocations only work if users follow conventional avocations. Users re-assert cultural conventions more often than escaping them. Invocational media are the epitome of a technology that embodies Isaac Newton's reference to standing on the shoulders of giants (Astrade 1950: 35).

Computerised systems impose their control using methods that seem more liberal than the disciplinary, paper-based bureaucratic machines. Contractual roles are increasingly policed by controlling user modes, rather than by applying physical constraints. Where a subject who wrote a signature was bound to be in only one place at a time, users can act where they are not present. Their field of action, instead, is quietly constrained by the modes to which they have access. They can also be (at least in theory) held accountable for any actions made under their name. These 'control society' mechanisms are no longer based on containment. Instead, users leave data trails behind their transactions and constitute a number of partial identities as profiles in different database systems (Mackenzie, Sutton and Patton 1996). Disciplinary institutions

haven't disappeared altogether, but control societies have started to offer new modes of control.

Control undermines the liberal notions of a privacy based on the inviolability of the subject. It changes what a subject is. Katherine Hayles (1999) observes that until some time after the Second World War the primary questions about the human related to where the subject was physically placed. She traces a cultural and technological transition towards new regimes which privilege pattern and noise over absence and presence (29). For example, in what she calls the 'posthuman' condition the measure of a bank customer becomes the pattern of the password or PIN, rather than their bodily presence in a bank branch. The word processor document exists as invisible patterns on a hard drive, which can be physically located anywhere, or in multiple places, rather than on physical pages with print on them. These posthuman politics are based not only on the pattern/noise opposition, but on a politics of user modes.

The efficacy of any invocation depends on which *user modes* are available in a particular state of a particular application on a particular platform. User modes are the implicit or explicit categorisations of avocations that will delimit the user's fields of action. In general computer discourse, the term 'mode' refers to a 'particular method of operation for a hardware or software device' (Chandor and Williamson: 304). For example, if a programmer wants to write a program that sends data between two devices, they would need to establish the *mode* of the connection before the process could start. In 'byte mode' data would be sent in one byte chunks, while in 'binary mode' the transfer would be a stream of single bits. Users are unlikely to notice a difference such as this directly, although the programmer's choice of mode might affect how the system performs. Programming is full of these kinds of decisions.

User modes define what a user can invoke at any particular moment. A familiar example of a mode is the choice between 'insert' or 'replace' mode in word processing. Insert mode adds new characters at the insertion point, pushing any text to its right further across. Replace mode overtypes text to the right of the cursor. The same physical action by the user has a different effect on the text depending upon which mode is operational.

Any complex software application uses a wide range of modes, but they are often hidden. Graphical user interfaces often integrate modes into the design of the software features. One of Apple Computer's 'human interface principles' is to create an impression of 'modelessness' (Apple 1992: 12). For example, a graphics program provides a palette of 'tools' and 'brushes'. Each tool performs different transformations on the image. One tool creates lines of variable width and shape. Another makes selections of portions of the image. Another adds or erases parts of the image, and so on. Because these modes correspond with 'real life' modes, like the difference between using a paint brush and an air brush, they don't seem to restrict the operations of a user. But each has been carefully designed, debugged and made natural. An application integrates and combines the appropriate modes for a vocation, including its social relations.

User modes are implicit to some degree in every function in any genre of software. In fact, looking at the set of user modes in a system is a good way to define software genres. Genres are defined better by their virtual users than by their features.³² Banking computers support the user modes of the customer or account holder on one side, and administrators, technicians and other bank staff on the other. Word processors don't only create user modes for authors, but also

³² Genre theory has been a highly active field in Australian linguistics, cultural studies and literary education since the 1980s. These approaches tend to move away from classical Aristotelian concepts of genre as modes of classification, towards seeing genres more in relation to social action, social process and pedagogy (Knapp 1997).

for designers, editors and readers. Microsoft Word has modes (or views) for different classes of user: users enter text and formatting in one mode, and preview the appearance of the document in another. The 'Revisions' function introduced in Microsoft Word 6 allows editors to make changes that can later be approved or rejected. Each of these modes implies an imagined or virtual type of user who will play the role of author, editor or customer.

Many systems restrict certain modes to particular groups of users. The user enters a user name and password, or swipes a card and enters their personal identification number (PIN), or even scans their hand or iris using biometric methods of identification. These identification mechanisms are equivalent to signatures on a contract, but have invocationary force. The virtual signature can then be attached to any invocation that the user performs, along with an automatic time and date stamp. Their identity is invoked with any changes they make to the system.

Like other apparatuses of capture, computer security has two poles: a system of privileges and a mechanism of modes (Deleuze and Guattari 1987: 424–473). The privileges usually reflect hierarchies within the organisation in which the system is installed. Each user (operator) is assigned a category which gives him or her privileges to read, write, erase or add new data or programs. Systems of privileges are enforced by restricting which modes are available. Each user is captured and positioned inside an array of virtual forces. Modes make major politics into micropolitics. The categories of privileged users are enacted by defining what a user can do within a system (molecular). In carefully designed systems, the entire view of the invoked environment depends on the user mode.

System administrators and developers usually have a higher and special level of 'privileges', because they are responsible for the overall functioning of the systems. They tend to follow the dynamics and logics of the invocational

assemblages as much as fulfilling the requests of those who commission the development. They know the system inside out, and have special rights because of this. Arthur Kroker refers to this group as the 'virtual class'. As beneficiaries of these special invocational powers, the virtual class agitates to further its own interests. But it tends to present the expansion of invocational systems as though it was inherently in the common good (Kroker 1994).

In other cases, user privileges reflect the stations in institutional hierarchies. A university's central computer gives students, administrative staff and academic staff privileges to access the system appropriate to their responsibilities. Each can see or change only specified parts of the total data set. Students can change their own contact details, but only certain staff can add or change grades. Mechanisms that identify operators are essential to any systems that track other individuals as objects. Student records are only valid when the systems have ensured that every change is authorised. Data integrity is critical. Any forceful invocational statement has to be legitimated by the identify of the operator who made the change.

The rights assigned to each operator (and to other subjects as data entities) seem at first simply to manifest agreements founded on Enlightenment political theory and articulated in contract law. Locke helped establish the modern principle that authority should derive not from inherited right, but through operations of reason (Locke 1988: 267–282). In invocational systems, users (re)establish contractual relationships with the entity that controls the system. However, the reasoned relations between parties to contracts become manifest as Boolean variables, and ultimately as switched signals in integrated circuits. Invocations blindly allow changes only if particular modes are in operation. This blindness, and the blinding speeds at which invocations operate, start to expose the contradictions and limitations of liberal subjectivity. How can users remain stably at the centre when processes follow invocational dynamics?

Struggles to define the user

The problem of the user resembles the ambiguous status of the author in literate cultures. There is a user-function in the same sense that Foucault talked about an author function (Foucault 1977). Users became a software category in the time-sharing systems in the 1960s. Time-sharing supported several simultaneous users of the same machine. Like the origins of authorship, logging on enforced user accountability. It also gave users special rights that separated their own work from others. However, most of these systems were not particularly secure. They made it easy to play pranks. These started to expose more fundamental problems with identity as simulation became just another space for social interaction.

The emergence of unsecured invoked environments, most notably the Internet, and even the commercial online services that preceded it, gave many people direct experience of breakdowns in boundaries of identity in invoked environments. A 'crisis' in the liberal humanist conception of identity is a well explored theme in cybercultural literature. Alluqu re Rosanne Stone's (1995) *The War of desire and technology at the close of the mechanical age* explores a series of cases where there are ambiguities about identity. In each example, identities are split, multiple, or unreliable. Part of the breakdown is associated with the capabilities of information technology. When there is no infrastructure to police user identities in invocational systems, users can easily manipulate others' assumptions and perceptions of their identity.

One of Stone's stories is a postmodern morality tale about online identity (Stone 1995, 65–81). It was originally told by Lindsay Van Gelder in an article in *Ms.* magazine in 1985. William J Mitchell (1995: 177 n11) also refers to the event. A New York psychiatrist Sanford Lewin joined an online discussion forum 'Between the sexes' on America Online in the early 1980s. He chose to log on to the forum with a woman's name: Julie Graham. In this forum he developed

relationships with women online who believed they were confiding in another woman. They were more honest and open with him than they would have been if they had known he was a man.

When he finally did reveal his 'true' gender these women felt betrayed and compromised. In the medium of online chat, user names are arbitrary handles that lack the redundancy that accompany face to face interactions. With a log-on name (and a persona that he deliberately sustained) he had invoked a gender switch. The participants felt outrage at this early breach of faith, but these practices of passing became an expected part of many online spaces. Without systems enforcing a correspondence between social categories and secured user modes, identity in online environments is prone to easy manipulation. Invoked identities complicate notions of subjectivity that have conventionally been based on presence and absence.

In a world where identity is invoked, users have to become pragmatic about the identity of others. Rather than constantly seeking proof of some stable foundation to every person or institution with whom they deal, users have to evaluate the thresholds of proof that are appropriate to each invocational transaction. Users also become expert at presenting their own invocable identities: customising their own avatars. These tactical interventions resist the strategic programs of avocational modes, tweaking the parameters of systems of control. Of course, avocational guerillas tend to be captured again by the virtual class. For many users, the instability of invocational identity is unsettling and threatening.

Licensing the user

While the Internet seems to support an undifferentiated chorus (or chaos) of invocational voices, there are many interests seeking to regulate and capture users. The *licensed user* is the necessary fiction that allowed the commodification

of 'shrink-wrapped' software since the 1970s. As John Perry Barlow emphasises, software can be copied perfectly and undetected with little or no cost. When it is 'stolen', the original owner still has it (Barlow 1995). The commercial software industry has been built on a new contractual relationship that faced that problem: the licensed user.

Microsoft was the first major software-only company that began by licensing programming languages to microcomputer manufacturers in the mid-1970s (Nash and Ranade 1994). In the 'Open letter to hobbyists' in 1976, Microsoft founder Bill Gates argues that software should be protected from copying. He appeals to people to stop copying his version of the BASIC programming language, and to maintain the incentive for programmers to develop new software. This new model of commercial microcomputer software demanded a new range of machineries: sales, distribution, support and enforcement. Organisations including the UK Federation against Software Theft and the Business Software Alliance invented and began to enforce the new crime of 'software theft':

As the 'voice' of the software industry, we help governments and consumers understand how software strengthens the economy, worker productivity and global development; and how its further expansion hinges on the successful fight against software piracy and Internet theft (BSA 2001).

The user mode of *licensed user* is a political and economic category more than a technical one, although software companies have attempted a range of techniques including copy protection, hardware dongles and registration. Commercial software applications created new genres of software, new legal concepts and new dynamics in economics. Applications became more comprehensive and 'user friendly'. Software didn't quite fit existing patent, copyright or trademark laws, so legal changes were made to protect intellectual

property rights. This new mode also produced a new economy based on controlling a monopoly over standards through market share.

The desire to police user modes continued into the 1990s. The ease of copying software expanded even further with the Internet, extending the threat to other industries which depend upon control over intellectual property. Book publishers and newspapers became uneasy. The music sharing software program *Napster* began scaring the recorded music industry, inciting a frenzy of legal actions against the service (*Computerworld* 2001). These industries are alternately excited and threatened by the emerging regime by which it seems all mediated experience might ultimately become invocable.

At the same time, some people have begun to engage directly in invocational politics by working according to different rules: copyleft rather than copyright. The GNU project sustains the tradition of distributing software freely.³³ It rejects proprietary standards, arguing not only that they encourage monopolies, but that they create inferior software. Richard Stallman, founder of the GNU project continues in the Nelsonian tradition of computing power to the people:

³³ The open source software movement advocates a direct alternative to copyright law. *Copyleft* licences not only allow the software to be freely distributed, but are also requires that developers release their programs with the uncompiled source code, so that anyone else can modify it. This is a direct political intervention to break down the distinction between programmer and end-user modes. The ideal of free software refers to the concept of political freedom, rather than the absence of payment:

“Free software” refers to the users' freedom to run, copy, distribute, study, change and improve the software. More precisely, it refers to four kinds of freedom, for the users of the software:

- The freedom to run the program, for any purpose (freedom 0).
- The freedom to study how the program works, and adapt it to your needs (freedom 1).
- The freedom to redistribute copies so you can help your neighbour (freedom 2).
- The freedom to improve the program, and release your improvements to the public, so that the whole community benefits. (freedom 3).

(GNU website 2000: ‘What is free software’)

My work on free software is motivated by an idealistic goal: spreading freedom and cooperation. I want to encourage free software to spread, replacing proprietary software which forbids cooperation, and thus make our society better (Stallman 1999).

In spite of these micropolitical interventions, invocation remains unevenly distributed socioeconomically. PCs are expensive consumer products with accelerated obsolescence plans. They continue a tendency Raymond Williams saw in the 1970s of an increasing self-sufficiency of the family, and increasing mobility — ‘mobile privatisation’ (Williams 1990: 26). Portable consumer products, rather than public technologies like public lighting and train lines, are becoming dominant.

The demographics of users strongly correlate with pre-existing social power (as well as age). This is significant not only for individuals, but for collectives, as more and more ‘normal’ social transactions take place as invocations. In the same way pedestrians only came into existence with carriages and cars, the expansion of invocation has the potential to further disenfranchise groups without access.

Conclusions

The processes creating users gradually became invisible. Just as the market regulations that governed private property after the 16th century became generally accepted as the natural order, invoked environments became natural by the end of the 20th century. The apparent fluidity of identity during that transition gradually crystallised as communities of users adjusted to these dynamics. Users developed invocational literacies and cultural conventions that presumed the operation of the invoked platforms. Users came to perceive the world differently, without really thinking about it. As trains changed passengers’ perceptions of space and time by making distant places closer in time (Schivelbusch 1979), invocational media bring some things closer to users

by making them invocable. Among these changes is the emergence of an invocational aesthetics, which is explored in the next chapter.

Ultimately it is not possible to sustain the approach I have taken over these three chapters of trying to break the invocational assemblage apart. The next chapter will explore the aesthetics of invocational events. This aesthetic confirms many of the conclusions from earlier chapters. It is a mobilisation of the ontology of the interval between input and output devices. It relates to values about machines that interleave command and memory and produce decisions. It helps drive the affective avocational machines that generate user subjects. Most of all, it re-asserts that the distinctiveness of invocational media is in events, not objects; becomings, not beings; dynamics, not formalisms.

6. Invocational aesthetics

The plastic membrane was heavier than I had expected, and quite flexible in my hands. A bundle of cables dangled from its back and lead into a mysterious stack of electronic gear. As we passed it from one to another, as though in some ritualistic ceremony, noise and strobing lights blared relentlessly around us. Flexing the membrane did seem to have *some* effect on the sounds in which we were immersed, but not in any predictable way. Any changes I was causing were barely perceptible in the disorienting din.

The installation we were immersed in on the roof of the Dutch Architecture Institute (NAI) in Rotterdam was called 'Anonymous Muttering'. Built by a group of artists called Knowbotic Research, it used a number of computers to combine sounds transmitted from four nightclubs around the city, mixed and replayed at this site. The balance of the mix, and the 'foldings' that the signals were put through were controlled not only by the membrane input device that we passed around, but also by virtual visitors logged onto a website.³⁴ The results in noise and light of these heterogeneous signals and controls had, as you might expect, little perceptible form. Even if all the inputs could have been traced and accounted for, it would hardly have explained visitors' experiences. The effect the work created was quite site-specific and bodily. This was complicated by the simultaneous presence of another audience experiencing the 'same' artwork through the website: listening to streaming audio, watching images, and controlling the work with Java applets. The result was chaotic. Not only was there little formal form to the content, but there was not even a complete version of the work that could be experienced.

³⁴ for more about the implementation and philosophy behind *Anonymous Muttering* see the Knowbotic Research site at http://www.khm.de/people/krcf/AM_rotterdam/ accessed June 2000.

'Anonymous Muttering' is an artwork peculiar to computers: it could not exist without them. But it doesn't use computers to pursue conventional instrumental goals. Instead, it deliberately overloads the system to create random and singular fusions of noise, light and movement. The combination of inputs creates accidents that are only possible using late twentieth century digital electronics. Of course this kind of computer application remains marginal and esoteric. Even though the artists' conceptual and programming skills were of a high order, the results would be virtually meaningless from the viewpoint of the dominant computing traditions. 'Anonymous Muttering' rejected and escaped the imperatives for formal coherence typically associated with computers. What, then is its value?

New media artists are researchers in the emerging fields of possibility that new technological environments open up. Art is the most obvious place to start looking for an aesthetic particular to computer-based media. Since the 1980s, many arts practices — photography, sound, cinema — have taken up computers in some way. But it is less clear whether any enduring new genres or forms idiomatic to computers have been established. Work in experimental electronic and digital arts during the 1980s and 1990s escapes any easy generalisations. Even grouping the work by delivery medium — CD-ROM, installations, online and video — fails to capture the diversity of the work. Each work seems to create its own genre (*n*th orality). However, with some broad brushstrokes, it is possible to identify schools of stated or unstated philosophical assumptions that underlie particular groups of works.

This chapter contrasts two, broad approaches to conceptualising the aesthetics of new media. One approach sees computer art as a task of modelling pure forms. The second sees it as generating singular events of expression. Traditions that tend to model forms include artificial life, automated music composition and some applications of virtual reality. These are traditions of *computational*

aesthetics. Those who focus more on expression include *avant-garde* and experimental artists, and many computer games designers. These are the traditions of *invocational aesthetics*, who are willing to abandon modelling in the interest of achieving effects that take advantage of the capacity of invocational media to allow users to call things up. They combine switchings and samplings, commands and memories. They play with the facial systems of interfaces, seeing them not as faithful mirror worlds, but as spectacular affective machines.

This chapter argues that applications of invocational aesthetics, such as Knowbotic Research's, better exemplify processes of innovation in new technologies. These approaches escape the view of highly formalist approaches that see their work as revealing universal mathematical truths. By remaining open to the accidental, and drawing attention to the contingency of aesthetic practices, invocational artists stumble onto aesthetic events that tend to generate the new in new media.

Artists within the formalist traditions of the computational aesthetic tend to create computer art that is quite different to 'Anonymous Muttering'. For example, mathematician Kemal Ebcioglu developed a computer program called CHORAL that generates four-part chorales in the style of Johann Sebastian Bach. Like 'Anonymous Muttering', it is a work that could not exist without computers, but it applies a totally different approach. CHORAL is based on three hundred and fifty rules of rhythm, tonality, melody, harmony and dynamics to automatically compose music in the style of Bach's chorales (Burns 1999). The compositions themselves can be generated automatically by the computer, or can be output as sheet music to be performed by musicians. This approach seeks beauty in the computer's power to weave patterns with recursive algorithmic transformations in symbolic dataspace.

Unlike Knowbotic Research, which pays close attention to the sites of its performances, Ebcioğlu is not particularly concerned about how or where the music is output. He is not even primarily interested in the music that any particular instance of running the program created. He uses the computer to demonstrate that there is a higher order of form above the sequence of notes. The problems of expression can be deferred because output is a trivial problem. It didn't matter whether the works were ever even performed at all.

Although both Ebcioğlu's and Knowbotic Research's work depends on computers, they represent contrasting aesthetic traditions. Ebcioğlu draws from mathematics, logic and engineering to search for a beauty that transcends the site and the time of its manifestation. He is interested in capturing beautiful things within formal grids of universal natural laws. Computers were conceived and designed very much from within this intellectual tradition. Knowbotic Research, on the other hand, is from a set of fine arts traditions with critical, surreal, *avant-garde* or postmodern sensibilities, and a different sense of time and place. By contrast, these artists are self-reflexive and highly conscious of the historical, physical and cultural contexts of their performances.

In the history of computers, the major, universalist traditions of computational aesthetics tend to lay down the frameworks: designing architectures; creating blueprints; building hardware; designing operating systems. The minor traditions of invocational aesthetics tend to put these frameworks into variation by moving applications into new territories: opening up possibilities for applying computers to new fields; playing games; making artworks. Often major traditions capture these variations once again, and put them back into closed systems and reclaim them as universal and transcendent. Later in the chapter I will return to the specificities of the invocational aesthetic by applying it to some other examples outside fine arts. First, though, I will trace a tendency

in the disciplines out of which computers developed to set aside materiality, and to dehistoricise aesthetics.

The traditions of mathematics, logic and engineering that grounded the early development of computing tend to systematically exclude embodiment from the problem of computability. They tend to see the material components of any system as interchangeable. The physical media that receive inputs, transmit signals and express results are simply sources of noise. Logical form is what endures. When these traditions ask aesthetic questions, they tend to favour formal explanations that would ultimately give reductive answers. They have a faith that true beauty can ultimately be explained (and simulated) by formal analysis.

The recurring cast of characters often invoked in histories of computers — Charles Babbage, Alan Turing and John Von Neumann — manifest some different versions of this abstracted attitude to aesthetic questions. Their work on computing machines was literally *a priori*, in that all three imagined computers before any had been built, or even had a name. They also tended to be philosophically *a priori*: founded in universalist disciplinary contexts and historical milieux intent on finding knowledge that was always valid, independent of time and place. While these three figures worked in different milieux, their approaches to aesthetics, as far as they can be discerned, overlap. All shared a hypothetical faith that computing machines might at some point be able to account for aesthetic questions, like any other problem, through calculative operations.

Reasoning machines and beauty

There has long been a tension between modern engineering's capacity to create embodied surface effects, and its claims to verify deeper truths. The story of Charles Babbage, the pre-eminent 19th century figure in stories about the early

development of computers, is a good example. His designs are considered visionary because they anticipated many of the structures and functions of the invocational diagram. His 'store' resembled modern computer memory; his 'mill' functioned like a central processor; programs and data were input on punch cards. Babbage even designed a printer to output results.

But he is most famous for his failure to convert this design into a working, complete machines. There is a range of historical explanations of why he didn't succeed:

Babbage's personality, the lack of credible progress, personal vendettas, an unresolved dispute with his engineer over compensation, problematic funding, runaway costs, an unfavourable entrepreneurial climate, political change, the cultural divide between pure and applied science... shortsightedness of the government' (Swade 1991: x)

His failure has inspired speculative imaginings in historical writing and popular culture, including a science fiction sub-genre known as steam-punk (Gibson and Sterling 1988; Spuford 1996). He became a useful mythological persona for 20th century engineers: a tragi-comic genius ahead of his time, who gave legitimacy to their work. His precedent has served to prove the historical validity of their work (Swade 1996: 35). In 1991 the Science Museum in London actually built a Difference Engine No. 2 to his plans. It is ironic that the machine that symbolised the triumph of reason would come to function only as an aesthetic object: the head designer describes it as a 'sumptuous piece of engineering sculpture' (Swade 1996: 51).

Babbage's failure was not simply the result of inadequate resources. He spent thousands of pounds of the government's and his own money trying to build a Difference Engine. He managed to spend on this project more than 20 times the amount that Watt spent on developing the steam engine (Swade 1991: 18). His partial success points to the tensions in play during Babbage's historical

moment. Babbage's story exhibits a strange mixture of rationalism and magic, science and art, that Richard Coyne calls 'technoromanticism' (Coyne 1999). Invocational media are often driven by similar cultural mixtures of faith and reason, surface and depth.

Babbage lived through the Counter-Enlightenment, when figures like Edmund Burke were calling into question the original Enlightenment values of Reason and calculation. Babbage remained a strong advocate of science and industry, against this resistance. It was also the age of Romanticism, which was trying to recover (or invent) a celebration of Nature against the onslaught of Rational Man. Babbage was not indifferent to these efforts. He hoped technology based on rationality would itself capture Nature's own truths.

Babbage conceived his computer as a cultural artefact that enabled nature (and therefore God) to represent itself in the form of mathematical equations (Batchen 1998: 15).

Babbage delegated the problem of aesthetics to Nature herself. At the time it was becoming common to claim links between technology and nature. Babbage was a close associate of pioneer photographer Henry Talbot. Photography also seemed to capture immediate images of Nature, just as mathematics and the calculating machines might reveal truths invisible to a casual observer (Batchen 1998). In both cases, a material mechanism provided an apparent transcendent view of pure forms. Both technologies, the camera and the analytical engine, seemed to offer possible scientific proof for miracles, one as images, the other as mathematics.

At the same time, Babbage repressed the cultural and physical specificity of popular aesthetics. He had no time for corporeal and affective human cultural issues. These were irrelevant or morally problematic. He had a particular dislike for entertainments such as organ grinders. He partitioned aesthetics off as

Other. It was feminine, and belonged in art galleries, or in undisturbed Nature. He believed that his Engines could logically analyse, and ultimately account for, these complex and apparently unpredictable domains of life to show that their truths transcend human concerns. His famous collaborator Ada, Countess of Lovelace, was more willing to compare the machine's operations with objects of beauty:

We may say most aptly that the Analytical Engine weaves algebraic patterns just as the Jacquard loom weaves flowers and leaves (Lovelace quoted in Schaffer 1996: 77).

A persistent theme in stories about Babbage is his fascination with mechanical automata — machines that imitate life — in the popular culture of the day (Schaffer 1996). As a child, Babbage's mother took him to a mechanical museum run by John Merlin, a notorious London figure who straddled the boundary between populist showmanship and a serious engineering. After young Charles had seen the public exhibits, Merlin took him upstairs to the workshop to show him some more exotic works. This is where he first saw automata in action, and they made a strong impression on his imagination (Schaffer 1996: 54–55; Shurkin 1996: 39). Among them was a naked silver woman about 30 centimetres high, holding a bird on the forefinger of her right hand. The clockwork woman danced, while the bird flapped its wings, opened its beak and wagged its tail. Babbage's reported ambiguous attraction to, and repulsion from, this machine is a significant illustration of the paradoxical role of aesthetics in engineering.

During the 1840s, a middle-aged Babbage bought the silver woman at auction, restored it, dressed it more in a more modest cloak, and put it on display in his reception rooms in Marylebone. He used it in demonstrations he arranged for the amusement and education of his visitors. During the demonstrations he also showed the half-finished Difference Engine in another room. The parallel

performances served to contrast the triviality of the dancer with the serious purposefulness of the Engine.

The Difference Engine made a counter-argument for industry and rationality. It provided a proof that mechanical and logical processes could work in ways that seemed to escape logic. In one demonstration Babbage showed that the Engine could make unexpected leaps in formal order. He programmed the machine to output a sequence of numbers: 2, 4, 6, 8, and so on. His audience would watch, and at each point, anticipate the next number in the sequence. At first these would be predictable, but at an apparently random moment, the machine would produce a number that the audience had not anticipated, revealing that the machine was invoking another order of complexity. For Babbage this demonstrated that, with enough mechanised computing power, and the appropriate programming, it should be possible to model any process, presumably including aesthetic production or judgement.

He complained that while overseas visitors tended to pay more attention to the Engine, English people remained transfixed by the dancing woman. This contrast made a moral point about the decline of English industrial spirit: a consistent theme in his later life (Shaffer 1996: 58). Even if he was himself curiously attracted to the automaton, it symbolised the frivolous, sensual distractions that must be resisted in order for Civilisation to progress. Because the development of serious rational applications was so interwoven with popular curiosities it demanded continual policing of the boundaries. Computer developers since often seem to follow the Enlightenment habit of partitioning off the irrational, bodily, sensual and affective elements from questions of a higher order.

The question of aesthetics was highly paradoxical for Babbage, as it was throughout the emergence of invocational media. On the one hand, it was one of

the mysteries that he hoped ultimately to reveal through mechanised reductionism. On the other, it was an immediate threat to his success that he needed to confront. And the only way to confront it was by himself playing games of appearances, like the random number games in his parlour. In playing these games, though, he was constantly frustrated by others' apparent incapacity to see the deeper truths he was trying to reveal.

Universal machines

Stories about the development of computers often take up a century later with the Alan Turing. Turing's influence on the aesthetic dimensions of computers is quite complex. He starts by demonstrating the limitations of the computational aesthetic, but continues effectively to embrace the invocational aesthetic. His first famous contribution is the paper on computable numbers (Turing 1965 [1936], Hodges 1993, Hodges 1997, Rheingold 2000). A will to deterritorialise and automate mathematical reason resurfaced in Turing's proposed 'universal machine'. The paper's primary concern was defining the bounds of what would be calculable, especially the 'halting problem' — that computing machines can become stuck in infinite loops from which they will never escape! Implicit in the question of finding the limits of computability (although certainly not articulated at this point) is the possibility that everything, including aesthetics, might be reducible to mechanical explanation. However, Turing's argument actually calls into question the limits of computational aesthetics.

The 'Turing machine' design is not an engineering blueprint, but a formal proof marking the boundary between what is theoretically computable and what is not. While Turing's paper was primarily a contribution to theoretical mathematics, it was taken up as proof of the possibility of an automatic logical machine that could solve any computable problem. In the famous 'Computable Numbers' paper Turing imagines a machine that could calculate complex logical

and mathematical problems with a simple mechanism (Turing 1965). Given unlimited computer power (in his design, this was a read-write head and an infinite paper tape) and unlimited time, the discrete state automated computer he described could solve any computable problem.

The paper's central thesis, however, is that there are some problems which can never be computed, and that it is impossible to tell in advance which problems these might be. There were bounds to what a mechanical device might calculate. The limitation Turing discovered was effectively inverted by its readers. While he proved the glass was half empty, budding computer engineers found it half full. All computable problems expressible in symbolic terms were 'trivial' and could be mechanised.

Historians see Turing's essay as marking a key point in the development of the modern computer. He articulated the possibility that computing machines could use the common currency of discrete or digital encodings. This made explicit the possibility that many technologically mediated processes could be translated into Turing machine operations. All representations could be comprised of digitally coded data, and all events could be converted to discrete and instruction-driven steps. Turing himself quickly began imagining what might be possible.

Turing's other most famous paper in 1950, 'Computing machinery and intelligence' is less a work of mathematics than speculation on the boundaries between humans and machines (Turing 1950). In it he suggests computers might ultimately simulate their creators. Turing sees no reason why it should not be possible to build a machine intelligence with human capacities to reason, imagine and even judge. His famous substitution test proposes that if a human observer could not tell the difference between a computer and a human, then this would constitute a successful machine intelligence.

Turing addresses a number of possible objections to the proposal that machine intelligence is possible. One of the objections he looks at in some detail is the difficulty of simulating the faculties of aesthetic creativity. Part of Turing's paper is a response to an oration on *The mind of mechanical man* by a neurologist, Professor Jefferson in 1949. Jefferson defends the human monopoly of art:

Not until a machine can write a sonnet or compose a concerto because of thoughts and emotions felt, and not by the chance fall of symbols, could we agree that machine equals brain—that is, not only write it, but know it had written it (Turing [1950]: 445).

Turing argues that Jefferson's 'Argument from Consciousness' is solipsism, because there is the same problem with another person: all that you can know about the other is what they say or do, and not the processes of consciousness that generated these acts.

However, in this essay, Turing is not challenging the status of the machine, but the status of the human. Turing's rebuttal of Jefferson's objection anticipates a crisis of authorship that was already emerging at the time in discourse, and in art. His proposition effectively contributed to the 'death' of the Author that cultural theorists observed some years later (Barthes 1977). Barthes argues that the Author is a peculiarly modern invention, attributed to works and carrying substantial parts of works' meanings. Turing's machine is only one of the technologies threatening the myth that artistic genius is an inalienably human attribute. If machines can be creative, then is art uniquely human? Debates over whether photography was art had already drawn into question the boundary between artist and technical apparatus. As I suggested in Chapter One, Walter Benjamin had already observed that in the age of mechanical reproduction, unique works of art were losing their aura (Benjamin 1977). Turing realised the extent to which the aura of humanity was being drawn into question, and

replaced by the mystique of simulation. His arguments resonate with the traditions that were already questioning the essentialist concepts of humanism.

Marcel Duchamp offered art its own Turing test when he put a urinal 'as found' on exhibition as a 'fountain'. In doing this he challenged his audiences to agree on a measure that would distinguish this work from 'legitimate' works. With Duchamp, Turing's indifference to essentialist distinctions contrasts with Babbage's desire to automatically generate transcendent images of nature. By privileging how users perceive that machine, rather than the logical operation internal to that machine, Turing's argument in 1950 actually advocates an invocational aesthetic, not a computational aesthetic at all.

The fields of artificial intelligence and artificial life, though, which emerged after the 1940s, assumed that there was an autonomous thinking subject and set out to model it. They believed that the Author was alive, and set out to simulate his brain. Where Turing's work was an imaginative deterritorialisation, the dominant tradition of artificial intelligence had an agenda which was most often to reterritorialise intelligence in systems in order to remove the necessity of human intervention in chains of command (de Landa 1991).

Von Neumann: from universal machine to general purpose computer

Invocational aesthetics emerged from computers in use, so obviously they could not exist until a computer was actually built. Even then, aesthetics were low on the priorities for the first computers, which were very expensive, and built for highly instrumentalist ends. The military industrial complex, mobilised by the Second World War, dedicated unprecedented human and capital resources to creating computers. Computers automated rationality within the centres of state power: breaking enemy codes, creating ballistics tables, and developing nuclear weapons.

But not all applications were so pragmatic. Von Neumann's early experiments with 'artificial life' are best understood in terms of aesthetics. A-Life was based on hard computational aesthetics — formalist and universalist — because it started with the goal of logically modelling biological systems. While the Turing test compared human and machine at the level of function or effects, Von Neumann compared them as two systems with similar engineering models. In preparing for the Silliman Lectures in 1956,³⁵ he makes a direct analogy between computers and nature, comparing the capacities and structures of digital computers with those of the human nervous system. He makes qualified, but confident comparisons between computers and natural systems, seeing both as instances of the same universal principles. He has little hesitation in using Nature as the model by which to judge the current systems, which he deems directly analogous with human nervous systems, if inferior to them.

Like Babbage, Von Neumann was fascinated by automata — 'self-moving' machines that mimic Nature's creatures. Unlike Babbage's silver woman, though, his automata were invoked with mathematical imagination and computers. 'Von Neumann sought to embed the logic of life in these abstract thought objects' (Emeche 1994: 56).

In A-life, computer simulations produce patterns of development that seem to resemble simplified living organisms. A-Life proponent Christopher Langton (1993) sees it as 'the biology of possible life' which 'attempt[s] to recreate biological phenomena from scratch within computers' (25). Starting with a small number of entities, and rules by which they will 'evolve', the micro-worlds are set into motion, and the results observed. The resulting patterns seem to simulate processes in Nature: the growth of individual organisms, the evolution

³⁵ He never delivered the lecture series, as he was weakened by cancer, which was possibly associated with exposure to nuclear products. He died on February 8, 1957.

of reproducing life across generations (48–50), or the flocking behaviours of birds (51). The resemblances between A-Life and Natural forms supposedly validate the claim that this demonstrates something universal. Like Kant, A-Life researchers look to Nature as model and inspiration in seeking pure aesthetic forms.

Computational aesthetics are grounded in a faith that Natural forces are universal and eternal, and that human understandings and representations create insights into this truth. Their machines, whether Babbage's mechanical devices or Von Neumann's electronic ones, are called to provide some glimpse into deep truths beyond human reach. Their aesthetic sensibilities are based in projects to 'discover' patterns in pure mathematical forms which might generate the elusive qualities of beauty. So Babbage admired the lacework of the Jacquard loom, and the photograph. Von Neumann admired the sublime complexity of the brain, and modelled his machine on it.

Computational aesthetics in computer art

The computational aesthetics of formalist computer art resonates with a dominant, but paradoxical, tradition in Western Philosophy of looking for universal and *a priori* principles for beauty. If something is beautiful, that necessarily begins with how it affects the senses. However, those who believe in autonomous beauty insist that beauty is not just subjective; it is grounded in something beyond the instance, and it must be communicable to others. By one school of interpretation, if beauty is not subjective, then the immediate world apprehended by the senses must be only an incomplete view of higher orders of form. Among the inspirations to these approaches was Plato's famous theory of the Forms, which informed invocational modes of representation (see Chapter Three). Plato sees everything on earth as only an instance of pure forms (Plato 1974). The Christian division of body and spirit suggests things on earth are

only a weak reflection of the perfection in Heaven. According to Kant, the quality of beauty is part of the noumenal world, and is more fully appreciated by an elite of people with the qualities of genius and taste (Kant 1952).

One of the earliest public exhibitions of art using computers was *Cybernetic serendipity* in 1968, where technically trained people who also worked at companies like Boeing, Bell Labs and the Jet Propulsion Lab, created a range of works in visual and auditory arts (Hardison 1989: 216). When facing aesthetics, the engineers typically tried to apply the same formalist and universalist strategies that they had used in dealing with pure logic and practical engineering.

The two most common goals of computational aesthetics are mimicry and reductionism. Mimics aim to create computer-generated works that can not be distinguished from human art, or from 'natural' forms (including A-Life). So Michael Knoll created works of abstract art that resembled Piet Mondrian's paintings (Hardison 1989: 216). Reductionist approaches search for higher order formalisms that could account for, or produce aesthetic effects, hoping to find pure content. These art works are separate and distinct from the day-to-day operation of the computers.

This computational aesthetic is grounded in a beauty beyond or before expression: a beauty in pure mathematical form. In the book *Digital mantras*, Steven Holzman discusses the commonalities between twentieth century formalist artists and thinkers, and works using computers (Holzman 1994). He starts by examining the principles of Western musical scales and tonality, and surveys the work and philosophy of musicians, artists, and linguists who try to find abstract languages that transcend expression (240). He looks at a range of works: Kandinsky's painting, Schoenberg and Boulez's music, Chomsky's

universal grammar, Turing's machine, and artificial intelligence systems, and concludes that in all cases:

it is the codes, the rules, of a system that are the key to its interpretation... All artistic modes of expression must conform to some analysable system of structure (Holzman 1994: 260).

Holzman concludes by relating purely formal patterns to transcendent and mystical experiences. He compares art that adheres strictly to formalist patterns with mantras in Eastern religions. For Holzman, the best art touches on mythologist Joseph Campbell's concept of 'fundamental vibrations of the universe' (286).

Darren Aronofsky's π (1998) presents a similar thesis in a fictional film. The central character, Max, is an obsessive but brilliant mathematician and computer programmer looking for a highly secret and powerful number. This eternally significant number is related to Pythagorean mathematics, the formula for the Golden Spiral, and to the Kabala. Max's voice-over keeps returning to hypotheses about the significance of this formula:

My new Hypothesis: If we're built from Spirals while living in a giant Spiral, then is it possible that everything we put our hands to is infused with the Spiral? (quoted in Gulette 2000)

Apparently the spiral is also somehow a key to predicting the movements of the stock market. Drawn by the promise of Max's research, there are several mysterious groups of people stalking him. As his calculations get closer and closer to discovering this magical number, his life becomes more and more chaotic. The film-makers try to integrate formalistic elements into the film's structure. Scenes keep recurring, as though the flow of the film itself is following an ever increasing downwards spiral. In spite of the formalist motivation, though, the most striking things about the film are its stylised and

claustrophobic visuals and *mise-en-scene*. It is a highly cinematic work, all surface play, in spite of its attempts at revealing deeper truths.

Douglas Hofstadter's book *Gödel, Escher, Bach: an eternal golden braid* (1979) is a classic in the same tradition, tracing commonalities in the formalist problems behind the works of the Baroque composer Johann Sebastian Bach, metamathematician Kurt Gödel and Dutch graphic artist M.C. Escher. Although Hofstadter ultimately acknowledges that formal methods cannot explain everything aesthetic, he vigorously pursues the ways in which an abstract principle (the 'Strange Loop') can be a basis for aesthetic effects across different modes of expression: in music, visual arts and pure logic: 'Bach and Escher are playing one single theme in two different "keys": music and art'(13).

Hofstadter implies that the 'deep beauty' in the form found in music such as that of Bach is superior to the works of composers like John Cage because it is more self-contained. He gives Cage's piece 'Imaginary Landscape No. 4' as an example. Twenty-four performers randomly tweak the volume and tuning of twelve radios for the duration of the piece. Like 'Anonymous Muttering', the form of content in this piece lacks coherence. Hofstadter speculates that if a recording of this was sent into outer space and picked up by an alien civilisation, they would be able to make no sense of it (163–4). Cage's music would have to be accompanied by explanation of the cultural background of the work. With Bach, on the other hand, there is more intrinsic meaning in the internal relationships within the work, no matter how it might be perceived (174). He claims this would demand less cultural background for the alien listeners to appreciate its beauty.

While outsiders sometimes consider computer programming to be a scientific and highly procedural means of developing something arcane and functional, many programmers themselves think of their work as the highest form of art

(Knuth 1973 [1968]). In the invocational incorporeal spaces, their work seems to be close to pure form, but it is always constrained by the unfortunate and unavoidable events of input and output. For these artists, the expression of the results of the processes of computation can seem relatively unimportant. The choice of output device—screen, print out, or loud speaker — should make no difference to the meaning. Output modality is a matter of convenience, with little significance. The same data can be output in several forms, without any one being the final expression. The best programs are those that found the most elegant and transparent translations from the higher space of the machine into the lower order of physical space.

Some computer scientists in the late 1990s continued searching for computational aesthetic truths. David Gelertner's *The aesthetics of computing* (Gelertner 1998) claims that engineers and computer scientists had all along been motivated by beauty: 'beauty is the most important quality that exists in the computing world' (26–27). Gelertner insists that this 'machine beauty', characterised by 'simplicity and power' (2) is a universal 'deep beauty' that transcends place and time. He rejects arguments that beauty is socially constructed or historical by claiming that beautiful things are appreciated through the ages (17–20). He cites the Turing machine (the 'Mona Lisa' of the computational Louvre (47)), Algol 60 programming language and the Macintosh desktop as examples of beautiful software. These examples supposedly prove that good software is beautiful forever. That none of these systems, while influential, is still in use as designed does not seem to phase him.

Another example selected by Gelertner in an attempt to refute what he casts as social constructionist arguments does not work at all. He cites Garry Wills' historical observation that Gothic cathedrals, considered exemplars of beauty in the 20th century, were not at all appreciated in the 18th century. His counter-argument is remarkably weak: 'The great cathedrals we admire were admired

also in 1950 and 1900 and 1850. That's a pretty fair run, isn't it?' An alleged consensus of a hundred years does not give much empirical backing to his claim that aesthetics is timeless and universal (19). Gelertner expresses frustration at the 'culture chasm' between his view of deep beauty and the social constructionists who refuse to see things his way.

Most of *The aesthetics of computing* provides eloquent evidence against Gelertner's own premise. He traces historical genealogies of beautiful systems, and gives accounts of the conflicts within engineering and other disciplines over aesthetics. For example, he argues that in the interface wars (which I referred to in Chapter Five), those who put down the Macintosh for 'cuteness' had a perception that 'beautiful technology is unmanly' (36). Surely this reading of gender stereotypes is a strong example of the degree to which technological history is inflected by social forces? The fact that Gelertner maintains his naïve faith in a pure universalist computational aesthetics, in spite of himself, demonstrates how resilient this peculiar belief in the absolute power of formalism has been in cultures close to computers.

Invocational media developed in a milieu dominated by a modernist aesthetics that devalued surface play. Surfaces were significant only as evidence of deeper truths. Engineering cultures tend to have expertise and faith in universal mathematical formalisms. This allows them to pose direct analogies between their work and natural truths. However, a different aesthetic sense tends to emerge with computers in the field. Invocational aesthetics becomes most apparent with interactive systems after the 1960s.

Underlying computational aesthetics are the modernist values of depth and metaphor. These values depend upon a faith in the truth of metaphor. Surface effects are seen as distractions in the search for deeper truths. But this faith came increasingly under challenge in the late 20th century. Depth and truthfulness in

representation were increasingly threatened by the proliferation of media forms and texts that generated the 'depthless image', particularly those of digital media (Darley 2000). Writers such as Baudrillard, Eco and Jameson identify the disappearance of referentiality and depth, and their replacement by spectacle and illusionism (Darley 2000: 58–77). Ironically, the success of invocational media itself was among the developments that undermined the faith in deep truths. In practice, there is little difference between modelling something 'real' and something 'fictional'. If something passes as real, it is effectively real. Illusion is the only essential remaining. There is ultimately little difference between systems that guide, mediate or simulate.

Even if their authority has come under attack, the formalisms developed by the traditions of computational aesthetics are not totally discredited. But their meanings must be qualified and put into context. Programmers' strategies do invoke logical and mathematical regularities. Some invocations really are more powerful, efficient and elegant than others. However, culture infuses every event in the history of computing, even its most treasured formalisms. Mauchley's 'Short Code' was the first standard for programming that moved above the level of machine code. He used acronyms to invoke processor circuits by name instead of by number. This simple way of helping programmers remember commands was an aesthetic intervention at the lowest level of technical events (*Time/Life* 1986: 13–14). Invocations must resonate simultaneously in the singular material, cultural and formalist, abstract, mathematical levels of the event.

Gelertner's distinction between social determinism and deep beauty is a false opposition. They are not contradictory. At issue in the difference between invocational and computational aesthetic traditions should not be a conflict between formalism and social causation, but defining the relationship between formalisms and the world. If mathematics and computers can somehow extract

useful formalisms from particular objects and relationships, then what is the nature of this process of extraction?

Invocational immanence or computing transcendence?

If I run a computer program now, and run the same program again tomorrow, following exactly the same procedures, a transcendent formalist approach would consider those events as essentially identical. An invocational aesthetic would insist that the two were quite different. The whole set of circumstances around it are different. My memory of the earlier event is infused into the second event. It is a 'refrain' of the event, not a reproduction.

Because the dominant traditions in computing have a transcendent concept of forms, they down-play how computing is always an event. They privilege standardised, static structures and principles as though they were stable and permanent (which is paradoxical in a field that changes as quickly as computers). Computer scientists tend to start by teaching students about hierarchical sets of entities and their properties (Appleby 1991).

However, as the previous chapters have shown, computer processing works as a series of similar but singular *events* — invocations. The fetch-execute cycle reads in instructions, moves data from memory, and back into memory; and expresses results with output devices. These invocational events are the genetic element in all computer operations. All the effects computers create have their genesis as invocations. This is the characteristic mode of becoming particular to all assemblages that include digital computers.

An invocational approach modifies Negroponte's concept of *being digital* (Negroponte 1995). It sees computer-mediated events as *digitised becomings*. Invocational events open onto a future created by the virtual dynamics that determine what is invoked next at each moment. As Chapters Three and Four

showed, invocations extend over space (command) and time (memory), and manifest events of decision as outputs on motor devices and facial systems.

The being of digital forms is secondary to the becomings of invocational events. Invocations are how images come to appear on the screen, sounds come out of speakers, and so on. Negroponte confuses metaphor for description when he claims that the basic difference between old and new technological paradigms is defined by the difference between atoms and bits.

A bit has no color, size, weight, and it can travel at the speed of light. It is the smallest atomic element in the DNA of information. It is a state of being: on or off, true or false, up or down, black or white...’ (14)

Bits don't actually *move* at all. Solid state circuitry is indifferent to movement altogether. Rather, it mediates calls as switched voltage differences across a range of electronic components and cables. Traces of these calls are recorded in magnetic and optical media such as hard disks, tapes, magneto-optical drives, CD-ROM, CD-R or CR-RW. These events of switchings or recordings are not beings, but becomings. Invocational events are different from mechanically reproduced images because of the processes by which images appear. They invoke images in a different way from printed documents, cinema screens, physical spaces, or human imaginations.

The invocational aesthetic is not conceived beforehand, but emerges as an epiphenomenon of using actual computers. It is not exclusive to computer art: it comes into all computer-mediated events. Computer developers and users often claim to work ‘by feel’. Many design strategies reject transcendent formalisms, encouraging designers to follow intuitive aesthetics based on the particularity of the events of programs they are writing on the platform that users will actually use. Such strategies tend to trace machinic connections with intuitive cultural and embodied knowledges of users and designers. They make invocational

dynamics open to forces outside conventional standards. Empiricist approaches remain open to users only to the extent that they capture useful slices from the complexity of their experiences. They make only limited attempts to conceptualise the results or to define their relation to other social and technical machines.

Iterative design methodologies create simple prototypes of a system, and then gradually refine it by slightly modifying the design through many iterations. 'User-aided design' is one iterative design approach which incorporates users' questions about an earlier version of an application into a future design. For example, the designers of the Apple Guide help system started by asking users to 'think aloud' about the problems they were facing using Hypercard. The researchers grouped the users' questions into 'How do I...', 'What is...', and 'Why...' questions (Knabe 1995: 286–287). Another method, 'user-centred design' also incorporates observation of users, but returns to a computational aesthetic. It captures and reports results as static formalisms (e.g. Spreenberg and Joe 1995).

Programmers in institutions are usually pressured to demonstrate, document and delimit their work. But programmers are notoriously hard to pin down (Coupland 1995; Ullman 1995). Development teams are intense sites of almost inevitable conflict between sorcerers and priests. Most of the structures in computer science originated as crazy experiments that were later captured and standardised: magical events that become invocational religious forms.

Computer software development has been characterised by conflicts between formalism and dynamism. Programs themselves are inherently formal systems. The sequence of instructions in a computer program is unambiguous. Every bit is either a one or a zero. However, the execution of that program can progress in a less deterministic manner. When a large amount of data is input, or random

elements are introduced, it can become impossible to predict the behaviour of a program in advance. So while invocations are supposedly reducible to logically traceable events, in practice they are often so complex that reductive formal explanations are inadequate. While invocations seem to be finite as switchings, events with invocational assemblages can often become chaotic and infinite.

The tension between scientific formalisms, which attempt to capture events as finite, and artistic dynamisms, which remain open to the infinite, is not exclusive to computers. Behind this tension are long-standing epistemological questions about complexity. While it is really a gross oversimplification to group approaches to complexity, one might distinguish two approaches: transcendence and immanence. Plato presents a transcendent, universalist proposition in ancient philosophy about the existence of another world of perfect cases, in the theory of Forms. In modern thought, Kant claims special techniques of transcendental deduction could uncover ‘things-in-themselves’ behind appearances. Holzman, Gelertner and, to a lesser degree, Hofstadter take transcendent approaches.

On the other hand, theories of immanence see complexity as generated through dynamic, and ever-changing forces. Complexity is generated by heterogeneous machinic interactions that move between layers of actual and virtual events in material, linguistic, affective fields. These approaches emphasise becoming rather than being. Theories of immanence include Spinoza’s pantheism, Deleuze and Guattari’s machinism, and Manuel de Landa’s non-linear history (Spinoza 1974, de Landa 1997, Deleuze and Guattari 1987). In the following section I trace the interplay between these philosophical traditions in the history of computers.

So we return to the question of aesthetics. The interplay between work motivated by an aesthetics of pure form and that motivated by an aesthetics of expression has been pivotal in the phylogenesis of the invocational aesthetic.

The aesthetic senses are not oppositional, but work in dynamic combinations. Their intertwining is complex and particular: ‘major’ and ‘minor sciences’, rather than thesis and antithesis (Deleuze and Guattari 1987: 108–109). The major science of computational aesthetics is strategic and formalist, constructing Baroque structures. The minor science of invocational aesthetics is tactical, darting through the structures, testing the unanticipated and emergent qualities of the machines in action. In developing this argument, I will borrow from aesthetic and ethical paradigms of Gilles Deleuze and Felix Guattari, who try to avoid dialectical oppositions, and unnecessary transcendences (Deleuze and Guattari 1994; Deleuze and Guattari 1987; Guattari and Gonesko (ed) 1996; Deleuze 1993).

In creating philosophical concepts, Deleuze and Guattari engage with key figures in major traditions, including, for example, the Danish linguist and semiotician Louis Hjelmslev and Enlightenment philosopher Immanuel Kant, not by rebuttal, but co-option (O’Connell 1997). If these writers offer universal truths and totalising systems, Deleuze and Guattari take up what they created, and use it to produce something else again. Rather than simply rejecting a static system, they put it back into movement. They open it to infinite variation again, showing that it is always open to be reproduced differently.

Putting Hjelmslev into Flight

In the spirit of converting static forms into dynamic becomings, I will start by applying Hjelmslev’s analysis to Ebcioğlu and Knowbotic Research. While Hjelmslev’s work in linguistics did not aim to address music or installation art, it is useful here to borrow his approach for a moment. Hjelmslev’s terminology contrasts the levels of meaning production to which each of these artists give priority. Hjelmslev’s distinctions between *content* and *expression* at one level, and

form and *substance* on another, comprise four strata in an intricate formal algebra for language called *glossematics*.

Glossematic analysis aims at providing complete formal explanation of linguistic events (Hjelmslev and Uldall 1957: 20 – 35). Under the ‘Principle of Empiricism’ (20) descriptions should be self-consistent, exhaustive and the simplest possible. The analysis should continue until the point when deductive descriptions have produced ‘as few final resultants as possible while remaining self-consistent and exhaustive’ (22). This kind of analysis seems to parallel Ebcioğlu’s formalist approach to music. It aims to account for complex dynamic phenomena using formalist algorithms. The movements within and between strata, while possibly very intricate and complex in form, would be manageable. This would not be the case with the artists of the invocational aesthetic.

Hjelmslev’s formalism is a formalism of dynamics. He rejects the Aristotelian ontology of objects with properties that performed activities (Aristotle 1958).³⁶ Hjelmslev defines the task of analysis as analysing functions (Hjelmslev 1957). He sees the sign not as an object with properties and behaviours, but as one terminal in a sign function.³⁷ Every sign function has a *form and substance of expression* and a *form and substance of content*, but the four can operate independently (Dineen 1995: 339–366).

³⁶ It is notable that object oriented software inverts Hjelmslev’s move. Where Hjelmslev reduces the ‘Aristotelian trichotomy’ to functions with terminals (Hjelmslev and Uldall 1957 :9), object programming creates a programming realm that reinstates Aristotle’s object in a domain based on reduction to functions. When compiled into machine code, a program that has been written as object language reverts to functioning serially. Programmers, though, can continue to believe that they are working with functions and objects with properties and behaviours. The invocational assemblage works at its lowest with flows, while offering users the comforting stability of invoked objects.

³⁷ Saussure’s theory of the sign established the distinction between signifier and signified, which Hjelmslev’s work modified (Saussure 1959).

Of these elements, Ebcioğlu privileges what Hjeltmlev calls the *substance of content*: stable and abstract patterns and structures to which the music adheres. Analysing and modelling Bach's music, his algorithms work as a substance of content that generate the form of content: the sequences of notes, rhythm, timbre and so on. By decrypting regularities in the music, they extrapolate a grammar of higher order patterns. Ebcioğlu has less interest in *substance of expression* — the sound vibrations in the air wherever the music was played. This is an interchangeable and less important dimension. In this music, the form of content and the form of expression will be identical because the instructions created by the computer should correspond exactly with the notes played.

Knowbotic Research, on the other hand, privileges the *substances of expression*: the combinations of sensory events (sound vibrations; light; bodily movements) which audiences experience, and the infinite subtleties that emerge during the event. At the same time, they draw attention to the problematic of *substance of content*, which is the 'most mysterious' of the strata, by refusing to give it coherent structure (Hjeltmlev and Uldall 1957: 26).

These artists of immanence deliberately distort and obscure formalised *forms* and *substances of content* by creating arrangements that generate chaotic combinations of pre-formed and semi-formed content. They mix and distort already formed contents like radio signals and nightclub music to create something else again. In this way, the expressed sounds are supersaturated with logically overdetermined and singular forms of content. Traces of sensible form remain, but they follow connotative and connecting lines between and outside formalised strata and dimensions of meaning. From this process, new effects emerge from unpredictable combinations that break out of any formalist grid.

In another version of Turing's halting problem, it is hard to know when a Glossematic analysis will stop, or whether some of the functions across strata

will ever terminate. In the case of 'Anonymous Muttering', as the title of the work implies, the invoked voices are not attached to any author. What it invokes are not lucid statements, but mutterings, indistinguishable as language. In this case, the functions *never* terminate, but continue to follow 'lines of flight'. It is impossible to give a complete Glossematic-inspired analysis of Knowbotic Research's work.

The plateau '10,000B.C.: The geology of morals' in *A Thousand Plateaus*, (Deleuze and Guattari 1987: 39–74) adopts Hjelmslev's terminology, but abandons his totalising scientific ambitions. It extends the theory beyond and below language, and discards any claim to calculate the analysis until there is 'no remainder' (Hjelmslev and Uldall 1957: 22). The concept of stratification, and the double articulation of form and expression, can apply just as well in non-human systems such as geology and biology (and by extension, installation art or music).

As importantly, Deleuze and Guattari refuse to see the systems as closed. Instead, they develop concepts like the *line of flight*, which conceptualises movements across strata continuing to infinity (Deleuze and Guattari 1987: 111–148). Rather than finishing at static terminals, movements across strata continue indefinitely, beyond any possibility of formal accounting. In a way, Deleuze and Guattari use Hjelmslev's formalisms in the same ways Knowbotic Research and Cage used radio signals, by throwing them into infinite variation.

I have used these examples of artistic applications of computers as a way of introducing a contrast between formalist and invocational approaches to creating artworks with computers. And yet some of the works in these supposedly opposing schools have something important in common. The work of both Ebcioğlu and Knowbotic Research could not exist without a computer. In spite of their differences, they stand on the same platform and work with the

same invocational order-word machines. With a computer, both exercise unprecedented control over the planes of content and expression in their work. Ebcioğlu uses the computer to perform a complex series of logical operations that would be uneconomic to calculate in another way. Knowbotic Research combine and deform digitised signals in real time only because they have computers. If there is a means of expression idiomatic to computers it will need to account for both these kinds of work.

Invocational aesthetics

Invocational aesthetics cannot be defined in any absolute sense. It is certainly not universal: nothing is less appealing than a sluggish and low resolution invocational system that has recently been superseded (until it is nostalgically recovered, as some old arcade games have been recently). Invocational aesthetics emerges as a system is being used. If invocational media work with decisions, it has something to do with those decisions seeming right. Invocations call to things beyond the system, juxtaposing familiar but unexpected patterns against others, as in *bricolage*. The invocational aesthetic centres around events that call things up.

When a computer is running, it is moving data constantly across strata: invoked from memory contents to interface expression, and from input vibrations to virtual machines. The concept of invocation foregrounds the deferred question of how constantly reformed data is manifest in time and space. The invocational aesthetic starts with the perceptive and affective dimensions of using a computer: how the computer engages a user's senses and affects a user's state of mind. It starts below the level of the user's cognitive engagement, and operates at a finer grain than the bits of digital information. It moves in continuous paths, rather than in discrete steps. It is the feel of the keys on the keyboard; the rhythms and speeds of repeated operations; the glow of the screen in the room.

While computer systems are designed to provide rapid, accurate answers to logical problems, there have always been significant dimensions to the operation of these machines that aren't reducible to the formalisms. Computers heated up, insects flew into relays, processing times imposed long delays, results were displayed on print-outs or screens that required users to find new positions for their bodies, new ways of reading and writing. Dealing with these accidental, noisy, inconvenient dimensions to using computers was as important to how this technological phylum proliferated as the algorithms and high tech engineering developed by the computers' designers. Innovations in the application of computer media have followed lines of flight between strata of expression and content.

Deleuze and Guattari define art as the creation of percepts and affects (Deleuze and Guattari 1994). The invocational aesthetic always concerns percepts and affects, more than scientific functions. Game players call it 'playability' (Jordan 1997). Janet Murray identifies 'immersion', 'agency' and 'transformation' as the key aesthetics of the new medium (Murray 1997). The lawyers at Apple Computer call it 'look and feel'.³⁸ Software reviewers call it 'elegance' and 'user friendliness'. Hardware reviewers call it 'responsiveness' and 'the cool factor'. These aesthetic terms particular to computers relate to speed of response, richness and complexity, and a sense of 'presence' of the representations on the interfaces. Some of the invocational aesthetic is reducible to technical specifications: speed of processing, numbers of colours the video card can display, resolutions of screens, sample rates of sounds and so on.

However, tech specs are not a sufficient explanation. They don't explain how a 'killer application'— that mythical and unexpected development in software

³⁸ When Apple sued Microsoft in the early 1990s, they claimed that Microsoft had copied the 'look and feel' of the Macintosh interface when designing the Windows operating system. Apple lost the copyright suit in 1992 (Wallace 1997: 153–4).

that is so compelling that people will buy the computer just to use it — is so much more successful than other products.³⁹ It doesn't explain why the constantly shifting aesthetic values in video games have remained similar in spite of the exploding technical capacities of new generations of computer platforms.

Video game players since 'Pong' have judged games by their capacity to keep them engaged, active and responsive (Nichols 1996). While the first Atari systems in the 1970s had dramatically different processing power to the Nintendo 64 gamestation in the 1990s, or the Sony Playstation II of the 2000s, the game player's motivations for playing hasn't changed much. It pushes the same buttons (Murray 1997). For the same reason, 'realism' is not an adequate basis for assessing games or other systems. The boundaries of what is considered realistic shift with each new released product, and are based on different properties in different genres. *Myst* and *Doom*, both ground-breaking mid-1990s games, create totally different worlds, with contrasting pace, visual style and gameplay. This is not to say that all games are equal. Some applications create a more effective 'reality effect' than others. But sequels are not necessarily superior to earlier versions. Marketing video games is notoriously hit or miss.

The first commercialised computer game, Pong, was developed by Atari in the 1970s, although Ralph Baer, the self-proclaimed 'father of home video games', patented the concept of using the television to play games in 1966 (Baer 1999). This game was many peoples' first experience of the invocational aesthetic. Pong is a rudimentary game, featuring a black playing field with blocky white

³⁹ As mentioned in Chapter Three, the first program called a 'killer app' was the spreadsheet — *VisiCalc* — introduced for the Apple II computer at the West Coast Computer Faire in 1979 (Nash and Ranade 1994: 18). Other programs often cited as killer apps include word processors, desktop publishing (*PageMaker*), electronic mail and the web browser (see also Mello 1994: 19–20).

bats that move along only one axis: up or down. Even if by the 2000s, many games approach photorealistic image quality, they follow the legacy of Pong. This new aesthetic, even though it is played on a television set, has an aesthetic with little in common with TV or cinema.

Pong introduces a new system of semiotic structures. Peter Bogh Andersen gives a formalist analysis of a similar game called *Breakout* (Andersen 1997: 193–212). He applies a reductive Hjelmslevian analysis of game elements (bat, ball, bricks and borders). Andersen identifies ‘handling’, ‘transient’ and ‘permanent’ features in the interface which combine as a self-contained semiotic system. However, his analysis offers little insight into the aesthetics of computer game playing, or even games design. The invocational aesthetic does not relate only the logical system of invoked entities behind these images. Nor can it be reduced to the quality of the images on the screen.

Although ‘Pong’ doesn’t look much like a game of table tennis, it does produce a set of effects similar to hitting or missing a ball (even if it is just an animation of low resolution pixels). It establishes a playing field and zone of action where the game takes place, and a ‘bat’ which serves as agent or part-subject for the user. It calls up users’ competitive drives, and sustains them with a scoring system. Overall it creates a line of flight into a virtual play space. If realism means replicating table tennis, it never comes close to being table tennis. It is a *becoming ping pong* of the computer.⁴⁰

Pong moves the ping pong table into a screen in the living room. It is a *deterritorialisation* of ping pong, moving some of the codes, speeds, intensities and affective fields associated with players, bats, balls, playing fields and

⁴⁰ For a discussion of *becoming* see the chapter ‘1730: Becoming-intense, becoming animal’ in Deleuze and Guattari (1987) *op cit* pp.232–309. See also the collection of essays on this theme edited by Elizabeth Grosz (1999).

scoring, and reterritorialising them in commodity form as the first home console game. The deterritorialising game reterritorialises as an invoked virtual machine.⁴¹ Nolan Bushnell, who designed Pong and established Atari in the early 1970s, found a way that the microtechnology of the day could reterritorialise ping pong as an electronic game. He had been an enthusiast of *Space War*— probably the first video game — that was developed by Steve Russell at MIT as a playful experiment on the first interactive computers (Turkle 1984: 71). If *Space War* took the military industrial technology on a deterritorialising line of flight into space, Pong bounced it back to reterritorialise as a new industry.

Pong is more than a miniaturisation of tennis or ping pong. Unlike pinball machines, which were literally pushed aside when Pong first arrived in amusement parlours, the content and expression of the ball are on different strata. Every moment the whole game dematerialises into binary data and rematerialises again on the interfaces. More important than the look of the ball (it is square) or the authenticity of the electronic 'pong' when it is hit, is a player's sense of immediate and responsive fidelity to the *Gestalt* of the gameplay. This demands that the cybernetic feedback loop between input and output operates beyond the threshold of the real time. The computer models a world of pixel bats and balls. The TV screen makes the world visual, and the paddles provide physical contact with the world. The speaker and synthesiser give it a soundscape. It establishes this Pong world inside a tolerable latency between user's physical action and the actions on screen. Although the meanings are constantly moving between inputs and outputs, through

⁴¹ It is notable that the deterritorialising game of ping pong reterritorialised on a technology that was already deterritorialised: the television. See especially 'Year Zero: Faciality' in Deleuze and Guattari *op cit* pp.167-191 for discussion of these processes.

computer-modelled collision-detecting routines and pixel animations, the user has a sense that it is simultaneous.

Pong is not based on any goal of creating a true model of ping pong. It is a mimetic invocation of a game — ping pong without the ping. Like any magical illusion/allusion, though, what it calls up is not the same as the original. Not because it is an inferior copy, but because it simultaneously creates a paradoxical connection and displacement from its inspiration. It traces a connection with tennis, but thereby removes itself from it. 'Mimesis becomes a metamorphosis' (Taussig 1993: 126), and the ping pong/television becomes a video game, with its own intensities and spaces.

The invocational aesthetic comes into play not only for game players, but also for people doing work. The image manipulation program *PhotoShop* is a good example. It begins as a invocation of a deterritorialised dark room. Its avocations mimic some of the functions of a photographic enlarger (crop, blur, filters), and also mimic some darkroom techniques (dodge and burn, solarization, masking). Other effects mimic special lenses (distortion). Most of the image manipulation features, though, have no direct equivalent in traditional photography. Instead, they subject bitmaps to algorithmic manipulation, based on the existence of the image as pixel values in memory. Some filters work with this data to produce 'sharper' images by analysing neighbouring pixels. Others give users access to the data values (levels, colour modes). Most features, though, move away again, to invoke concepts of all manner of image creation and manipulation technologies: painting (brush strokes), drawing (graphic pens), 'lighting effects', surfaces (burlap, bricks, plaster, notepaper), and so on.

For users of *PhotoShop* this avocational palette of mixed metaphors is not as confusing as it might seem. Because the effect of each invocation is immediately

visible, and can be undone, users get a sense that the image is infinitely reconfigurable. As many writers have observed, this malleability calls into question the evidential value of photography — photography is no longer a reliable record, if it ever was (Brand et al 1985). It also gives artists a huge range of new techniques for creating and altering images (Mitchell 1992). More than this, though, the dynamic of the application in use is lost when it folds over into a 'hard' copy. Users enjoy the command they have over images: selecting areas, applying filters, adding new layers, going to work with brush or eraser, and so on. This can create a sense of flow, with a positive feedback loop between users' imaginations and the effects their invocations summon. This sense remains in play as long as the images remain open to further transformation.

PhotoShop was a killer app which manifested its invocational aesthetic qualities by providing avocations which simultaneously called users and called up elegant algorithmic transformations on images. It worked with both the finite grids of engineering abstraction and the infinite, embodied universes of artistic expression. It connected with, but extended beyond, existing image production practices, offering powerful mechanisms for moving between command and memory within the invocational interval. It gave users critical points of decision — making selections, assigning variables, performing gestures. It enticed users by offering avatars of brushes and magic wands, paint buckets and spray cans.

The invocational aesthetic always involves singular reterritorialisations in real time. In different assemblages there are different thresholds beyond which the duration of invocational loops becomes intolerable. For arcade game players a matter of a few milliseconds delay can make a difference. Physicists modelling multi-variant nuclear experiments might be willing to wait days for results. In text-based online environments lag is tolerated, and sometimes becomes part of the rhythm of the interaction between participants (Marvin 1995). The reterritorialisations always find alliances with existing cultural conventions,

user desires and social institutions. In any computer application there is an aesthetic dimension in calling universes to presence.

Although invocational media depend upon virtual machines and efficient algorithms which function properly, user experience cannot be reduced to these formalisms. Invocational media create percepts and affects by folding up and unfolding invocations. The invocational aesthetic is not a form of finality, but a productive virtuality that lands users in invoked universes that look and feel good. However, killer apps are deadly not only because of their beauty. As well as percepts and affects, invocations connect with other machines: technical, textual and political. In the next chapter I will use another prominent example — the web browser — to highlight the polyvocality of the invocation.

7. Hypertext, technology and invocatory acts

Introduction

[Click here to continue](#)

When Marc Andreessen at NCSA released the first GUI web browser in 1993, he called his program *Mosaic*. The name was quite appropriate. It refers to an ancient art form that used tiles, or tessera, of different colours and materials, embedded in a base to form new images. It is one of the most enduring, time-binding media. The *Mosaic* virtual machine, on the other hand, is one of the more dramatic innovations in space-binding media. *Mosaic* is one of the best examples of the layered nature of innovation in invocational assemblages. It drew together a heterogeneous collection of technical, aesthetic, economic and cultural components, and embedded them virtually into a simple invocational application.

At a technical level, *Mosaic* uses HTML (HyperText Markup Language) as its mark-up language and HTTP (HyperText Transfer Protocol) as the communications layer. These are the 'higher' level standards which comprise the 'world wide web' and were developed by Tim Berners-Lee at CERN. Some see Berners-Lee as 'twentieth century's answer to Gutenberg' (Luh 2000). *Mosaic* runs on top of the TCP-IP data link and network layers. It also used the GIF (Graphic Interchange Format) (and later JPEG (Joint Photographic Experts Group) as image standards. The release of this software coincided with the early emergence of faster and cheaper modems, changes in policies about appropriate network usage, and the growth of commercial dial-up Internet providers. Of course while all these changes were crucial, they do not explain why *Mosaic* was so compelling.

Mosaic was the killer application that made the web accessible. It gave the Internet an avocational face — combining links with formatted text and embedded images within a seamless screen space. The success of the web as a virtual machine was extraordinary. In the years after *Mosaic*'s release, the number of web sites grew exponentially from just over a hundred in 1993 to over half a million by the end of 1997 (Moschovitis et al 1999: 227), to over 28 million by 2001 (Netcraft 2001). This success can't be explained by technical factors alone. As a cultural machine it made powerful movements across other strata — finding not only technical, but powerful linguistic and social connections as well.

Although the web brought hypertext into the cultural mainstream, its story doesn't begin with *Mosaic*. The hyperlink is a cultural form with many other possible histories. In Chapter One, I argued that the dominant tradition in literary hypertext had made excessive claims about the liberatory potentials of the form. I argued that 1990s hypertext theorists' reading of hypertext was grounded in misreading critical textual theory. In this chapter I will present an alternative history of hypertext that will attempt to present a more grounded conceptual and political reading of the form.

The conventional histories of hypertext that the hypertext tradition relies on usually begins with Vannevar Bush's famous essay 'As we may think' (Bush 1945) written at the end of the Second World War (Fraase 1992, Landow 1992). His vision of the Memex, a mechanical device for storing a large archive of writing, and, equally importantly, storing connections and pathways through the material, has been credited as a key inspiration for hypertext. Douglas Engelbart's (Engelbart and English 1968) demonstration in 1968 of the OnLine System (NLS) was another landmark, which introduced the powerful combination of windowing graphical interfaces, the mouse and networking, all of which were crucial to the web. The other hero in the canon is Ted Nelson,

who invented the term “hypertext” in 1965. His grand theory (what he calls his ‘20/20 vision’ for the year 2020 (Synder 1996: 27)) is of a total ‘docuverse’ through which all human knowledge will be available everywhere. The hypertext tradition echoes with Nelson’s rallying call to his romantic dream of docutopia.

In this chapter I will argue that this history, also, is incomplete. Rather than repeat a history of great men in the hypertext canon (Nielsen 1995: 33–66, Snyder 1996), this chapter develops an archaeology of the hyperlink. What lies underneath the Mosaic? What tiles is it built from? What are the cultural foundations in which it is embedded? Why is the web by far the most successful expression of the hypertext concept? I will argue that the best strategy to answer these questions is to diagram the abstract machines that connect three levels in culture: the technical, the textual and the performative.

I will present three partial pre-histories of the hyperlink. Each will apply the approaches of a different intellectual tradition: the phenomenology of technology; hypertext theory; and speech act theory. Each has a different methodology, and each gathers a different set of objects and events. From the phenomenology of technology hyperlinks are a kind of button, and the web connected computer is an instance of a technical artefact. With a phenomenological eye, the problem is how the artefact transforms users’ life worlds.

Taking up the viewpoint of a literary theorist, hyperlinks appear to be a textual device that defines a new genre of literature. Hypertexts might be compared with other literary forms such as poetry and novels, and links might be compared with marginalia, footnotes and other amendments, citations or references. However, literary forms are also economic models. Traditional literary genres are grounded in the capacity of companies to sell books. The web

found some new economic models that radically shifted the dominant textual conventions in hypertext away from those anticipated by the early hypertext theorists.

Finally, as a speech act theorist, I will see hyperlinks as a means to perform *invocatory* language acts. The click is a locutionary event, which mediates an illocutionary act, and produces a range of online and offline perlocutionary events.

None of these intellectual approaches on their own offers a conclusive insight into the success of *NCSA Mosaic* and the web browsers that succeed it. It is only by connecting these approaches with the concept of invocational media that the immanence of these layers becomes apparent. This connection is usually separated by disciplinary boundaries. While layering is a good technical strategy in engineering, in cultural studies it is more productive to concentrate on the movements between layers.

Mosaic is a good example of innovation in invocational media, because, in itself, it was not particularly innovative. It cannot be mistaken for the apex of any teleological history towards perfect technology. The web is a relatively static and conservative form. Web pages are not that different from word processing documents. In fact, they are less visually rich than many word processors. *Mosaic* was a competent, but not particularly notable, example of computer programming. Its interactivity was far less powerful than many multimedia authoring packages available at the time, such as *Macromind Director* and *Hypercard*. Hypertext packages such as *StorySpace* and *Intermedia* provided linking structures with far more sophistication. *Mosaic* did not succeed because it was a work of isolated genius, but because it invoked connections with other machines.

It is impossible to say unequivocally whether the hyperlink is a kind of machinery, or a system of language, or the producer of events. To a software engineer, a link is a logical object with properties that invokes a series of system events. To a literary theorist or linguist, a hyperlink defines a meaningful connection with another text. It also functions as a means to invoke that semantic connection automatically, and to draw the invoked text to screen. To a lawyer or accountant, a hyperlink or button can invoke a legal obligation. Invoking is simultaneously a technical event, a semantic event and a pragmatic event. Language and technical artefacts are meaningful only within the social formations within which they operate. They always express relations of power.

Invocational technics



The web button is an invoked screen image of one of the more familiar day to day objects that proliferated during the twentieth century: the push button. A button is a variation on one of the primary human technologies: the lever. It is a lever abstracted and miniaturised until the gesture that triggers it is as small as possible. It functions as a discrete switch and marks a decision. Keys on a musical instrument are buttons for producing sounds on a fixed scale. Clockwork and industrial machines use buttons to start, stop or change their actions. Buttons, switches and keys are scattered liberally around lifts, car dashboards, aircraft cockpits, and an endless range of other devices.

A button is an invocatory device: it calls on a named virtualised event. The action of pressing the button, like a spoken invocation, bears no necessary relation of scale or homology in gesture to the actions it invokes. Whether it turns on a light, drops a bomb or calls a lift, a button exists first as the pair to the finger that will press it, and more remotely as the producer of an effect on bodies in the world, or on a field of abstraction like the law or money. A button

usually has a label that identifies the event that pressing it will produce. A button abstracts input from output, and makes the virtual domain it rules as controllable as a servant. It is simultaneously linguistic and mechanical. It is a standardised, abstracted trigger that summons up events at the 'press of a button'.

For philosopher of technology Don Ihde, a button is an archetype for acting on the world in *hermeneutic relation* (Ihde 1990). Ihde is a phenomenologist, influenced by Heidegger and Husserl, so he is interested in technological engagements in day to day experience. For Ihde, technics is an ontological issue: it is fundamental to the nature of reality. If acting in the world involves using technology, the nature of that technology has a substantial impact on the nature of reality. In *Technology and the lifeworld*, (1990) Ihde argues that different technological assemblages provide different ways of perceiving and acting on the world: he distinguishes the three most important ways in which the 'human-technology-world' relationship can be constructed: embodiment, hermeneutic and alterity relations (72–123).

Embodiment relations extend or amplify actions of an operator's body. A telescope seems to bring objects closer, but maintains the same dimensions of up and down, left and right. Using a hammer to hit a nail extends the power of the hammerer to exert influence over the world, but functions only to extend and amplify the arm's power. In embodied relations, the technology is relatively transparent in the processes of which it is a part. It might amplify or reduce the relation, but remains within a similar perceptual and experiential frame.

Hermeneutic technics involves a separate stage of interpretation, which resembles writing and reading (80–97). Using an analogue clock to measure time means *reading* the time as a kind of text from the clock face. To read a clock, people must already comprehend the system of hours and minutes, am and pm,

and know what the positions of the hands mean. The act of using the clock is an act of interpreting the current time by looking at its face. In the same way, users of an invocatory device like a button, should already understand what the result of pressing it will be. Usually this means reading a label. The sense of disparagement about the term 'button pusher' hints at ethics of the qualitative change when embodied processes become hermeneutic. Using buttons rather than pre-industrial and many industrial controls became more like language because operators became less physically engaged with the processes.

Ihde's third mode is alterity relations, where the operator experiences the technology as a quasi-other. The artefact seems to have an autonomous existence, by which the buttons and displays offer a highly artificial impression of the processes. Many invocational systems present in alterity relation. If mechanical buttons are invocatory, and translate actions into something resembling language-actions, invocational media are often invoked as 'other', and respond quasi-autonomously. Instrument panels and computer screens displace the range of hermeneutic and embodied actions to replace them with remotely controlled robotics. As Chapter Four showed, the invocational diagram was modelled on the human relationship of delegation. When workers adopt invocational media they take on a quasi-management role.

Shoshana Zuboff (1988) studied the computerisation of processes at a pulp mill she called Piney Wood during the 1980s. The managers at Piney Wood installed computer controls in the place of older mechanised systems. Zuboff found that workers had trouble adjusting to controlling the production process by reading data off screens. They were accustomed to using heavy equipment as a collection of physical objects. The change from embodiment relations to alterity relations meant that they had to read the state of the machine and interpret it as a kind of text, rather than gauging it from seeing, feeling and walking around

the machines. The workers were forced to read the affective state of the invocational other by reading the facial systems of output devices.

The workers had some trouble adjusting to their new relationships with artefacts. Invocation required a certain degree of faith. They had to learn to believe in the efficacy of acts that they performed with buttons. They had to learn how to answer the avocations. As one of the workers complained: 'If you don't have actual experience, you have to believe everything the computer says...' (65). Deterritorialised and encoded, the materiality of the process was abstracted to displays and buttons. The reorganisation was more than a change in process, it changed the workers' world.

Through buttons and scanners, and the devices connected with them, actions are deterritorialised and made available as structured avocations rather than physical artefacts open to embodied manipulation. An invocation is a quasi-linguistic event that brings phenomena into presence along channels established beforehand in a collection of material and immaterial avocations. Until workers come to read the invocational aesthetics of the system, the function of their bodies is reduced to making purely formal and abstracted invocational gestures, like pressing buttons.

The changes in human-technology-world relations this century extend well beyond work places and into many aspects of daily life. Much of it involves encountering invocational technologies. Automatic doors even lack a button: the mere presence of a moving body triggers them. As Baudrillard observes, the proliferation of these devices changes the texture of peoples' experience of the world. Peoples' world of action becomes largely mediated through invocatory and invocational interfaces:

7. Hypertext, technology and invocatory acts

...what the technical object bespeaks, no longer requiring anything more than out formal participation, is a world without effort, an abstract and completely mobile energy, and the total efficacy of sign-gestures (Baudrillard 1996).

The broad historical trend for buttons over the past century has been to move from mechanical systems, through electrical systems and then to computer-mediated systems. This has meant a shift from embodiment, through hermeneutic, to alterity relations. Expressed in another way, the mediation was first mechanical, then invocatory and finally invocational. Since the 1960s more and more systems work as invocational media, in which buttons are part of a computer system's interface. Each of these changes deterritorialises the button, making it less bound to physical form and location.

Mechanical buttons are physically linked to any actions they create, preserving some degree of embodiment relation. For example a mechanical door bell or knocker remains fixed to the door. Users adjust their gestures to suit the device (twisting a rotating bell; swinging a knocker or whatever). The manually operated bell is an artefact whose physical location and form are inseparable from its function of alerting the owners that visitors have arrived. The doorbell has a layer of meaning-making as part of its function. It is part of a system (along with the doorway, welcome mat and closed door) that defines the boundaries of a property. The knocking device embodies an implied request by the inhabitant that visitors should make their presence known, and provides the means for doing so.

In security apartment buildings where everyone has the same front door, a manual door knocker is not adequate. Instead there is a panel of buttons with residents' names alongside. This moves towards hermeneutic relations, and to electronic invocatory devices. Bells are electrically rather than physically attached. Visitors have to rely on the label to know whom they are calling. When someone presses the button it completes a circuit that activates a bell in

the appropriate apartment. The invocatory device still has only one function — indicating that someone is at the door. A door bell is sometimes accompanied by other invocatory devices, like an intercom and a button in the apartment that remotely unlocks the door. Events triggered by these invocatory switchings are relatively simple.

After the 1970s embedded microchips became cheaper than custom electronics, so many devices like door security systems started using computers. In avocational assemblages, door bells on panels no longer switch current on and off, but become input devices. When a visitor presses a button, the system registers the action as a logical event which triggers an appropriate programmed sequence of actions. It might turn on a video camera, trigger a pager, notify a security guard or whatever else it has been programmed to do. Operating with digital code, any input (such as a doorbell button) produces a range of results, since the relationship between input and output has become arbitrary. Because the machine is controlled by its programming rather than its electronic engineering, a button press invokes a complex series of operations, according to the avocational structures its designers have provided. Applying operators such as Boolean conditional instructions, the same button can trigger different events under different conditions.

The web is similar, in that it invokes 'gateways' and protocols, requests and responses, passwords and authentications in its invocational architectures. The Gateway Protocols and Border Gateway Protocols determine the standards by which data entities can gain entry to specific invocable domains (Internet RFCs 2001). There are no longer any physical doors, only invoked gateways. As I will explore later, these transactions become more and more like language.

Returning for the moment to the domain of technical objects, then, the windows in *NCSA Mosaic* incorporate a style of deterritorialised button which originated

in the GUIs developed in the 1980s. Graphical user interfaces dematerialised the button. They reterritorialised buttons as icons on a screen. Iconised buttons are pressed by a disembodied hand avatar. The user's physical gesture is displaced onto a mouse, and the mouse button becomes the universal button whose meaning is completed in the screen image. If physical buttons are already abstractions, bitmapped computer screens are a domain with an even higher order of abstraction. The appearance and behaviour of the button on a screen is arbitrary — a user illusion. It carries only sign value without being bound to functionality. In fact, it is a dramatic simplification of the switching processes that 'pushing' it invokes. The reterritorialised button mimics the embodiment relation that the button pusher had had with buttons, but offers the full invocational vocabulary of virtual events.

The Macintosh interface (later known as MacOS) and Microsoft Windows™ popularised a range of conventions for iconic machine/textual devices with a vocabulary of actions/texts. The designers extracted the meanings of buttons from their instrumental functions within machines, and employed them as semiotic devices. As well as the standard button (including the ubiquitous 'OK'), graphical interfaces offer a variety of other conventions. Dialogue boxes are the standard device to elicit decisions from users. They offer a number of ways of choosing options or throwing switches, including fields where text can be typed, radio buttons, check boxes, and submenus. Icons can be clicked, double clicked, or clicked-and-held.

Each of these devices/texts carries semantic and logical meanings within the domain of operating the computer. The designers' choices of metaphor come equally from texts and machines. Radio buttons are like a car radio (Apple Computer Inc 1992), where pressing one button makes another release. Only one can be on at any one time. 'Check boxes' are invoked from paper forms. The person filling in a form can write a tick or cross next to any or all of the

appropriate labels. The distinction between these two interface conventions is semantic: the machine (radio buttons) offers the choice of ‘this or this or this’, while the text (check boxes) offers ‘this and this and this and not this’. The interface designers mixed their metaphors of machine and text without compunction.

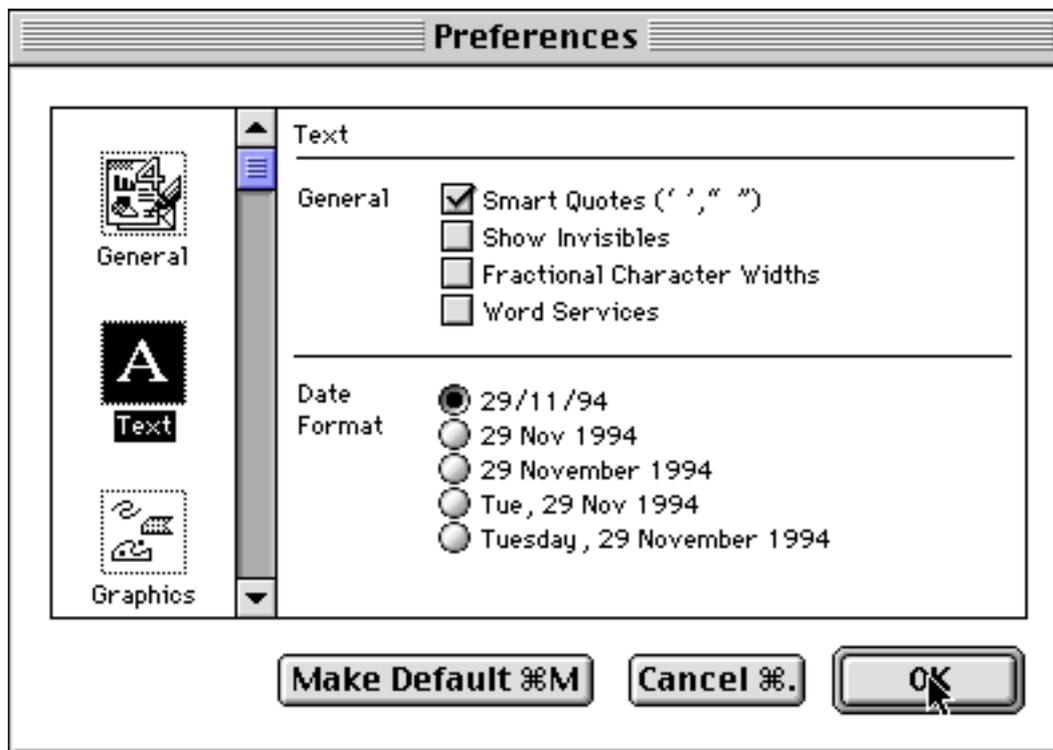


Figure 2: Dialogue box from Claris Office 4. The check boxes at the top can be independently checked, while only one of the radio buttons (bottom) can be on at any one time.

The button on a web page is an artefact becoming language. It is closer to textual form than a user interface object. On the web everything is held in place by a standard of textual mark-up. HyperText Markup Language (HTML), creates buttons with tags. Tags are invisible to end users, but written by authors to bracket different sections of the text with logical and physical properties. For example, text between two `bold` tags will appear on screen in bold face. To create a web button an author uses the `<INPUT>` tag, inside `<FORM></FORM>` tags. `<INPUT>` has a `LABEL` property, which determines what is written on the

button, and an ACTION property which determines what processes it will bring about.

In many previous hypertext systems, creating links required an operation distinctly different from writing the text. HTML's success as a standard is partly because link-programming is part of the writing-composition action.

Mechanism and text are so interwoven that they can barely be distinguished. A button is simultaneously written and designed, read and used. It is both text and engineering, document and artefact in the same invocational package.

But was the common sense distinction between machines and language ever a simple opposition? Were language and technology ever distinct? Crossovers between language and artefacts have always operated in both directions. Artefacts work as language, and language does things that belong in the realm of action. Buttons were always ambiguously artefactual and linguistic.

In a history of artefacts, hyperlinks are a special kind of button. They are a hermeneutic device embedded in an invoked facial system of virtual alterity. Links refer to other virtual pages, and only sometimes to external physical events. Web page buttons are virtual artefacts become text. New linguistic modes of *n*th orality emerge through the mediation of this artefact. The meaning of links becomes comparable to other textual conventions — paragraphs, punctuation, formatting and layout. As such, I'll need to toggle my system to another view, to see the web as a form of text.

Electric language: invoked text

If hyperlinks are a special kind of button becoming text, in this section I'll approach them in the opposite direction. Buttons and hyperlinks are modes of writing becoming technological. Another way to see the history of electronic writing and hypertext is that hyperlinks are a technical instantiation of

experimental forms in the history of literary and media practices. Computers are major divergences from hand writing, print and typewriting. First, they change the material form of the text, and second they open the possibilities for new textual conventions with devices such as the hyperlink.

Electronic text was invocational before it was hypertextual. Jack Gilmore, an engineer at MIT, is credited as being the first to invoke text on screen when he wrote a program called 'Scope Writer' in 1957 using a TX-0 computer that displayed text on an oscilloscope. Gilmore and other computer scientists were most interested in using text to speed up editing programs and controlling the computer. The DEC PDP-8 had a word processing program called the 'Expensive typewriter'. It was not until the early 1970s that the Wang WPS (Word Processing System) commercialised electric writing as word processing that it became an invocational medium for writing texts for human readers (*Time/Life* 1986: 35–46).

If typewriters separated the hand of the writer from the site of inscribing the text, computers split the process further, both in time and space. Writing's existence was separated into several interdependent parts: input, memory, storage, display and print-out. The user's hands type text as switches on a keyboard. Traces of these switchings are held temporarily in random access memory, and stored semi-permanently on magnetic storage on disk. At the same time they are made visible as patterns of pixels on a screen. The text on the screen is continuously invoked as the monitor refreshes sixty or so times each second, unlike ink on paper, which persists across time as permanent marks. The invocational text glows in a perpetual electrical present, open to deletion, addition or manipulation. Computers animate a fluid world where text can be inscribed without any marks, and deleted without trace. Word processors, particularly on microcomputers, saw electronic, invocational texts increasingly becoming part of everyday life (see Heim 1987).

The invention of hypertext added some significant new components to the word processing machine. As a technical innovation, the hyperlink was trivial. But it resolved in a simple but effective way the problem of navigating through online texts. Hypertext is a form of writing designed to be read on screen. Although programmers had already been reading text on screen, code is a form of writing in which the meaning is only complete when the programs are executed. Text in a word processor is an intermediary form which is complete only when the file is printed. Electronic mail and bulletin boards are other genres of *n*th oral text read mainly on screen. These forms are more like conversation, and don't usually extend beyond one or two screens. They also have their own forms of organisation: mail client software.

Hypertext incorporates into the text itself a capacity to invoke other textual fragments. Again, this act has predecessors — word processor users opened files from disks; FTP and gopher clients (other Internet protocols for transferring files) called up files through the Internet. Hyperlinks articulate this act of calling up a new file as a semantic element within the text itself. With hyperlinks avocations become part of a writers' vocabulary, and invocations become part of the reading process. Writers compose and assemble websites: interlinked invocable collections of virtual texts. Readers surf the avocational waves without a thought to the individual invocations they make.

The central metaphor for hypertext is another nautical reference: links are chains from a source anchor to a target anchor. This concept is ambiguous, and often misread. Links are not followed, but trawled up. Don't imagine following the link to the anchor. Imagine dragging the chains on board to pull up the next anchored text onto the deck. The user doesn't move, what is connected to the anchor does. Linking invokes another piece of text into the *same* space — a user's screen. Connections between texts, and texts about texts, are manifest by the computer as links. These allow readers to draw related documents directly

onto the screen. These innovations demand new conventions for reading and writing.

The hyperlink is a significant assemblage in *n*th orality — the new language situations supported by invocational media. It adds to writing and reading a new layer: avocational semantics. Links can have several different types of meaning.⁴² They function as invocationary conjunctions between two blocks of text/image. Although the automated decisions made by the invocational assemblage are based on the Boolean logical ANDs and ORs, hyperlink semantics open up a wide range of possible meanings, similar to conjunctions in sentences. In each of the following examples, the event of linking itself has a quasi-grammatical function.

- Temporal sequence (the story continues...)
- Result of a calculation (see the result)
- Contrast (on the other hand...)
- Subordination (a link brings up definition of a term)
- Citation (a link to a bibliography)

Some links assert a formal logical relation between link and linked page (deduction, induction, analogy). Many links, though, are not framed so formally. Irrespective of their meaning, all links share their invocational functionality. A link usually invokes an entirely new page, replacing on the

⁴² In a PhD thesis on link types, Randall Trigg (1983) identifies thirty four 'Normal' link types and fifty one 'Comment' link types in scientific writing.

screen the page on which the link was sitting.⁴³ The invocational event itself is distinctive, but almost invisible.

It is telling that some parts of the meaning of a web page are lost in hard copy: the invocational semantics. The text 'click here to continue' at the top of this paper document invokes nothing (although it evokes the medium of the hyperlink in general). Once they have folded out onto the surface of a piece of paper, links no longer have the power to invoke anything. Invocation changes how readers encounter 'pages' of text. Reading printed pages is always structured by the spatial layout of pages. In a traditionally bound book, or stapled printed documents, text and other elements are arranged across the page, and pages are stacked in order. Reading a typical non fiction book, for example, involves physically turning over each page and reading marks arranged across each page. Readers often deviate from the main path to locate indexes, references or footnotes by reference to numerical ordering of physical pages, but to do this takes some effort.

Text on screen on a web page is negotiated in quite a different way. Users sit in front of a screen with a mouse and keyboard, using navigational controls including scroll bars, hyperlinks, 'back' and 'forward' buttons to read beyond what is on screen at any moment. These controls invoke text from immaterial domains of storage and memory, and across the Internet. This is quite unlike moving physical pages into and out of view, although the interface (with layered windows, scrolling 'pages', and a capacity to move sequentially forward and backward) mimics this form.

⁴³ The innovation of frames in later web browsers allowed designers to divide the browser window into panels. With frames, a link changes one panel, while another panel remains unchanged (this innovation is reputed to have been implemented primarily to support banner advertising).

As we saw in Chapter One, a number of literary theorists in the early 1990s greeted hypertext as though it was an extension of literary theory's own concerns (Barrett 1989A & 1989B, Bolter 1991, Landow 1992 & 1994, Lanham 1993, Joyce 1995, Snyder 1996). In their eyes it embodied the results of literary experiments with intertextuality. It was a technical solution to the conservatism and linearity of the print form. It overthrew the tyrannical position of the author over the reader.

Their hope that hypertext would triumph over forms of domination and hierarchy has been shown up by the explosion and commercialisation of the world wide web since the mid 1990s. These developments have thrown into doubt their faith that a new form of writing would necessarily produce social benefits. The utopian and technological determinist claims about hypertext were hard to sustain in the face of the world wide web that emerged in the late 1990s.

In many instances web texts are as closed as any print material. Although there is a proliferation of personal home pages, chat sites and online 'zines, the distinction between authors and readers, for the most part persists. The sites that companies and institutions create are professionally-constructed public faces. If a hypertext reader attempts to become a co-author, this is not a textual experiment, but a criminal security breach (see Sterling: 1992, Wallace and Mangan: 1996). The authority of authors is systematically protected with firewalls, encryption and other security measures. Although copyright law is complicated by how easy it is to distribute material, it does not collapse, but only corrodes around the edges.

Most of the texts on the web are not literary or expressive, but marketing brochures, online shopping centres, online newspapers and so on. The sheer volume of sites competing for limited attention effectively limits the significance of the apparent space opening up for free expression (Portante and Tarro: 1997).

This is reinforced by a gradual rise in user expectations about the use and aesthetic values of web sites. At the same time, users who experience how slowly texts on the web download grumble about the hyperbolic promises of instantaneous, seamless access to a world of knowledge. While utopians await hypertextual nirvana, the medium becomes something different again. Mosaic was commercialised under a neo-colonial banner of 'Netscape Navigator', and was soon met in head-to-head battle by the biggest player in invocational Universes in Microsoft's Internet Explorer. By the end of 1999, Explorer was declared the winner of the browser wars (Vaughan-Nichols 1999).

Links became commodities. Popular web sites began to charge for banner advertising per hit or click-through. IP names became valuable as brands. Control over domain names became an international political issue. This was heralded by a notorious 1994 case when a journalist registered the domain name 'mcdonalds.com'. The restaurant chain's lawyers demanded that the trademarked name be released (Leventhal 1995–1999). However,

[a]fter McDonald's unsuccessfully attempted to obtain the domain name in court, Quittner named his price and McDonalds agreed. The hamburger giant contributed \$3,500 to a public school in Brooklyn's Bedford Stuyvesant area for the purpose of setting up a high-speed internet connection at the school (Leventhal 1995–1999).

Other new hierarchical structures began to be imposed. Search engines and indexes appeared to categorise and classify web pages and sites. In some of these sites, paid content appeared more prominently in listings. The genres of web page that emerged, while certainly not the same as other genres of writing, hardly fulfilled the aspirations of the hypertext evangelists. Only a tiny minority of web sites have literary value, unless you include Amazon's online book store, which once again subordinates hypertext to the commodity form of the book.

The inability of hypertext theorists to understand the emergence of the hyperlink as a cultural phenomenon stems from their focussing too closely on the medium of writing. Even within genres of writing, they concentrate primarily on literature. They speculate about the wider implications of hypertext by projecting a political teleology onto the formal properties of the system. When a new media form based on hyperlinks did emerge, in the web, its textual conventions were connected as much to the politics and economics of their publishers as to the formal technical properties of the material form of the writing.

The web illustrates how politics doesn't emanate from form or genre. Novels and books are not just characterised by their writing conventions, but by their marketing plans. Books only continue to be published because there are audiences who read them, critics who analyse them, and companies that make money selling them. The web's textual form is equally conditioned and structured by its social and economic models.

The web developed its own expressive conventions, built around the dynamic between hyperlink avocations and user invocations. Web pages are a tactile surface, which gradually came alive with animated elements. Animated gifs were the first to introduce movement, and were the first of a collection of avocational tactics that designers mobilised to capture users' attention. Users tend to stroke their avatars across the surface of the page, 'feeling' for hotspots. The 'mouseover', which was introduced with *LiveScript* (which later became *Javascript*), introduced invocational events to this surface.

Hyperlinks are part of the avocations that vie to articulate and capture users' desires. That desire is actualised when a user chooses to click-through a link. Designers attempt to build destination pages to satisfy the promise that was made with the originating link. The page then also offers further avocations to

hold the user's interest, and retain the visitor to the site. Web sites are avocational universes that use consistent design and image to evoke an atmosphere in which users continue to invoke further pages.

While a user's contribution to a commercial website is constrained by modes, and designers' strategies, everything on a site remains hidden until it is invoked. Users' actions are recorded by the server. In this way users involuntarily perform as writers as well. They write their own log file entries. They establish their own order of things with the order-word machine. This log is of value to the site publisher, and the patterns in this log are used to re-design the avocational writings that compose web pages. Users only continue to invoke if they have an interest. This is the critical point: web site visitors must have an interest. There must be something at stake.

Language as technology: language acts

Even with their enthusiasm for active readers, hypertext theorists underestimated the significance of what writers and readers actually do with their language (or language does with them). As well as technology sometimes becoming like language, and language becoming technologically mediated, language itself always did more than describe things: it does things. So-called 'ordinary' language overlaps with what is sometimes considered a domain of technology — extending peoples' instrumental control over the world. In Chapter Four I briefly referred to the tradition of 'speech act' or 'language act' theory, which analyses the performative functions of language. I will go further into this tradition here.

In *How to do things with words* (Austin 1962), philosopher of language J.L. Austin develops a theory of speech acts (or language acts). He starts by distinguishing the most common understanding of what language does: it makes constative statements. That is, statements make propositions that might be verified as

logically consistent, and judged as empirically true or false (3). However, Austin argues that language does more than report or describe events. Instead, it actually produces events. Making a promise by saying 'I promise such and such...' is not reporting the act of promising, but is actually making the promise in saying the words. Based on this premise, he distinguishes three components of the speech act: the locutionary, the illocutionary and perlocutionary.

The locutionary part of a speech act is the event of uttering sounds (in the case of speech), or making marks in the case of written language acts. If I make a promise, the series of sounds in the utterance "I promise to pick you up at 8 o'clock" are the locutionary act. If I write the same promise on paper, then that document performs the locutionary act.

The illocutionary act is the abstract promise itself. It takes the form of a proposition (collecting you at 8), backed up with a force (I am committed to doing this). This force can be strong (such as a solemn vow), or less so (I'll pick you up unless there's something good on TV).

The perlocutionary act is what comes about as a result of that act. Promising might have the perlocutionary effect of reassuring the promisee. Like technology, speech acts are ways of trying to predict and control the future course of events. Speakers and listeners perform speech acts to create interpersonal contracts that try to preordain a certain result.

Although language act theory helps conceive how language works as a mode of action, it has limitations. Linguists who develop the speech act concept such as John Searle, particularly, generally confine their analysis to interpreting language acts as just another system. Searle acknowledges that language acts operate in domains of institutional facts, and not 'brute facts' (Searle 1969: 51), but he makes little attempt to develop a conception of how language acts relate to other technologies of social power.

Speech act theory is most useful when it is coupled with a theory of social power. Pierre Bourdieu argues that the efficacy of a speech act has less to do with linguistic competence than with the relations of power between the speakers (Bourdieu 1991: 72–77). The words someone says are meaningful only if they're backed up by people who go along with it, and systems that put it into action:

Austin's account of performative utterances cannot be restricted to the sphere of linguistics. The magical efficacy of these acts of institution is inseparable from the existence of an institution defining the conditions (regarding the agent, the time, the place, etc) which have to be fulfilled for the magic words to operate (Bourdieu 1991: 73).

As well as a theory of power, speech act theory is usefully extended outside of the domain that is usually considered linguistic. Language acts are not exclusively performed through language. Some promises are made so regularly that they are standardised and made material. Paper money and cheques originated as promissory notes that represent promises by a giver to provide goods of a certain value in the future. Analysing this as a language act, handing over the notes is a locutionary act which instantiates the illocutionary act of paying. The verbal promise has been translated into notes. The perlocutionary effect is that the purchased item changes hands. In this case, promises have been institutionalised and embodied as the system of notes, coins, cheques and so on. The value of the currency is not present in the exchange (another point of decision, or switching), but, in a way, invoked, with the authority of the State to back it. There is no clear boundary between speech acts in ordinary language and these institutionalised practices.

In Chapter One of this thesis, I introduced Deleuze and Guattari's argument that every statement is already a language act: an order-word. 'The elementary unit of language — the statement — is the order-word... language is made not to be

believed but to be obeyed' (Deleuze and Guattari 1987: 76). Every statement is implicitly an act of power. This reverses the order in which Austin presents speech acts. The order-word *begins* with systems of implicit, presupposed, social obligations. The virtual dimension of every statement, the conditions for the mysterious 'perlocutionary' act, precede the performance of the locutionary act. Before I make any request, the circumstances that make it possible for me to say it are already in place. When the order-word is articulated it performs an 'incorporeal transformation' which instantly makes some change in those relationships that it presupposes. My request attempts to impose some form of obligation on the person I am addressing.

This brings me back to the button, which I can now present as another way of performing language acts, and particularly what I call *invocatory acts*. Let's return to the door bell. If there is no bell on someone's front door, visitors are likely to call out 'hello, can I come in?' This is an everyday speech act that can be categorised as a request, and is likely to be followed with a greeting and an invitation to come in. The knock on the door is also an act of power, and not only when it is the secret police coming at three o'clock in the morning. It demands to be answered, if not as a threat of violence, then as a social obligation.

When there is a bell, it displaces the voice, and offers an avocation to the visitor to make the same request with a gesture. An electronic invocatory device like an electric bell separates the button from necessary physical proximity, but still has only one voice, and one invocatory statement: 'please open the door'. A panel of buttons in a security apartment offers the means of expressing the same request to different tenants, but opens a hermeneutic as well as physical gap between visitors and residents. They have to remember which apartment their friend lives in. The distance between the bell and the door is a strategic change

in the assemblage. It is part of the security machine that distances the apartments from the street.

Invocational assemblages call up a wider and more extended series of actions than analogue technologies. While a manual invocatory device like a knocker or bell has a very limited repertoire of invocatory acts, an invocational system is programmable, and invokes a range of language events defined by the avocational virtual machines. The call enters as an input, and is delayed and folded through the invocational interval before it is output. It is therefore capable of a more differentiated range of invocatory acts. The 'voice' can be split into an invocational chorus, and the same invocatory event of switching can speak in a number of ways (such as recording the visit on a log at the same time as notifying the tenant).

The 'statements' and potential perlocutionary effects are also various, which is how the same button that rings a bell, can also call a security guard. The invocatory order-word, which is only partly expressed as a natural language statement, has become increasingly articulate in its mobilising the asignifying semiotics of virtual machines. The invocational infrastructures (which also incorporate peripheral devices that reterritorialise as actions) give buttons a wider vocabulary with which to articulate invoked results. The hermeneutic specificities of promises or requests are translated into Boolean logic models. For example, the building manager might be able to say that visitors can only visit some areas during business hours unless they have a key. Algorithmic calculations and archiving devices factor in as well: the door could record the number of visitors to certain apartments.

Calling up a web page also involves a series of invocatory language acts and order-words. Some of the avocational systems by which web sites operate borrow their concept from natural language speech acts. When a user clicks on a

hyperlink, the web client sends an HTTP *request* to the server, which responds with a *reply*. A secure server requires *authorisation* with a *password*, and *authentication* that the message is from the authorised sender. Depending on the kind of data, the server *invokes* different methods in how it handles the request (these are part of the HTML and HTTP specifications: see Internet RFCs 2001).

Buttons extend the hyperlink to invoke more complicated avocational mechanisms that build pages 'on the fly'. Buttons must be inside a form. Users complete fields on the form, avocational spaces requesting particular types of information. When the web browsing software registers an 'onClick' event, it most often POSTs the query, usually to a 'common gateway interface' application (CGI) on the server. The CGI constructs a new page. If necessary it invokes other processes such as sending a query to a database, or invoking a peripheral like an image from a web camera. Finally, the web server composes the page and replies by sending a new HTML document to the client browser.

Users need know nothing about the avocations that handle their web browsing experience, but how they encounter web texts depends upon these structures. Web page designers use the HTTP, HTML and CGI protocols to construct avocational virtual machines that anticipate requests that users will be happy to make. As well as offering the text that users will read, and producing the images they will see, designers configure the invocationary requests and promises users are able to make. They position these within evocational machines of conventional images and texts.

Although most hyperlink order-words are trivial ('follow this link'), all are registered and logged by the web server. Commercial sites use these logs to sell advertising. Input devices are still technologies of surveillance. Databases capture every event that marks an individual decisions in the human sensorimotor interval. Statisticians analyse the millions of page views, and their

referring pages to identify and quantify trends in the social dynamics of hyperlink invocation. These feed back into the future designs of web pages. Avocational virtual machines can discriminate to the level of the individual, offering content customised to each user.

The capacity of invocational media to mediate language acts has often been mistaken for intelligence. Part of this belief originates in the conception of language as constative. If the measure of whether computers are linguistically competent is based on how well they make casual conversation, the state of the art in 2000 is not great. If, on the other hand, we use the invocational Turing test to assess how well they mediate language acts, they are high achievers. There is no doubt that these media might seem to invoke intelligence, but intelligence is not their defining quality.

The web button is not an act of intelligence, but an invocatory act that mediates a transaction. Clicking on a web page button can purchase a product, agree to a contract (such as a software licensing agreement), or subscribe to an electronic mail list. These are not intelligent acts, but automated invocatory language acts performed through a medium in which the parties are not present in the same space or time. The composition of the intricate foldings in the avocational structures within the invocational interval are developed by programmers. The avocations reflect social and political relations, rather than making the abstract links of a creative intelligence.

Winograd and Flores (1986) apply speech act theory to computer software design in *Understanding computers and cognition*. They advocate that a designer starts by analysing the typical conversations within the particular work domain to which the system will be applied. For example, proprietors of a dress shop regularly deal with customers and suppliers, and many conversations involve 'requests/promises, offer/acceptance, and report/acknowledgment' around

purchasing dresses (159). A customer might order a certain style of dress, which a supplier makes to order. At each stage the next part of the process is triggered by a speech act. In different cases this is performed face to face, over the phone, or on written order sheets. If this process is to be computerised, Winograd and Flores show how the system should be designed so that it transmits, tracks and records these commonly invoked speech acts. Although it seems that such a system would be restrictive, replacing free discourse with a far narrower range of speech acts, many of the routines of the shop are already highly ritualised.

While Winograd and Flores' work addressed problems that could be applied directly to system design practices, their work is more broadly useful in analysing how computer mediated speech acts (invocatory order-words) operate in social and economic assemblages. Invocational systems offer infrastructures that mediate language acts by storing, tracking and transmitting the commonly used requests and confirmations. In a computerised clothing shop, the invocational system builds in the roles of customers, suppliers and shop owners.

In critiquing speech act theorists, Bourdieu argues that the performance of power is always associated with a symbolism of power (Bourdieu 1991: 75). The staff in the shop already wear uniforms that denote their speaking position. In a computer system, this symbolic power takes the form of avocational virtual machines: passwords, keys, special training and physical positioning of the machines. System designers endow each actor with capacities to perform certain invocatory acts. Each person's level of access supports the promises and other commitments they need to make. While computers don't create the roles of customers, shop assistants and suppliers, they articulate these positions more formally. What was sometimes implicit for human actors about their roles must often be spelled out to eliminate ambiguities the system cannot tolerate.

Winograd and Flores observe that designing a system does necessarily change the nature of the tasks and relationships.

A web site offers a deterritorialised domain for making and accepting commitments, promises and other language acts. The medium is not so much about delivering content as about performing relationships or mediating invocatory order-words. At the level of hardware and software avocations, these mediate invocatory requests and replies in interchanges between clients and servers.

In social terms, the website substitutes for the usual material conditions necessary for performing such acts. The web provides an invoked platform or environment in which relationships can occur without reference to time or place. In many ways, this is not all new or unique. Many institutions and technologies deterritorialise and encode relationships and meanings: bureaucracy, writing, capitalism. Invocational media homogenise and accelerate sequences of events until they approach real time. Hyperlinks draw relatively seamless lines from users to institutions and back again.

The Hyperlink machine

The original name of the first GUI web browser — *Mosaic* — seems quite appropriate after this discussion. *Mosaic* embodies in object-oriented code the avocational structures which drew together elements from a range of disparate domains, and recomposed them in a new invocational ‘technogram’ (Latour 1987: 138–139). Not only did it invoke layers of networking protocols and operating system components, but more importantly, it invoked connections to technical, linguistic and performative machines in wider universes. It combined science, art and philosophy to create a well oiled machinic assemblage.

Although it did offer some new aesthetic and political possibilities, it also made

relative reterritorialisations onto state forms — the institutions of economic and political power.

The challenge this chapter started with was to find a way to theorise the interweaving of language, technology and politics when someone invokes a hyperlink. As I have argued throughout the thesis, the concept of invocational media traces unbroken lines between artefacts, language and social formations. Clicking a hyperlink is simultaneously a language act and a use of technology in hermeneutic relation. The hyperlink is semantically an intertextual movement and a set of technical events. It is language becoming machine, and machine becoming language.

Web sites are different from books not only because of the textual properties of hypertext, but also by the nature of relationship that they establish between readers (users), authors, publishers, designers and other actors. The web will never directly replace books, because they do different things. Web sites draw actors (readers, writers) into a closer virtual relation in time and space within their twisting avocational pathways. Any particular instance of invocation is singular, encompassing a particular configuration of statements: illocutionary acts, invocationary acts, perlocutionary effects, and social relations.

Bearing all this in mind, let's try to make sense out of the buttons on the Amazon online book store website (Amazon 2000). If I bring it up on my Mac, the page appears on a screen in Australia, even though the 'original' is in the US. Like any web page, the document I read was not dispatched, but invoked. In fact, these 'originals' were only constituted a moment ago from a database just before I saw them. They were not strictly authored, but invoked in one mode of *n*th orality.

I log in using a user name and password, which validates my identity. This site invokes details of my past purchases, and speeds up any purchases I make. The

site front page offers three columns, and a range of buttons and hyperlinks. Most of the page is a series of short headlines and illustrations about new books or special offers, personalised to my interests based on my previous invocations. At the top is an avocational 'navigation panel' that includes buttons for searching by keyword or browsing books by topic. Among the buttons is one that adds items to an invoked 'shopping cart'. Even more dangerous is the 'one click purchasing' avocation which reduces the tactical distance between desire and decision.

I choose 'view source' from a menu in my web browser, to read how everything I see on the page is built as tagged text in HTML. At least at the level of the page, I can see some of the avocational structures: image maps, JavaScript, embedded images. On the other hand, I can't see the database structures that invoked this page. I close the window, though, since in this form what I see has no invocatory force.

Back in the web site itself I find a book I have already read, and particularly liked, so I decide to write a review. In a way, this is a powerful new form of free speech. It redresses the imbalance between author and readers in the way that hypertext theorists celebrate. At the same time, though, I am doing some free work for Amazon. If they had commissioned me to write the review I would have charged them, but since I am contributing to the common good, I am happy to write it. However, I suspect if I looked in the fine print, I'd find that they now own the copyright on my work.

So what does this environment tell me? The web browser reminds me that I'm using a technical object. Its avocational structures recall physical buttons. Invocational media are mimetic machines, so that buttons appear as a deterritorialised quotation of mechanical buttons. The browser even quotes my hand on screen as a pointing device, fused in a relation with the mouse on my

desk. It reconstitutes an embodiment relation between my gesture and my avatar. Clicking is a highly abstracted lever, where layer upon layer is differentiated, displaced, textualised, digitised and ephemeralised. I click a button to purchase.

The browser also reminds me that I am performing social actions. I am entering a secure site. I click OK to confirm my purchases. The button performs invocationary order-words. Clicking on the button makes a request and a commitment. It commits me to paying, and commits the site to shipping the book I have just bought. If I default on this agreement, it could have real world consequences, such as a debt collector banging on my door. The system not only eliminates the need for a speaker and listener to be present, it allows Amazon to operate with little consideration for time or place. It traces the validity of my credit card, and sets in train my payment. It triggers the ordering, packaging and shipping of the book. Amazon's avocational systems have black boxed many elements in the series of language acts, mechanical operations and social roles associated with selling books.

The invocational universe invoked by the web browser mingles a pragmatics of technology, language and social formation. Textual genres, technological artefacts, social formations and systems of language acts are contiguous components arranged into a machinic assemblage. But even in 2001, Amazon's success is still in the balance. It has lost money consistently since its launch.

The web browser is a good example of a new genre of invocational media that is significant not for its intrinsic qualities, but for the heterogeneous connections it makes. It was not a culmination of earlier, lesser precursors. For one thing, the web is quite limited as an expressive medium. Unlike computer games, which create dynamic invocational universes of virtual space, web pages concentrate avocational openings on relatively static hot-spots. As a technical object, *Mosaic*,

and even the later browsers, are no better examples of computer code than many other, less popular, pieces of software. As social action, the purchases I can make on Amazon are little different from ordering something through mail order. What is genuinely new is the critical singularity that this invocational assemblage achieves by combining these components. Web browsers build invocational links on a global scale in real time, connecting individuals and institutions in mediations that involve simultaneous events of technology, language and power.

Conclusions

Now that the concept of invocation is out of the genie's bottle, as it were, we can briefly consider its place in the rapidly emerging field of 'cyberculture studies'. It joins a rapidly growing, but heterogeneous range of concepts from many different disciplines. As suggested in the literature review, recent work on new media cannot (yet) be considered a coherent tradition. There is, of course, a conventional canonical history of the early development of computers. I have touched on this throughout the thesis, and put some different inflections on the stories of significant figures such as Babbage, Turing and Von Neumann, but this history does little to explain contemporary experiences with new media. Outside a small circle of hypertext theorists writing in Literary Studies (whose work, as I have argued in several sections of the thesis, is problematic) there is no clear consensus on the best methodologies with which to approach the increasing ubiquity of computer-based media.

The concept of invocational media offers a credible alternative to the traditional view that computers fit exclusively into histories of mathematics, logic and abstraction. By contrast with this conventional conceptualisation, invocational media, as I have presented them, emerged with a number of histories. The term invocation, with its simultaneous connotations of calling to history, mediating command, and summoning magical effects, has been a productive base on which to construct a different conception of these new media.

At one level, invocational media belong to a history of invocatory devices — switches, buttons and levers. They are a special phylum of switches because they have memories, creating what I have called the 'invocational interval'. Where a simple switch can mark a user's single and immediate decision, the circuits within this interval can interleave commands with memories to produce many more finely differentiated and delayed decisions. Invocation is a cultural

form, or abstract machine, marked by this combination of command, memory and decision.

The will to create invocational media, then, comes not only from a will to abstraction, but also from a desire for a machine that mediates and answers commands. This desire is not entirely rational. In order to make a command, users must imagine and articulate what they want. Freud argued that in civilised societies technology displaced primitive magic. It offered a means of answering desires in the subconscious (Freud 1913, 1930). So when invocational media appeared they were somewhat familiar to Western cultures because they fit these primitive archetypes of magic, offering to call up effects at the whim of the invoker. As the myth of the Muses suggests, invocations must be made carefully, because their consequences will not necessarily be exactly what the supplicant had in mind.

Several other writers have examined the connection between magic and technology in much closer detail than I have in this thesis. Erik Davis's (1998) *Techgnosis* is perhaps the most comprehensive, but Dery (1996), Wertheim (1999), Serres (1995) and Noble (1997) make major contributions. I feel my work on invocational media complements, and is itself strengthened by, these recent works.

At the same time, invocational media are also characterised by the far more instrumentalist machines of command. Commands are a mode of expression most common within hierarchies. Hierarchies include both technological and human components, especially in the military. As I argued in Chapter Three, the development of invocational media has been very much embedded in social and military hierarchies. Digital computers displaced human computers, who were themselves already at the bottom of a social relationship of delegation.

The most significant thing delegated to invocational media is delegation itself. Detailed commands can be stored up and distributed indefinitely, often with minimal human intervention. Some systems operate in real time, invoking environments that mediate perception and action. Delegation is as much about persuasion or coercion as it is about articulating instructions clearly. As Kittler says, '[u]niversal discrete machines settle the old question — how to make people die for others' (Kittler 1997: 118).

However, while both the magical and military associations with computers are fascinating, this thesis is not primarily historical. Rather, its main project has been to build a concept that captures the distinctiveness of invocational cultural and technical assemblages. Invocations are distinctive events that are simultaneously technical and cultural. Invocational media mediate these events. In refusing to separate technology from language, culture or society, I am arguing that both social and technical factors have non-trivial consequences. So while invocational media may have answered existing cultural desires, they also have unanticipated consequences that emerge from technical characteristics. I have been influenced by actor-network theorists in taking this approach. Invocations are mediated through composites of human and non-human actors.

Using the concept of invocation, then, I have traced connections between the technical level of microelectronics, the experiential level of computers in use, the intersubjective level of the cultural imaginary, and the political level of social institutions and power. In this way, the thesis has made connections between a wide range of literatures: from technical manuals to political manifestos! With the breadth of this sweep, there remains plenty of scope for further work that might deal in more depth at many of these levels.

With such a broad field, this thesis has not been able to give a comprehensive periodisation of invocational media forms, preferring a diverse sampling of case

studies, each of which helps build the concept. For example, I used electronic mail as an example to develop the concept of invocationary acts — language acts which are simultaneously commands to a machine, and meaningful utterances to others (pp. 196–198). I used the computer game *Pong*, and the graphics program *Adobe PhotoShop* to illustrate the concept of the invocational aesthetic (pp. 283–287) — an aesthetic that emerges in use, rather than the computational aesthetic, which seeks explanations for beauty in pure mathematical forms. In Chapter Two it took several examples to show how at different historical moments invocational media have invoked such varied contemporary cultural tropes as intelligence, Big Brother, popular culture, magic and space.

Although the concept of invocation is broad-reaching, it is not an epochal grand theory. Many works dealing with new technologies seem to characterise historical shifts as though they begin as large scale cultural transformations, and go on to infuse every corner of the world. McLuhan's age of electric media, Daniel Bell's postindustrial society, Lyotard's postmodern condition, Mark Poster's second media age, Baudrillard's orders of simulacra, and Deleuze's control society (Bell 1973, Lyotard 1984, Poster 1995, Baudrillard 1983, Deleuze 1990B) all identify substantial historical changes associated with new media. However, these concepts often remain somewhat monolithic in nature, in spite of the examples and arguments that each uses to try to back up the wider assertion. While invocational media forms certainly have been associated with dramatic cultural and even ontological changes, this thesis does not rely upon making larger claims about the 'age' or the 'society'. It is possible that it might be compatible with some of the works that use this common strategy of labelling an era or a civilisation, but it does not itself make such a claim.

Instead, invocations are tiny events that work in combination with billions of others to mediate events in a range of complex and sometimes contradictory

ways. This approach of conceptualising complexity as something emergent has more in common with Latour's 'programs' (Latour 1991) and with de Landa's 'non-linear histories' (de Landa 1997) than with top-down explanatory models. It is certainly clear that the complete designs for the invocational assemblages of 2001 were not available in 1945. Rather, development proceeded in complex and iterative ways, often in multiple directions simultaneously, and often being itself subject to the dynamics of invocation (computer-aided software engineering, computer-aided design/computer-aided manufacturing). Small differences in initial conditions could have produced quite different outcomes in what invocational media have become. Today's PCs are not the optimal design of all possible computers, but a result of cumulative, non-linear dynamical processes. Seeing change in this way is sympathetic with some of the more interesting new work in the field.

The theory of invocation offers some ways of evaluating new media forms that may appear in the future. For example, while the recently developed standards for digital television use computers to manage transmission and reception of signals, they remain fundamentally a broadcast medium. Although these systems are 'digital', they are not invocational. Digital television is simply another form of broadcasting, with some invocatory options for viewers, possibly improved reception, and (sometimes) higher definition. It is less likely to change media consumption habits (particularly in Australia with the constraints the Federal Government has imposed (Parliament of Australia 2000)). The Internet, especially with broadband, remains the most prominent emerging truly invocational medium.

To choose another contemporary example, while DVD-Video seems to be a direct replacement for video cassettes, they may in fact be quite a different medium, moving away from conventional cinema. The invocatory functions of changing angles, branching narratives and alternate sound tracks, while not

invocational, certainly are not cinematic. However, the decisions that drove these standards were not only aesthetic, but also economic. They were motivated by a desire for a new format that would encourage consumers to buy new copies of movies that they already owned on video, or had seen in the cinema — another example of invocations from the past.

The concept of invocational media can also help ask ethical and political questions about particular technical implementations. Modes of *n*th orality create any number of technical forms/social situations. Each mode can be evaluated according to how avocational structures position different classes of user. Avocational structures can be assessed by their user modes, which determine what and how a user can invoke at any moment. This approach can incorporate the controversial concept of privacy, but go beyond it towards more subtle readings of usergenesis — the processes by which user subjectivities are generated.

The concept of invocational media offers a way out of some long standing controversies. Artificial intelligence, virtual reality and artificial life are three contentious fields based on claims about the capacity of computers to reproduce 'real world' phenomena. The debates about these have tended to polarise into more or less sophisticated slanging matches for and against. Invocational theory resolves this by concluding that these fields are better conceived as invoked intelligence, invoked reality and invoked life. The distinctions between human and machine intelligence, VR and reality, life and A-life, do not have to be absolute. These technologies never will exactly reproduce the phenomena they claim to model, but the work they do in trying to invoke these things will have real effects. Of course this observation won't stop the debate, but it will offer those who are tired of them a way to move on to more interesting questions.

This may be the end of this thesis, but in many ways it is only the beginning for the concept of invocation. This work is not a complete program or theoretical model, but an intervention into the discourse around new media forms. If it is taken up by any other writers, it will be transformed into something else again. However, the concept itself could function as a genetic element in future work in media and cultural theory.

If Jeannie and the Muses are any precedent, invocation has a genetic predisposition to longevity. Although *I dream of Jeannie* went out of production some thirty years ago now, she lives on — in television re-runs, video tapes, and several official and unofficial websites. The Muses, too, continue to recur, not only in Ancient History texts, but also recently as an English band ('Muse') and a (forgettable) Al Brooks comedy starring Sharon Stone (*The Muse* (1999)). Irrespective of the life of the concept, though, the technological lineage that I have dubbed 'invocational media' will undoubtedly continue to be a powerful component in cultural, economic and social practices into the foreseeable future.

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