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Forging Chrome:

Media Influence on the Technological Development of Virtual Reality Systems

by

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Abstract

The development of any new technology draws on varied sources of inspiration. An example can be seen in how current computing technology now exhibits functionality that was confined to the realm of science fiction less than fifty years ago. However, the processes by which these ideas shift from are taken from science fiction and turned into reality is under-explored. These processes often exhibit evolutionary characteristics, occurring via the accumulated change over time of the technology and literature. The question of how this process occurs remains unasked: how have contemporary designers of virtual environments been influenced in their design by literary examples in science fiction? Using the cultural evolutionary framework of memetics to trace the connections between the fields of technology and literature can demonstrate the points where the different fields interact. My thesis constructs a historiography of the computing industry in the 1980s to examine the parallels between the works of fiction and the actual implementations of virtual reality. As the memes from science fiction are highlighted within the historiography, they reveal an inextricably intertwined act of mutual co-creation, as both cultural and technology influence each other in an ongoing evolving process.

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Chapter 1

Introduction

> "When Neuromancer appeared it was picked up and devoured by hundreds, then thousands, of men and women who worked in or around the garages and cubicles where what is still called new media were, fitfully, being birthed; thousands who, on reading his [description of cyberspace], thought to themselves, That's so [expletive] cool, and set about searching for any way the gold of imagination might be transmuted into silicon reality." (Womack, 2004)

1.1 Research context or problem

Jack Womack's above quote succinctly describes the effect that William Gibson's novel *Neuromancer* had on those working in the high-technology sector in the 1980s. But the process by which "the gold of imagination might be transmuted into silicon reality" is left unexplained, and in the field of innovation studies, the role by which media may influence technological development is underexplored. It is readily apparent to any casual observer that the household and handheld objects we use on a daily basis now exhibit functionality that was confined to the realms of science fiction less than 50 years ago. Science fiction then, may have some influence on the manner in which a new technology is developed. The question of how these technological changes have come to pass and by which processes this influence occurs needs to be explored.

In order to ensure this project is manageable, one specific technology and its media representations will be examined. Jack Womack made a rather Heisenbergian assertion that the science fiction stories of the 1970s and '80s were the impetus for the creation of at least a few of the modern forms of computerized virtual reality (VR). His hypothesis is representative of a range of opinion on fiction's role as a source of technological change, and presents a potential avenue of exploration. There are a number of media sources available that can be drawn on to allow the following question to be asked: How have contemporary designers of virtual environments been influenced in their design by literary examples in science fiction?

1.2 Research objectives and questions

My objective in this project is to build a narrative that can identify and trace the paths by which the evolution of virtual reality, as both an idea and a technology, has taken place. The concept of VR has been transferred between the media, the designers, and the technological instantiations, over and over again in recurring cycles. This narrative will provide a point of reference allowing the processes by which media influences innovation to be highlighted. I am not attempting to say that this study of virtual reality technologies is the only example of media influence on innovation, nor am I suggesting that media influence is the only way the ideas that give rise to innovations are communicated. Rather, I am suggesting that media presents a fruitful avenue for the study of technological evolution, as it illuminates the close ties between cultural and technical change, and may also shed some light on the underlying evolutionary mechanisms.

However, tracking the influence that media may have on an audience over time—an audience that can include the developers of a technology—can be problematic. Research into media usage has been irrevocably polarized by the 'effects' paradigm put forth by Gerbner and other researchers in the 1960s. By positing that media is highly influential and uses that influence to negatively effect the audience relative to the normative view of culture is to argue that the researchers presuppose media usage—be it television, film, comic books, or rock-n-roll—be demonized as harmful to the audience involved. Despite numerous studies, there has been little or no concrete evidence for their results, and a number of methodological problems with their empirical research has been brought to light (Gauntlett, 2005). I intend to stay clear of the effects line of research, and instead focus on an alternative line of thought in which media may provide a beneficial influence in people's lives (Dill, 2009). In order to clearly demarcate the difference between the two extant media theories and my research, I will clearly label the term as 'media influence' at every opportunity.

1.3 Definitions

Given the complexity of the task ahead, functional definitions of the key concepts of evolution, technology, and culture are needed. Evolution often gets attached to theories as a shorthand for "change over time" (Vromen, 2007), but a more full-featured definition is in order for my work here. While the theory of evolution originally arose from the study of biological creatures—and a number of definitions presuppose that—any definition of evolution that would be usefully applied to fields of inquiry as varied as technology and culture would need to be relatively "substrate neutral" (Dennett, 1995, p.353), and functional regardless of the characteristics of the evolving entity. To this end, a functional definition of evolution, such as that proposed by Richard Lewontin, may suit my purposes. He defines evolution as the adaptive change over time of an entity, occurring when the three conditions of Variation, Heredity (or Replication), and Differential Fitness are met (Lewontin, 1970).

Culture also has a myriad number of definitions, depending on the standpoint of the researcher. Many of these focus on the informational characteristics of culture. This ranges from defining culture as extra-genetic “transmitted information” (Aunger, 2002) through to “…information capable of affecting individual’s phenotypes that they acquire from others by teaching or imitation.” (Aunger, 2002, p.50). A more inclusive, feature-complete version of the above can be seen in Boyd and Richerson’s definition, where culture is “information that people acquire from others by teaching, information, and other forms of social learning” (Boyd and Richerson, 2005), and this is the definition that will be used throughout the thesis.

With respect to technology, a shift has taken place away from viewing just the single artifact and towards a holistic view of technology as a complete system. The artifactual definition, such as Feibleman’s “the inventions & usage of artifacts materials altered by human agency for human usage.” (1982) is too instrumental—it misses the point on how there is more to a technology than just the item itself. Similarly, alternative definitions from the field of Science and Technology studies can be so broad and ambiguous as to leave out the artifact entirely, as can be seen in John Laws’ definition of “a family of methods for associating and channeling other entities & forces, both human and non-human…” (Law, 1987). A combination of these two extremes may provide a useful definition. If technology is the material embodiment of an artifact and its associated systems, materials, and practices that is employed to achieve human ends, then the sought-after characteristics of both the artifact and the larger context are accounted for.

1.4 Literature review

There are two sections of literature that are relevant to the research question at hand. The first section includes the mass-mediated sources that contain the representations of virtual environments that end up being used as “key texts” by the creators and innovators. Several of these have already been selected, including “True Names” (Vinge, 1981), *Neuromancer* (Gibson, 1984), and *Snow Crash* (Stephenson, 1992). This section also includes recent work on the design of virtual environments by the innovators themselves. The relevant texts include biographies (Kushner, 2003), design manuals (Bartle, 2003; Crawford, 2003), historical accounts (Koster, 2004), and ongoing published accounts in magazines and industry journals (i.e. *Game Developer*, gamasutra.com, etc).

The second section includes the academic work that formed the basis for my theoretical approach. This covers the areas of research that intersect within this paper, including innovation and cultural evolution. The innovation work will provide a focus on the processes of technological change that the cultural approaches lack. Nelson and Winter (1982) use an evolutionary model applied to industry to explain economic change. Bassala (1988), Petroski (1992), and Arthur (2009) have also written on evolutionary approaches to technology. Finally, an examination of the role of technology as part of culture (Borgmann, 1984; Nye, 1994; Mosco, 2004) should provide a further link to the culturally-bound nature of technology.

Within the field of cultural evolution, the theory of memetics provides a cultural analogue to biological evolution (Dawkins, 1976; Dennett, 1995; Blackmore, 1999) and an exploration of how applicable its unit-based model of culture is to the disparate fields of media, innovation, and technological change is needed. Memetics may provide a method to track the interplay that occurs between the material and immaterial realms of implementations and ideas. There are some concerns with using a memetic approach as there are few empirical case studies that have been conducted (Edmonds, 2002), but the ones that do exist are quite instructive, as they provide a model for how a memetic approach might be used. (c.f. Drout, 2006; Leskovec et al., 2009).

1.5 Theoretical Framework

The key component of my theoretical framework is the memetics, as it provides a quantifiable, unit-based approach to cultural change by viewing it as an evolutionary process occurring over time. This time-based component is what separates memetics from other theoretical approaches grounded in cultural studies or the social sciences. The adaptive evolutionary framework of memetics is flexible enough to allow for the transgenic, boundary-breaking effects that I am looking for to come to the forefront. A broad evolutionary perspective is being employed to mitigate some of the perceived issues with memetics as a science, drawing from evolutionary theorists from a wide variety of sources (Gould, 2002; Smith and Szathmary, 1999; Watson, 2006; Margulis and Sagan, 2002).

1.6 Methodology

Building on a preliminary historiography I conducted on the timeline of the development of computer games, I will identify key texts within the science fiction literature that have been cited as influential (Drout, 2006). Using this historiographic framework, I situate the key memetic components of these texts, and use interviews, biographies, designer notes, and analysis of the implementations of virtual reality themselves to identify where these memetic components re-appear. This framework will use a descriptive, bottom-up approach, as suggested by Gaddis (2002) with respect to history, as well as by Latour

(2005) and Law (2004) with respect to the social sciences. This approach should provide a broad overview of the technical and cultural change that occurred in the development of virtual reality technologies.

1.7 Goals and Contributions

Based on the above theoretical framework, I hope to be able to make contributions to the literature in the following 3 areas:

1. <u>Innovation</u> Within the field of innovation studies, literary and social factors are often ignored, or at best assumed as inputs in the process. When studies on innovation do explicitly mention communication channels, such as in Rogers (1983) work on diffusion, they are often focused on a product-centric approach to innovation, and not on the procedures by which innovation occurs. By focusing my research on the processes by which the innovations emerge, and not on the actual products and artifacts themselves and how they diffuse, a different perspective on how innovation takes place can be brought into the literature. I am not looking at how the innovative ideas spread, I am interested in *how ideas breed*.

2. <u>Media Influence</u> By recognizing the critiques of the "media effects" models, and avoiding the pitfalls raised by Gauntlett (2005) and others, I seek to shed some light on the positive influences of media use, in particular that of science fiction literature. While some work has been done in this area (Bainbridge, 1986; Kirby, 2003), it has only been done for a few select technologies, so much still remains to be explored.

3. <u>Memetics</u> The field of memetics has been relatively quiescent in recent years, since the closure of the *Journal of Memetics* in 2005 due to the lack of quality submissions. The term is still in use, with recent books by some of the particulars in

the field (Dennett, 2006; Dawkins, 2006) still using the term. But memetics is still used as a conceptual metaphor that is assumed proven *a priori*, and many of the criticisms laid against the field by Edmonds (2002, 2005) have not been answered.

By keeping the research focus narrow, and conducting a rigorous approach to the methodology, I hope to address Edmonds' (2002) criticisms of the field, and demonstrate a reliable way to conduct memetic-oriented research. Edmonds challenges are, in brief, to: 1) provide a conclusive case study; 2) theoretically demonstrate when a memetic model is appropriate; and 3) create a simulation of the emergence of a memetic process. Meeting the tasks of challenges one and two should occur by necessity in completing this paper, and while option three may be beyond its scope, developing a simulation would not be precluded from happening in later follow-on works.

1.8 Outline

The remainder of this thesis proceeds as follows. Chapter 2 examines the state of the current literature on technological evolution, historical accounts of computing and virtual reality, and how the mythic potential of cyberspace as presented in science fiction literature affects the work of the technological developers.

Chapter 3 covers the theoretical approach of memetics as a specific cultural evolutionary theory. How memes are an example of—and can be applied to—the study of media influence on technology will be examined. Problems with the implicit assumptions that underlie memetics' evolutionary metaphor for cultural change will be addressed by current empirical analyses of memes in a historical context, and opening up memetics to the full panoply of evolutionary mechanisms. How the historical method works with a memetic framework in the context of this paper concludes the chapter.

Chapter 4 presents a linked narrative of the development of the personal computer and virtual reality computer systems that occurred during the 1980s based on a historiography of that era. The multiple implementations of the vision of cyberspace that arose from the literary texts—the memes they generated—are outlined as exemplars of this evolutionary process.

Finally, chapter 5 will conclude the paper with an analysis of the memes that were uncovered in the previous historiography, a summary of the implications this may have on innovation and cultural evolutionary research, and the potential for further research using either the topic, theory, or methods employed in this thesis.

Chapter 2

Technical and Cultural Evolution

My inquiry begins by surveying the literature of technological change. Technological change may be evolutionary in nature, but even if one assumes this is true, how could you tell? Indicators of evolutionary change within a technology are not always readily apparent—certain characteristics may be obfuscated by the "black box" of the technological form. Many artifacts provide a black box that could be opened up—the personal computer is one such modern technology. But narrowing a field as broad as computing down to a specific example is necessary. Virtual reality and its related systems may provide just such an example. Virtual reality has the added feature of having been depicted in cultural products on a number of occasions, but choosing from amongst the available sources and determining how they may influence technological change could be challenging.

This chapter examines the literature that explores technological change, and how technology and culture are inextricably intertwined. With computing being one of the defining technologies of the current era, a study of a specific type of computing technology may prove fruitful for examining this trend. To this end, virtual reality (VR), a computer-mediated simulated environment, provides one technological system that can be used as a case. As much of the technology behind VR is tied to that of the personal computer, a brief overview of their shared histories is required, and this historical approach informs the choice of method. The chapter concludes with an exploration of literature's role as a cultural artifact, and how science-fictional representations of a technology are relevant to the study of that technology.

Throughout this thesis, the standpoint of the developers is of primary interest due to the agency that they employ in the creation of new technologies, an agency that can be seen in their personal accounts. As Hafner and Lyon (1996) explore in their work on the origins of the modern Internet, there was a strong subculture that was "tuned-in" to the science-fictional and fantasy literature of the day. These groups and their outside interests led to the programming of the first networked computer games. For example, Will Crowther wrote *Adventure* part-time in 1976 in order to have something to play with his kids, and the discovery of his work on the company mainframe led to it becoming the most popular application his employer had (Hafner and Lyon, 1996, p.206).

2.1 Technological Change

Computers have been lauded as one of the defining technologies of the 20th century. One of the most obvious characteristics of personal computers is how much they have changed in the 35 years since their introduction. True, this change does not often manifest externally—the same basic beige or black boxes with keyboards and screens still abound. But the internal change in capabilities and functionality has been enormous. This internal, obfuscated change is what Albert Borgmann would say is indicative of the computer being a 'device': a technological artifact that has a "sharp internal division into a machinery and a commodity procured by that machinery" (Borgmann, 1984, p.33). This commodification of the computer is key; the ability to treat it as an interchangeable, fungible item has led to its swift adoption and near ubiquity.

Despite maintaining this relatively static form, the capabilities inside the "black box" have changed substantially. A current computer from 2010 is approximately 2,000 times faster, with 60,000 times more memory, for a price that is approximately seven one-hundredths that of the equivalent 1977 hardware component. The maxim of Moore's Law regarding the doubling of computing power every 18 months has largely held true since the law was introduced in 1965 (Chesbrough, 2003, p.114). A modern computer can draw high-definition images in millions of colours faster than the human eye can perceive them. The internal components of the system have "changed radically without threat to the identity and familiarity of function of the device." (Borgmann, 1984, p.43).

The effects of media on the external aesthetic characteristics of the computer have been explored—these are largely what we would consider 'fashion' (Chapman, 2006)—no effect is had on the functional capability of the device. The changes that have happened occurred internally, which Borgmann sees as having been 'concealed' or subsumed into the device (1984, p.44). These internal changes can also be driven by media and exhibit evolutionary qualities. It is this tripartite interplay—of evolution, technology, and media—that drives my current inquiry, and each area shall be examined in turn.

2.1.1 The Study of Technological Evolution

Current theories of the evolution of technology largely fall into three camps. The majority of these theories are device-centric, or technology focused. Other theories approach changes in technology from an environmental standpoint, where changes in the firm, the economy, the landscape, or other extrinsic forces drive the change. The last group focusing on technological change view it from the point-of-view of the social drivers: the fields of Science & Technology Studies including theories on the Social Construction of Technology (SCOT) (Bijker et al., 1987), the Social Shaping of Technology (SST), (Mackenzie and Wajcman, 1985) & Actor-Network Theory (ANT) (Latour, 2005).

The technology-centered approach has an engineering or design-oriented background. It stems from observations conducted by people involved in technological development on the processes of development itself. Early theorists include Bassala (1988) and Petroski (1992). As befits the positivist and instrumentalist framework that underlies these engineering and design disciplines, the tech-centric standpoint has a very deterministic approach—the technology itself is seen as a causal agent, affecting the social and cultural milieu in which it is situated. But this standpoint of technological determinism is not limited to the hard sciences. Authors outside the hard sciences with a similar viewpoint include Ellul (1967), McLuhan (1964), and Rogers (1983).

The second approach towards technological evolution is one that takes the technologies' surroundings into account. It paints a broader picture which includes economic and environmental factors—extrinsic forces that influence the design and deployment of a given technology. This approach does not by necessity require a deterministic approach, but it does lean that way more often than not. Though there is some overlap with the previous tech-centric group, these individuals are largely focussed on forces outside the technological framework as drivers of technological change. Authors in the field include Nelson and Winter's work on the evolution of the firm (1982), Brian Arthur's works on path dependency and technological evolution (1989; 2009), and Rogers' (1983) work on the diffusion of technology.

The third approach is that undertaken by those who emphasize social change. This has a large buy-in from the Science Studies fields, including authors in the STS and SCOT fields. Authors include Latour (2005), Law (2004), Bijker et al. (1987), and others. Their work is often about a specific artifact or technological system, looking at how the social relations of actors situated in place and time influences the development of that technology.

While a media-driven approach could straddle the boundaries between the second and third groups above, a different theoretical approach may be needed. While the media is a component of the environment, true, it is only one among many factors. Isolating "the media" from other environmental effects can be problematic (Garnham, 1990, p.6). Little work has been done on how science fiction influences technological change—notable stand-outs include Bainbridge's work on the influence of early science fiction on the development of the Apollo Rocket program in the United States (Bainbridge, 1986) and Kirby's work on the role of science consultants in film production (Kirby, 2003). While the above are good and relevant works, neither work uses an evolutionary approach, and their lack of adoption by the mainstream science studies fields without a critical dismissal of their work suggests that more emphasis on the importance of media on development is needed.

When Jacques Ellul spoke of technical change, he likened it to a "self-generating process", noting "[technology's] evolution ... is progressing almost without decisive intervention by man." (Ellul, 1967). This requires further explanation. The manner by which this 'decisive intervention' is occurring is tangential to the common narratives of technological development. The intervention comes through the form of influence, of a subtle shaping of our desires, on the part of both the developers and the technology at large, through the media by which the populace comes to know of the technology.

George Bassala felt that technology changes in an incremental way. He bases this on the work of Augustus Pitt-Rivers, who explains, "the form of a modified artifact was based on that of a pre-existing predecessor." (Bassala, 1988). Moreover, Bassala felt the myth of the heroic inventive genius, nationalistic pride, and the patent system has done much to obscure the technological continuity between artifacts. For Bassala, there is no room for the radical breakthrough. There are no “eureka” moments, only gradual change (Bassala, 1988).

Henry Petroski takes Bassala’s idea further. He views technological evolution as driven by *wants* rather than *needs*. When an artifact is lacking in some way, if it is imperfect, then we want it to do something more, or something different. This is when change occurs. For Petroski, “Luxury, rather than necessity, is the mother of invention”. (Petroski, 1992)

Rounding out the look at technological evolution, Brian Arthur notes, “Early technologies form using existing primitive technologies as components. These new technologies in time become possible components—building blocks—for the construction of further new technologies” (Arthur, 2009, p.21). Arthur calls this *combinatorial evolution*, and notes that this combination has much in common with a Schumpeterian conception of change (Arthur, 2009, p.19-20). This combinatorial evolution is remarkably similar to the biological evolutionary processes that have been dubbed “compositional” (Watson, 2006), and this provides a remarkable degree of consilience between technological, cultural, and biological evolution.

For Arthur, technology is a singular item, a device supplying functionality through execution of a process (Arthur, 2009, p.29-31). This definition allows for methods of use to be included, and there comes a point in time where the technology is “complete”. The artifact has become situated and reified, and any further change is either cosmetic, or results in a new technology. At this point, the technology in question is much the same as Borgmann's "device" (Borgmann, 1984) mentioned earlier. This provides a further point of consilience: technologies evolve when they become devices, embedded in the background, and are then combined into new technologies.

2.2 A History of the History of Computing

Modern computing is an incredibly broad field—it suffuses nearly every aspect of the late modern period. Many of the historical accounts of the development of computing manage this breadth by focussing on a specific firm or institution (e.g. Swisher (1998, 2003); Gawer and Cusumano (2002) & Stauffer (2000)), a particular instance (or type) of technology (e.g. Freiberger and Swaine, 1984; Hafner and Lyon, 1996; Zygmont, 2003), or a certain viewpoint (e.g. Levy, 1984; Chesbrough, 2003; Chapman, 2006). Their narrow focus tends to occlude the view of the larger picture of computing, but the authors cannot be faulted for this due to the scope of the subject. And while there is much useful historical information available, the Whys of a particular development get lost in the Whos, Whats, and Hows. The causative process of technological development gets subsumed in the narrative, and the method by which modern computing came to be falls to the tired tales of 'great men of history' (Garnham, 1990, p.12).

In order to avoid these tired tales and get a clear picture of the evolutionary development of computing technology, two things will be needed. One, a focus on a specific type of computer technology: the field is too broad and complex to be dealt with otherwise. Secondly, the computing technology must have appeared in both the science fiction and computer history literature somewhere, providing enough references to see how the technology has developed over time. Following the trail of development of this specific technology should tell the story of what the developers were trying to achieve—and what actually came to pass. How these narratives differ will illuminate the historical traces of the co-evolutionary processes of culture and technology.

As a technology that appeared readily in the science fiction literature, Virtual Reality enjoyed several different formulations, and texts that employed the metaphor of 'cyberspace' were abundant during the 1980s (Benedikt, 1992). As the technology to provide a VR experience employed an assembly of several different computing technologies (Rheingold, 1991), there are concerns that it may be too broad or diffuse to treat as a single 'technology', but as Raymond Williams notes in his study of television, any developing technical artifact is usually assembled out of extant technologies, so it must be taken into account (Williams, 1974).

Virtual Reality (VR) encompasses a range of technologies that are available to most computer users, and includes several specialized devices for input and output that enable the computer to simulate some aspects of reality. A rather textbook definition of VR is:

> Virtual Reality is a high–end user–computer interface that involves real-time simulation and interactions through multiple sensorial channels. These sensorial modalities are visual, auditory, tactile, smell, and taste. (Burdea and Coiffet, 2003).

The overall goal of virtual reality is simulation: representing other times, places, or events, either real or imagined, that the user might not have access to normally (Heim, 1993). This is accomplished via digitizing the essential components of the experience so that they may be rendered through computer technology. VR encompasses multiple related technologies that enable this simulation through stimulation of our senses; facilitated the other requirements of a fully-realized world such as feedback, immersion, and telepresence; and providing networked communications so that one wasn't simply trapped in a solipsistic existence when in the virtual world (Heim, 1993, p.109-116). These seven goals—Graphical Representation, Interaction, Immersion, Networked Communications, Connectivity, and Spatial Representation—comprise the different paths towards which VR development has been directed.

In order to achieve these goals, various designs have been implemented, including having a VR user wear a head-mounted display and a wearable suit and gloves that provided tactile feedback, to Myron Krueger's work in creating a room which projected an image onto every surface and included surround-sound audio, so that the user was completely immersed in the artificial construct (Rheingold, 1991). Either of these was connected to an array of computers which would provide the necessary imagery and sounds, and run an instance of the 'world'. This array of computers is a subset of systems that comprise the core components of VR technology.

Ivan Sutherland's work on the subsystems of VR (in Utah in 1970) exemplified Raymond Williams' notion of how a technology was assembled (Rheingold, 1991, p.105)—he figured out what he wanted to do, assembled the existing technologies he needed, and then tackled the technologies he would have to invent. Sutherland determined that any virtual reality system would need to consist of six technological components. These included a matrix multiplier, able to handle the complex three-dimensional math; a vector generator, to generate the world based on the matrix co-ordinates; a clipping divider, which eliminates unseen lines in the virtual world; a headset to provide binocular vision to the visitor to the virtual world; a head position sensor; and a general purpose computer to co-ordinate the above subsystems and provide additional information about the world. (Rheingold, 1991, p.106-109) At the time, each of these components needed the resources of one complete computer subsystem. Over time, they could be reduced and optimized, but they would still be necessary.

2.3 The Computer in Science Fiction Literature

Despite the repeated attempts at development, virtual reality has not yet been fully realized and implemented as envisioned. The technology is still a moving target. As Borgmann would define it, VR has not yet become a 'device'. While computing has changed in significant ways in the last 35 years—most notably in portability, ubiquity, and embeddedness—certain potential uses remain out of reach. They are not closed off as avenues of development, as potential technologies, as if society were locked-in to travel a certain path, but the visions remain distant and mythic, and the drive to implement them may be due to some of that "old-time religion", that mythic fervour. It is through this mythic dimension one must travel to uncover the literary sources of virtual reality.

This mythic dimension is where imagination comes to the fore, and surfaces in our cultural artifacts, such as literature, the arts, films, and song. As Bruce Sterling points out, "Motives are found in the desires of humankind." And where should these motives be sought? "The most fertile ground for analyzing motives is pop culture—not because pop culture is deep, but because it's so shallow. It's where those wishes and longings are most nakedly evident" (Sterling, 2002, p.xii-xiii).

Marvin Minsky makes a similar note about culture's influence on development. He asks: "But where do we get the new ideas we need? [...] most concepts come from the societies and cultures that one grows up in" (Minsky, 2001). It is in our early tales where the mythic dimension is breached. "Our contemporary age is one that stands in awe of the power of imagery" (Hutton, 1993, p.89). If one can harness this imagery, then one can shape the myths that arise. They remind us what is *possible*.

Because these myths are so primeval, so ancient, they are reflected again and again in our histories. Following this "river of history", as Halwbachs would say (Hutton, 1993) allows us to retrace these steps and plot out the "notable landmarks along the journey". While it is self-evident that a historical approach is useful in uncovering the past, a number of modern historians have provided some particular insights. Among them, Gaddis (2002); Hutton (1993); Breisach (1994) have all noted particular ways in which the methodology of history might be employed in aid of the pursuit of either the recent or mythic past. Michael Drout has also looked at the historical record of tenth-century England through monastic literary sources (Drout, 2006), and provided a useful overview of how the literature of the time affected the culture of the monasteries.

History provides a way of understanding an era, whether it is through the people, the places, or the objects that are observed. Hutton notes "we no longer have a strong sense of the places of our memory. . . . it reflects the nature of memory in an electronic age in which the elements of tradition are continually broken up and reused in the kaleidoscope of reconfigurations by television and other electronic media." (Hutton, 1993, p.166). History is a way we as a culture can learn and construct even our recent past. History becomes "the study of imaginative representations for what they reveal about the modifications of collective memory as it is borne forward in living tradition." (Hutton, 1993, p.89). Literature is a source of these imaginative representations.

2.3.1 Literature as Culture

What is the primacy of literature as a cultural artifact, and what special role does a text play when in the development of a technical innovation? The role literature takes in this instance is that of an exemplar. It points forward toward a daring, imaginative goal that may not be achievable, but at least gives those who may be in a position to enact change something to aim for. As Northrop Frye notes "[the written word] re-creates the past in the present, and gives us, not the familiar remembered thing, but the glittering intensity of the summoned-up hallucinations" (Frye, 1981, p.227). It is in this role that fiction finds itself: as creator of those prophecies that contradict the conventional wisdom. For it is these "contradictions and oxymorons often signal future opportunities. They suggest that something formerly unthinkable is within humankind's grasp." (Sterling, 2002).

Echoing the words of Northrop Frye (1982), J.R. Saul elaborates: "[fiction] often reveals to us a greater understanding of our own society as it functions today. In other words, great fiction can be true for its time, as well as somehow timeless, and true for our time." (2001, p.205). This then is the basis of my research. A technical document on the creation of the Internet, of the virtual reality spaces that have since come into being will necessarily be dry and dull, and fail to capture the imagination of those involved. Literature, however, can have a lasting effect:

> Decade-old serious 'non-fiction' often seems arcane, irrelevant. The written style itself seems to become old-fashioned. Two-centuries-old decent 'fiction' on the other hand can easily remain fresh. It often becomes our principal source of understanding for its period and place. And [fiction] often reveals to us a greater understanding of our own society as it functions today. In other words, great fiction can be true for its time, as well as somehow timeless, and true for our time. (Saul, 2001, p.205)

The key concern here is deciding which books should be chosen; which sources are relevant to the study at hand. The most obvious literary works with a broad technological theme is the genre of science fiction, but even within this field the works can vary considerably in scope and detail. Examining the science fiction that was relevant during the key developmental era of the computer narrows the focus. There were a number of relevant titles produced during this period, titles which have been widely cited and are representative of both the genre and the mythic ideas mentioned above. Vernor Vinge's "True Names" (1981), William Gibson's *Neuromancer* (1984), and Neal Stephenson's *Snow Crash* (1992) are all seminal stories of the computer generation of the 1980's, during which many of the later designers of VR systems grew up and/or attended school, and as such were in a position to be influenced by the work they read. Further, these books were award winning and highly touted, with a large readership (though Vinge's "True Names" did have some circulation problems due to the format) (Frenkel, 2001, p.11). Finally, all three stories were highly evocative and metaphoric: they were tech-centric, without getting too deep in to the details, which can date a book, and hardly ever comes true in the way it is envisioned (Womack, 2004).

2.3.2 Paucity of sources

Part of the problem with studying the effects of media on innovation is the shortfall of sources and first-person accounts. In accounts which are generally framed towards technology as a whole the influence of media may be mentioned, but often only tangentially, i.e. as conjecture. The processes of media influence are not explored in depth. For example, *Wired for War* (Singer, 2009) includes a chapter on science fiction, but merely lists the extant forms in various media. Similarly, there are multiple books dealing with *Star Trek*'s technology (Gresh and Weinberg, 1999; Krauss, 1995; Shatner and Walter, 2002) but even these look at the connection on a surface level. Finally, some work has been done on the science fiction's influence on the American defense industry, and specifically DARPA (Defense Advanced Research Projects Agency) in developing next-generation weapons like the Star Wars initiative (Edwards, 2005; Franklin, 2008). These works are interesting and relevant, but unfortunately draw only the most tangential of connections between media and technology, ignoring the processes by which this influence might occur, and don't really relate to the specific technologies under observation.

Of the computer-related texts, more has been written, but many of the sources touch on the role of literature in only the briefest of ways. They'll include an obligatory reference to William Gibson's *Neuromancer* and its role in coining the term 'cyberspace', but little else (examples include Murray (1997) and others). A different range of sources needs to be examined. The histories of computing mentioned earlier (e.g Freiberger and Swaine, 1984; Levy, 1984; Hafner and Markoff, 1991; Hafner and Lyon, 1996) offer an alternative source, but these are more instructive in detailing the development of the technology itself.

Chapter 3

What Can Memetics Contribute to the Study of Innovation?

3.1 Theory

Given the strong ties between technology and culture, evidence of technical change may be visible in the cultural products of the society in which the technology is used. One approach to cultural change would be to study it from an evolutionary perspective, but this begs the question as to how cultural evolution may be observed. A number of different theories attempt to explain cultural evolution; finding a theory that incorporates both technology and literature is needed. Memetics is one theory of cultural evolution that meets this criteria, but there are drawbacks to using this approach. What these drawbacks are and how they can be mitigated needs to be understood before the theory can be applied, and identifying a method by which the memes can be identified and studied is necessary.

The following chapter briefly outlines the history of cultural evolutionary theory (CET) as a discipline, and how the current assumptions about the field were formed. Key components of the memetic subset of cultural evolutionary theory are looked at, as are the objections to memetics that are raised by critics both internal and external to the field. An examination of several recent workable empirical studies of the memetic diffusion of culture (Drout, 2006; Leskovec et al., 2009) are conducted to determine their relevance and applicability to this study, and an alternative explanation based on the work of Gray et al. (2007) and Watson (2006) will be explored. The method by which this study was conducted concludes the chapter.

3.1.1 A brief history of Cultural Evolution

Early attempts to treat culture as its own distinct field of study came with the rise of the discipline of anthropology in the late 1800s. Early work by Franz Boas and others sought to describe the cultures under observation, but it wasn't until the 1950s that the focus in anthropology shifted towards studying the processes of cultural change (Bloch, 2000; Plotkin, 2002). Cultural evolution didn't find its roots as its own field of study until the 1960s, when the field was influenced by the work of some population biologists. Using newly-discovered advances in tracing the human genome, they found that the previous extant theories on what constituted 'race' needed to be questioned, as their results could not be explained by biology alone (Aunger, 2002).

Several competing theories of cultural evolution were proposed during this period of the late 1960s and 1970s to account for the mechanisms of cultural change. They include sociobiology (Wilson, 1975), a geographical model of population change (Cavalli-Sforza and Feldman, 1981), a co-adaptive dual-inheritance model (Boyd and Richerson, 1985), and several models of cultural analogs of the gene. Work based on this latter concept included further work by Cavalli-Sforza and Feldman (1981) based around a model of the 'idea', Lumsden & Wilson's 'culturegen' model (1981) and the concept of the 'meme' as a selfish replicator (Dawkins, 1976). The single feature common to all these theories was the assumption of cultural change occurring. They differed in the processes and mechanisms by which that change occurred. Common to the latter theories was the search for a quantifiable 'unit' of culture, that could be examined empirically and that would bridge the gap that existed between the 'hard' and social sciences (Plotkin, 2002, p.11).

Rounding the corner into the late 1980s, there was still some jockeying for position amongst the theorists within the cultural evolution field, but Dawkins' ideas regarding memetics were beginning to take the lead. It likely wasn't due to any empirical reason; Dawkins simply had created (inadvertently or not) the 'stickiest' concept (Heath and Heath, 2007). The meme was easy to conceptually grasp, and the most rhetorically flexible version of the concepts put forth. By appropriating the metaphoric associations that academia had with biology and genetics, Dawkins' idea found fertile purchase in the minds of others. As noted in Mysterud's detailed analysis of the plethora of versions of CETs, by the mid 1990s even Lumsden had agreed that memetics had grabbed sufficient mindshare to be representative of the field, and conceded to memetics (Mysterud, 2004).

3.1.2 Memetics

The English biologist Richard Dawkins approach to cultural evolution was characterized by the existence of a self-replicating unit called the 'meme'. Dawkins developed this as an analogy for the 'selfish replicators' that he used to distinguish genes from other biological proteins. In effect, he gave genes and memes a degree of agency; anthropomorphized to the extent that they could be 'selfish'. "Memes. . . have their own ruthless ways of propagating themselves" (Dawkins, 1976, p.213) 'Fitness' of the entity was determined by looking through 'the meme's eye view'. Memes may include "tunes, ideas, catch-phrases, clothes fashions, ways of making pots or building arches" (Dawkins, 1976, p.206). Moreover, memes propagate themselves in the meme pool by "leaping from brain to brain" via a process of imitation. This imitation is the key, as it allows for replication to occur and fulfil one of the requirements of evolution.

Richard Dawkins altered his memetic concept in 1982's *The Extended Phenotype*, redefining the meme as: "a unit of information residing in a brain. . . It has a definite structure, realized in whatever physical medium the brain uses for storing information. . . .

I would want to regard it as physically residing in the brain." (Dawkins, 1982, p.109). This represents a small change at first glance, but one with rather significant implications. Dawkins made this change as he found the original definition "insufficiently clear about the distinction between the meme itself, as replicator, on the one hand, and its 'phenotypic effects' or 'meme products' on the other" (Dawkins, 1982, p.109). This second definition will be referred to as 'Dawkins B' following the work of Gatherer (1998), with the earlier definition being 'Dawkins A'. As Gatherer notes, this subtle yet important distinction changed the discourse around the concept of cultural evolution. It separated the meme, the unit of cultural inheritance, from culture's place alongside humanity as the co-evolutionists thought, and increased the meme's agency, by which the meme could adapt on its own terms. Further, it introduced the viral metaphor, which was much more readily grasped by a lay audience which had been taught the germ theory of disease since grade school. For a world in the 1980s just starting to come to grips with the specter of HIV and AIDS, Dawkins' viral metaphor resonated with its audience.

Consolidation soon produced results, as a number of other authors began writing on the theme. Memetics spread out of the realm of biology and affiliated hard sciences, and began to be theorized by scholars from other disciplines, notably the cognitive sciences. This included the philosopher Daniel Dennett (1995), psychologists such as Susan Blackmore (1999) and Henry Plotkin (1993; 2002), and anthropologist Robert Aunger (2000a; 2002). Their efforts led to the various works becoming coalesced around a science of memetics, and the *Journal of Memetics* was launched in 1997. Each author expanded and refined the concept of memes, adding to or explaining the functionality with additional processes by which memes 'worked'.

In addition to the academic work that had expanded the theoretical underpinnings of the nascent science, several non-fiction writers approached memetics from the perspective of enthusiastic outsiders, and began employing the memetic analogy (c.f. Brodie, 1996; Lynch, 1996). As their work was made to be accessible to a broad audience, they had a large uptake and accounted for some of the growing popularity of memetics as a concept. Brodie's *The Mind Virus* (1996) focussed on the meme as a 'hot button', and he drew heavily on the evolutionary psychology discipline. Lynch's *Thought Contagion* (1996) focussed more on creating a typology by which the various memes extant in the 'wild' might be classified. Both heavily relied on the Dawkins 'B' metaphor of the meme as a viral contagion for describing the processes by which memetic transmission occurred, and this proved to be problematic, as it created some misconceptions of the field within the broader populace.

3.1.3 Memetic Theory

At its core, memetics is an evolutionary-based theory, using evolution's concepts to account for the change that occurs with the particular subject under observation. To this end, memetics attempts to be "substrate neutral" (Dennett, 1995) to allow for the application of evolutionary terminology to non-biological phenomena. Substrate neutrality presupposes that Darwinian mechanisms of evolution should be generalizable (Vromen, 2007), and this can be seen in the definition of evolution that Daniel Dennett cribs from Richard Lewontin. Evolution, the adaptive change over time of an entity, occurs when three conditions exist: Variation, Heredity or Replication, and Differential Fitness (Lewontin, 1970). In addition to being 'substrate neutral', this definition is 'process-oriented' which should allow it to be "perfectly adaptable to other realms of scientific inquiry" (Boyd and Richerson, 1985, p.11). As I am looking at evolution as it crosses boundaries between media and technology, this broad view serves well.

A memeplex is a set of interlocking and mutually supporting memes that make up a larger functional meme. First described by Dawkins when he revised his definition of the meme (Dawkins, 1982), the notable examples are those of complex cultural forms such as science or a religion (Dennett, 1995, 2006; Drout, 2006), which tend to get transmitted as a whole. From a technological standpoint, any particularly complex piece of machinery would become a memeplex (Blackmore, 1999), and this ties with Williams' concept of the 'technological form' as noted in Chapter 2. As Michael Drout notes, "Memeplex and meme are thus actually different names for the same sort of entities" (Drout, 2006, p.5), and in order to limit the needless additional complexity the singular 'meme' will be used hereafter.

Transmission of memes occurs through a 'vehicle', which is the 'vessel' or 'artifact' in which the meme is inscribed or embedded. A vehicle may also be purely informational (Aunger, 2002). Examples include Dawkins' list of 'phenotypic effects', which may be "words, music, visual images, styles of clothes, facial or hand gestures. . . .." (Dawkins, 1982, p.109). The potential for the memes to be embedded is of interest here, as it links the memes to the technology they are associated with. Daniel Dennett notes that memes can become embodied in pretty much anything, and the meme's existence is *dependent* on that embodiment (Dennett, 1995, p.348). If such is the case, then artifacts should show reflection of the memes embedded in them, which I will demonstrate in the following chapter.

The embodiment of memes in artifacts represents the inextricable intertwining of the linkage between technology and culture. This can be seen in the quote "A wagon with spoked wheels carries not only grain or freight from place to place; it carries the brilliant idea of a wagon with spoked wheels from mind to mind" (Dennett, 1995, p.348). It is through the technological form that a meme can be shared once it has found purchase with a developer of a technology. However, one must take care that the metaphor is not taken too far. Aunger's assertion that "memes learned to use artifacts"(Aunger, 2002, p.4) cites a level of intentionality to the meme that cannot be confirmed. Blackmore's concept of "temes"—"technological memes"—introduced at a TEDtalk in 2008 (Blackmore, 2008) also does this—adding additional complexity to the memetic concept by creating a special case without significantly proving the distinction between memes which are artifactually embodied and temes, or by doing the legwork to empirically show that the memes exist in technology in the first place. As argued above, part of the aim of this thesis is to demonstrate how the memes come to be embodied in the technological artifacts.

The chief mechanism by which memes propagate is through a process of imitation. Rosaria Conte has categorized a number of the processes by which this imitation occurs (Conte, 2000), drawing widely from the fields of social psychology and sociology. She rates each of the imitative methods on the degree to which they emulate the evolutionary characteristics of fecundity, fidelity, and heritability (similar to Lewontin's Variation, Heredity, and Differential Fitness that I am employing), and notes to which purposes these various methods may be employed. While of great use in determining the spread of a given meme, it is of limited utility in determining the genesis of the meme, or how they mutate and change, two factors which are important to this study.

3.1.4 The Trouble with Memes

As a relatively young science—and some would contest to whether it is even a science at all, (see Atran, 2002)—memetics has been fraught with problems. Its detractors are legion, but fall into two broad camps: those that have issues with memetics due to its intrinsic characteristics, and those that attack from outside the field. Of the two, the extrinsic ones are more narrowly defined, and will be dealt with first.

The extrinsic detractors of memetics have aligned themselves in three groups: biological theorists, objecting to the over-extensions of the biological terminology; anthropologists, who sense some territorial overlap in the disciplines; and other cultural evolutionary theorists, with their own particular ideas of how cultural evolution works. A fourth, theologically based group has attacked the memetic concept on what largely amounts to ideological grounds due to the criticisms of religion made by Dawkins (2006) and Dennett (2006), and may be ignored due to the *ad hominem* nature of the attacks. The biological criticism is levelled by those who reject Dawkins memetic metaphor of 'replicators' as an over-extension of biology into realms in which it does not apply (Gould, 2002; Smith and Szathmary, 1999). Given that the biological objection stems largely from a dispute over terminology, their objections may be able to be mitigated for the time being, as it is beyond the scope of this work to get involved in doctrinal disputes in a different discipline.

The anthropological objection (Kuper, 2000; Bloch, 2000; Sperber, 2000; Atran, 2002) stems from a more difficultly-remedied problem: domain intrusion of the hard sciences into the 'social realm'. As Bloch notes: "Biologists would react in the same way if, for example they were told by a sociologist in 1999, ignorant of Darwin and Mendel, that she had made the following great discovery [of Darwinian descent with modification]" (Bloch, 2000, p.191). By doing so, memetics aggravates old wounds that go back to the founding of the disciplines, enflamed again by Snow and Sokal over the subsequent years (Shapin, 2010). There may be no way to get around the domain intrusion: both fields are looking at the same kinds of things, albeit from different angles. At best, a more complete and functional theory of memetics—one that can produce some verifiable results--would provide an alternate theory or method that anthropologists could employ.

The objections raised by other Cultural Evolutionary theorists may be similarly dealt with. Providing a complete memetic theory that is testable should go a long way to defusing the tensions. The CET theorists have also been among those to raise most of the intrinsic objections to memetics; as researchers in the field, they don't object to the cultural evolution as a concept, just memetics' particular framing of the question. The intrinsic problems inherent with memetics are as follows: the nature of the viral model (Gatherer, 1998); determining what 'counts' as a meme (Edmonds, 2002); the populist or 'scientistic' usage of the term (Edmonds, 2005); and its strong ties to 'stuff on the internet'.

The viral metaphor comes from the significant shift in the formulation of the memetic hypothesis between Dawkins' first mentions of the meme (Dawkins, 1976) and his later works (Dawkins, 1982, 1986). This amounted to a shift from a genetic model that mirrored and co-evolved with genes to a viral model of existence where memes were transmitted from brain to brain (Gatherer, 1998). This was a problem. Specifically, neither of Dawkins' definitions really deals with the process by which memetic research can be conducted. They incorporate the metaphor and then let it go. Dawkins 'B' assumes *a priori* the existence of memes, without providing either a theory for their generation, or anything but the most simple method of transmission, that of imitation, mentioned above. Further, a viral metaphor comes with its own set of implicit assumptions about how the processes and mechanisms work, and these are often at odds with the original genetic metaphor.

The shift to a viral model also led to confusion over the precise terminology and definitions one was to use when discussing memes. This was exacerbated in the memetic literature, where many authors cited Dawkins 'A', but used the conceptual models from Dawkins' 'B' formulation, or provided their own interpretation of the subject (Aunger, 2002). Outside of a few bibliometric studies, very little empirical or methodological work has been done in the field. In contrast with the other biologically-based approaches to cultural evolution (Wilson, 1975; Cavalli-Sforza and Feldman, 1981; Lumsden and Wilson, 1981, and Boyd and Richerson, 1985)—all of whom had a method of some form—memetics provides very little in the way of method. Even the most vocal proponents of memetics status as a science—Aunger, Plotkin, & Blackmore—point to using qualitative methods (Edmonds, 2002, 2005). This is problematic for conducting an empirical study and has led to some of the misconceptions listed in this section: every purported study begins anew, and few produce anything approaching identifiable results.

Adding to the conceptual problems of the viral metaphor and the resulting doctrinal disputes, the viral model is also the version that was largely taken up by the second-order popularizers of the memetic theory. Starting in the mid-1990s, pop-science books devoted to 'memetics' emphasized the viral nature of the transmission process (c.f. Brodie, 1996; Lynch, 1996), despite the lack of empirical evidence at that time. This was further compounded by their extension of the process and their 'coverage' of the different ways in which memes could appear. Later theorists discussing the subject either built on the popularizer's work (Blackmore, 1999) or had to address it in some fashion (Aunger, 2002). Even current popularizers (Heath and Heath, 2007; Wasik, 2009) are still attached to the viral model, so it is unlikely to go away soon.

This popularization of the memetic concept also contributed to the emergence of the "internet meme". With the rise of the internet in the last decade, it is generally quite easy to see a particular idea "go viral", and the ability to follow linkages on the web can show definitive traces of an internet memes' dissemination. Several researchers (Leskovec et al., 2009) have leveraged this as a resource for study, but the problem remains that for many observers, and much of the public, the internet meme is the only kind of meme that exists. This unintentionally dilutes the memetic concept, elevating a small subclass to stand metaphorically for the entire field and making engaging in further research problematic.

3.1.5 The Way Forward

If the memetic approach is hopelessly flawed, as Edmonds suggests, or if the same subject could be handled better by other approaches, such as suggested by Atran and Bloch, then is there a point in considering memetics as a theory? If the concept of a meme has been hopelessly poisoned by the viral metaphor of the Dawkins 'B' model, why not toss the whole thing and pursue cultural evolution under another guise, another framework, another metaphor? Importantly, memetics does bridge the gap between the various streams I am looking at in this study, residing at the intersection between cultural and technical change. For this reason alone it is worth the attempt to see if something can come from the application of the theory. Logic dictates there are other reasons why it may be desirable to retain memetics.

Foremost amongst these reasons is the cognitive 'mindshare' the meme concept currently occupies in the Noosphere, the realm of human thought, with respect to cultural evolution. Any equivalent model will likely have to be pitted against memetics, favourably or unfavourably. As Mysterud (2004) has shown, the number of competing theories of cultural evolution across disciplines is quite large, yet despite this, memetics has prevailed; the 'meme' meme is quite robust (Aunger, 2000b). Other theorists have commented on their own Cultural Evolutionary theories in relation to the memetics terminology (Boyd and Richerson, 2005).

In addition, we are just now beginning to have access to the tools that adequately meet the empirical challenges to the field of memetics posed by Edmonds (2002, 2005) and others. The growing fields of bibliometrics and complexity sciences have developed tools that may allow for the problems of tracking cultural evolution to be mitigated. Recent studies such as the work of Jon Kleinberg's group on internet memes (Leskovec et al., 2009) show how a specific type of cultural component may be tracked. Michael Drout's work in tracing the changes of rules in monasteries gets at the hard problem of how to conduct a proper memetic analysis (Drout, 2006). Further advances suggest that similar methods might be of use in other studies.

Finally, it may be possible to look at the process of cultural evolution from a broader evolutionary perspective, one that is not so closely tied to Darwinism, and more broadly applicable. A number of alternative evolutionary mechanisms have yet to be addressed within a memetic framework (Gray et al., 2007). These evolutionary mechanisms, grouped under the heading of 'Compositional Evolution' by Watson (2006) suggest a broader approach that might provide a way forward when studying cultural evolution.

3.1.6 Current Approaches

Of the two recent empirical studies which have been conducted using variants of memetics, Drout's study of medieval manuscripts (2006) is more directly relevant to this thesis' field of study. Leskovec et al. (2009) is slightly less useful due to its focus on the transmission of internet memes—a problematic subset of memes as noted above—and the horizontal basis by which this transmission occurs. As such, Leskovec et al. (2009) is more representative of the viral Dawkins ‘B’ memetic variant that I want to move away from in this study. Leskovec and company’s focus on the spread, not the genesis, is contrary to one of this study’s goals of discovering how ideas ‘breed’.

By contrast, Drout (2006) focuses on the both the horizontal and vertical transmission of ideas in medieval monasteries, by looking at the memetic change occurring in Tenth-century Anglo-Saxon texts. His focus on literature as both a source of evidence and a vehicle for memetic transfer closely mirrors the goals of this study. Moreover, his more finely grained conception of a meme may have some utility in my analysis. Drout notes three sub-components of memes that contribute to the efficacy by which they may be transmitted and uptaken. These include: the *recognitio*, the part of the meme that recognizes the initial conditions which trigger its use; the *actio*, the action to be undertaken upon the *recognitio* being triggered; and the *justificatio*, the reason why the rule must be obeyed. For Drout, any of these sub-components of the meme may be modified independent of the others. Depending on how the modification occurs, a modified meme may prove to be more or less successful amongst the population (Drout, 2006, p.13-18). Modifying some components, such as the *justificatio*, may trump whether or not the given meme makes any sense or not.

While Drout’s distinction is useful for deriving the utility of various rules and commandments that occupied the Anglo-Saxon monks’ day-to-day lives, these components may not be readily apparent in the provocative and mythic memes that science fiction evokes in literary works. Science fiction is less imperative and prescriptive than the religious rules of the monastery. If it is obvious that a given science fiction meme is evoking one of these rule-based memetic sub-components, it will be noted, but otherwise the effect of this sub-typology will be minimized.

Drout managed to construct a workable model of memetic transmission and provided a rather convincing case—basing the study from a humanities perspective and not from the hard sciences—but there is still some room for growth in his study. There appears to be a degree of consilience between Drout's work and that of Gray et al. (2007), wherein the possibility arises of using a wider evolutionary framework than had been proposed by memetic theorists to-date. Of interest is the number of non-Darwinian evolutionary mechanisms that exist in the wild, some of which may appear in some form in a different evolutionary substrate, such as technology or science-fiction literature.

3.1.7 Compositional Evolution and Memetics

Compositional evolution (CompEv) comprises a broad class of evolutionary mechanisms that have been shown to occur in the wild with specific biological organisms. They differ from the 'descent with modification' or 'random mutation' mechanisms that form the bulk of orthodox evolutionary theory (Smith and Szathmary, 1999; Dawkins, 1976; Gould, 2002) in that CompEv allows for rather large and abrupt changes to occur to the genome through combinatorial mechanisms.

As outlined by Watson (2006), CompEv can include mechanisms as diverse as hybridization, sexual recombination, and symbiogenesis. Watson used these mechanisms in the process of computer modelling changes in genetic algorithms within an artificial life (A-life) environment (Watson, 2006), similar to others that had been conducted earlier (Dawkins, 1982; Kelly, 1994). Building on the methodology used by Christopher Langton in his landmark analysis of A-life, Watson was able to create a model that more closely mirrored the evolutionary processes seen in nature, especially with respect to the speed by which adaptation may occur.

While there is some dispute within the biological community with respect to the extent these mechanisms may be prevalent (Dawkins, 1976, 1982; Smith and Szathmary, 1999; Gould, 2002) with positions ranging from the orthodox positivist and deterministic stance arguing against their inclusion, to the respective evidence for each particular mechanism (Margulis and Sagan, 2002; Watson, 2006; Hird, 2009), the specifics of this argument are not germane to my current line of inquiry. The reason for including CompEv mechanisms is that evolutionary processes may function somewhat differently based on the substrate (biological, technological, cultural, computational, et al.) in which the processes are occurring. These evolutionary processes may occur in greater or lesser degrees, and certain substrates may favour particular mechanisms or strategies. For example, as Gould notes, "cultural evolution may be Lamarckian" (Gould, 1991). Also, Arthur noted the similar process in how technological change may be 'combinatorial', with certain technologies providing the building blocks for future technologies (Arthur, 2009). My concern is whether or not these CompEv mechanisms do exist, and in so doing, they may provide part of the solution to moving forward with a memetic approach.

By rejecting any *a priori* assumptions about how the mechanisms of evolution may work with respect to culture, and casting a broad net as to what works with the research target, we may be able to see what is out there in society. Rejecting baseline assumptions over what level of fidelity is necessary for effective transmission (Atran, 2002; Bloch, 2000; Sperber, 2000), we may be able to better outline whether the Cultural Evolutionary processes are happening at all. By framing the discussion in as broad a scope as possible, a useful argument as to whether we see a 'Universal Darwinism' may come to fruition (Lewontin, 1970; Dennett, 1995; Blackmore, 1999; Aunger, 2000b, 2002). If evolution is a generalized process then mechanisms that are viable in one substrate (i.e. biological life) may be more or less viable in a another substrate (i.e. culture or technology). Rejecting *a priori* assumptions about what mechanisms work may be a necessity.

Finally, this rejection of assumptions would necessitate a rejection of method as well. A 'return to first principles' would be in order, a historical tracing of the actors and lineages, the events and timelines that show the connections and transformations. The exhortation to view the network *in toto* from Blumer, and Williams will be the methodological guide for progressing with the research. Compositional evolution provides a means to look at how ideas breed. The combination of compositional evolution and a historical approach provides a way forward out of 'the problem with memes'.

3.2 Method

With the work of Michael Drout being one of the most comprehensive and detailed empirical analyses of memetic transmission to date (Drout, 2006), it seems that adopting his approach—that of a historically-based analysis of specific texts—is prudent. There are a number of reasons that support undertaking this approach, including the lack of a clear methodology proposed by the memetics field, and a high degree of consilience between the aim of this study and other historically-based approaches.

With the limited amount of empirical research in the field of memetics there are few examples as to how such research might be conducted, and the theoretical work in the field has been lacking in suggestions. A number of studies that follow the viral metaphor of memetics have been published recently—e.g. Leskovec et al's (2009) work tracking the flow of political catchphrases via their presence on the Internet—but the utility of this research may be limited due to the focus on the transmission, rather than generation, of memes.

Given that I am arguing for a return to the basic assumptions of the memetic metaphor—a return to a genetic analogue—perhaps a similar return to first principles in charting the data may provide a useful model. The warnings Blumer had for the study of media effects—the need to look at a given network *in toto*, rather than just trying to extract various bits (Blumer, 1969)—echo those of Raymond Williams (1974) regarding a new technology. A method that encompasses the full scope of a historical period may be best suited to the study that is being attempted. Early work in evolutionary research involved careful examination of the study subjects for their distinguishing characteristics, and charting the changes that occurred over time, from one generation to the next. This process is remarkably similar to those involved in undertaking a historiography.

3.2.1 Historiography

As Ernst Breisach notes, "History deals with human life as it flows through time" (1994). This has parallels in Halwbachs' metaphor of history as that of being "a passenger on a riverboat wending its way downstream" (Hutton, 1993, p.84). Charting this flow, creating this timeline, is the practice of historiography, and it is this 'mapping out' that needs to be done to explore where and when our various memes have arisen. The goal of the research is to uncover those memes that are persistent over scale and time. The goal is to "...seek patterns that persist as one moves from micro- to macro-levels of analysis, and back again." (Gaddis, 2002).

Using the historical method finds support in other fields as well, such as economics. As W. Brian Arthur defines them, "historical small events' are 'those events or conditions that are outside the *ex-ante* knowledge of the observer—beyond the resolving power of his 'model' or abstraction of the situation" (Arthur, 1989, p.118). These events and circumstances that may have influence on technology choices include "political interests, the prior experience of developers, timing of contracts, decisions at key meetings". While I am not personally privy to these events, there may be evidence of them within the relevant sources on the history of VR development.

The task in constructing this history will be to create "a phenomenological description"(Hutton, 1993, p.84) of the events of the past, and help place them into the flow of the river. One must be a lookout on the riverboat, "identifying new landmarks along the river's course as one passes them" (Hutton, 1993, p.84). These landmarks are the result of processes, "past processes have generated surviving structures—*documents, images, memories*—that allows us to reconstruct in our minds . . . what happened." (Gaddis, 2002, p. 114). These structures are the memes that I seek.

3.2.2 Sources

The literary sources begin with three chosen as representative of the era under review. They have been selected due to their reported influence, total sales, awards won, and number of citations. These initial titles include 'True Names' (Vinge, 1981), *Neuromancer* (Gibson, 1984), and *Snow Crash* (Stephenson, 1992). Further works that analyze these literary sources have been published (i.e. (Frenkel, 2001; Kushner, 2003)), and these will contribute to the memetic evidence below.

Additional literary works covering the period of analysis are included in two ways: an additional 'snowball' will be generated from the sources—works cited in this way are presumed to have some degree of influence, else they would go unmentioned, being the 'historically small events' Brian Arthur alluded to earlier (Arthur, 1989). This selection is not arbitrary, as Gaddis notes: "in every instance in which historians have singled out one individual from masses of others, it's because there's been a moment of sensitivity: some point at which small shifts at the beginning of a process produced large consequences at the end of it" (Gaddis, 2002). *The Shockwave Rider* (Brunner, 1975) has been included due to this sensitivity. Secondly, the resulting historiographic 'map' was compared to existing literature databases to determine if there are any major holes in the historiographic analysis. Titles included in the "Proliferation" section of Chapter 4—Sterling (1988); Gibson (1988); Banks (1988); Simmons (1989)—have been included to fill this gap.

For potential sources of information, authors on historiography such as Breisach (1994); Hutton (1993); Gaddis (2002) suggest that nearly anything may be included—both human and non-human actors may be involved in the transmission and translation of ideas. The early memetics research also suggests that books, music, objects, and artifacts may be included (Dawkins, 1976, 1982; Dennett, 1995). With this in mind, potential sources for the evidence of the memetic influence include:

Biographies of developers and designers, such as Kushner (2003), will be consulted to confirm actual instances of influence and citations occurring.

Designer Diaries the works, conducted either during the development of a title (e.g. Bartle, 2003; Crawford, 2003), or on a *post hoc* basis such as the development post-mortems published in Game Developer, or other magazines and journals.

Journalist's Interviews with developers, that have been conducted by third parties. This includes one-off interviews that may or may not be tied to an actual games' release, and are not included in the previous categories. As these are secondary and tertiary sources, they were evaluated accordingly, with corroborating information supplied where available.

Game design & programming manuals These works, typically written by industry insiders, (e.g. (Crawford, 2003)) tend to have a large amount of 'insider information', usually as a rhetorical method on the part of the author to establish *pathos* with the target audience and build their credibility. Again, the validity of data gained under this method was corroborated externally where possible.

Game design analysis Previews, reviews, and analysis of the games by third parties (bloggers, game development forums, etc.) led to insight to the sources of inspiration that are sought, though anything added to the record was weighted relative to the other sources.

3.2.3 Methodology

Individual instances of memes from the literary works are charted in the historiography—"placed on the map", as it were. The memes are placed on a timeline, and displayed visually using plotting software. Additional timelines covering the development of key technologies or key events in the development of virtual reality systems and personal computing (and related technologies) are also plotted. Linkages between the various components are drawn based on the evaluation of these sources. These linkages are representative of the effects of the memes I am tracking.

The timelines were initially constructed by placing the chosen literary texts (Vinge, 1981; Gibson, 1984; Stephenson, 1992) on the map chronologically, and expanding from there. Key events from several computing histories (Hafner and Lyon, 1996; Swisher, 1998; Chapman, 2006) were also added at this time. As this initial timeline was quite dense, the threads were split into their literary and technological components. Additional sources on the history of computing (Freiberger and Swaine, 1984; Levy, 1984; Hafner and Markoff, 1991; Chesbrough, 2003) were consulted to fill in more of the blanks, and additional material on the history of virtual reality (Rheingold, 1991; Heim, 1993) was added at this time. The combined technological histories again proved too dense, and were split into the twin streams of personal computing and virtual reality.

After the construction of the historical timeline, the list of sources (Section 3.2.2) was consulted to look for references, citations, and mentions of the literary texts, or the ideas they contained. At this point, the literary analysis was expanded to include Brunner (1975), due to the number of times his work was explicitly mentioned. Additional literary texts were also added at this time to bridge the gap in the literature timeline. Direct examples from a number of the sources (Frenkel, 2001; Kushner, 2003; Crawford, 2003) were extracted at this time.

The process was iterative and recursive—after each pass through the material, new sources were drawn, often from references embedded in the previous texts, and new information was added to the timeline. Information that initially seemed relevant was removed if there was not enough mentions to support its inclusion. Finally, the linkages were drawn between the various sources based on the historical record and the explicit mentions in order to see where the timelines intersected. The intersection of these linkages were the indicative of the memes that were born out of the literature. The linkages themselves represented the paths of influence by which the memes interacted with the other components on the timeline, both literary and technological. A map of the memetic influence accompanies each major section of the following chapter.

Chapter 4

A Dense History of Computing in the Eighties

Tracking the interplay of media and technological change can be difficult, and in order to facilitate the process the following section is arranged to chronologically trace the interplay between the science-fiction literature and the technologies that comprise virtual reality. This historiography explores four distinct timelines: that of the literary texts, with a focus on how technology was presented within the work; a linked pair of timelines covering the technological capabilities of the computing systems, focusing on both personal computers and virtual reality technologies; and a timeline highlighting the specific elements where the other timelines interact, the events, the memes, the tropes and influences taken from literature that are evidence of the cultural evolution of the technological form. The historiography is divided into sections that coincide with the time in which the literary text in question was released, and each section is further subdivided to detail the text, the computing and VR equipment of the day, and the memes that arose from a given text. As these timelines are complex and interwoven, several figures will be provided to attempt to untangle the connections. Key attention is paid to Heim's characteristics of virtual reality (Graphical Representation, Interaction, Immersion, Networked Communications, Connectivity, and Spatial Representation) and Sutherland's six technological requirements as outlined in chapter 2.

While there have been numerous visions of virtual reality appearing in science fiction literature prior to the coining of the term "cyberspace"—including early work by Isaac Asimov, Arthur C. Clarke, and Poul Anderson (Warrick, 1980; Vinge, 2001)— this chapter focuses on key 'core texts' and several ancillary works from within the science fiction genre. These key texts include Vernor Vinge's "True Names" (1981), William Gibson's *Neuromancer* (1984), and Neal Stephenson's *Snow Crash* (1992), with John Brunner's *Shockwave Rider* (1975) serving as a historical antecedent, while other stories fill in gaps in the timeline. These works populate the highly developmental decade of the 1980s, during which many of the later designers of VR systems grew up and/or attended school or university, and as such were in a position to be influenced by the work they read. Further, these books were award winning and highly touted, with a readership that was either large, influential, or both. Finally, all the stories were highly evocative and metaphoric: the texts manage to be tech-centric without getting too deep into the technological details which would unnecessarily date a book, and hardly ever comes true in the way they are envisioned (Womack, 2004). The stories managed to evoke the sense of the technological sublime, of limitless vistas and possibilities (Nye, 1994; Mosco, 2004).

These science-fiction books also share a number of thematic similarities. All the works studied deal with near-future dystopias, and are extrapolations of the current world around us. The texts are "real" in that sense that they are grounded in reality—brand names abound, and the action takes place against the backdrop of a post-modern, corporatized and globalized world. Even in a bleak near-future, Sony, BMW, and Mercedes have not gone out of style. And these corporate brand owners are part of the superstructure in the dystopic future: the future is a corporate oligarchy, a kyriarchy where the corporations have become the real powers, and the influence of the 20th century nation-states have dwindled into irrelevance. The protagonists struggle to sneak about like mice at the feet of giants. Many of the above similarities are due to stylistic tropes and conventions of the genre, but these are not necessarily consistent throughout the field of science fiction. There are also technological similarities between the texts; these are explored as each author is looked at in turn.

What follows is a narrative of the decade of the 1980s in the personal and home computing sectors from the perspective of a typical home consumer, parallelled by the science fiction texts as outlined above. A diagram of these timelines can be seen in Figure 4.1. Information from these events have been drawn from a variety of sources, including Levy (1984); Freiberger and Swaine (1984); Rheingold (1991); Hafner and Markoff (1991); Hafner and Lyon (1996); Stauffer (2000); Swisher (1998, 2003); Gawer and Cusumano (2002); Chesbrough (2003); Zygmont (2003); Chapman (2006), and Wolf (2008).

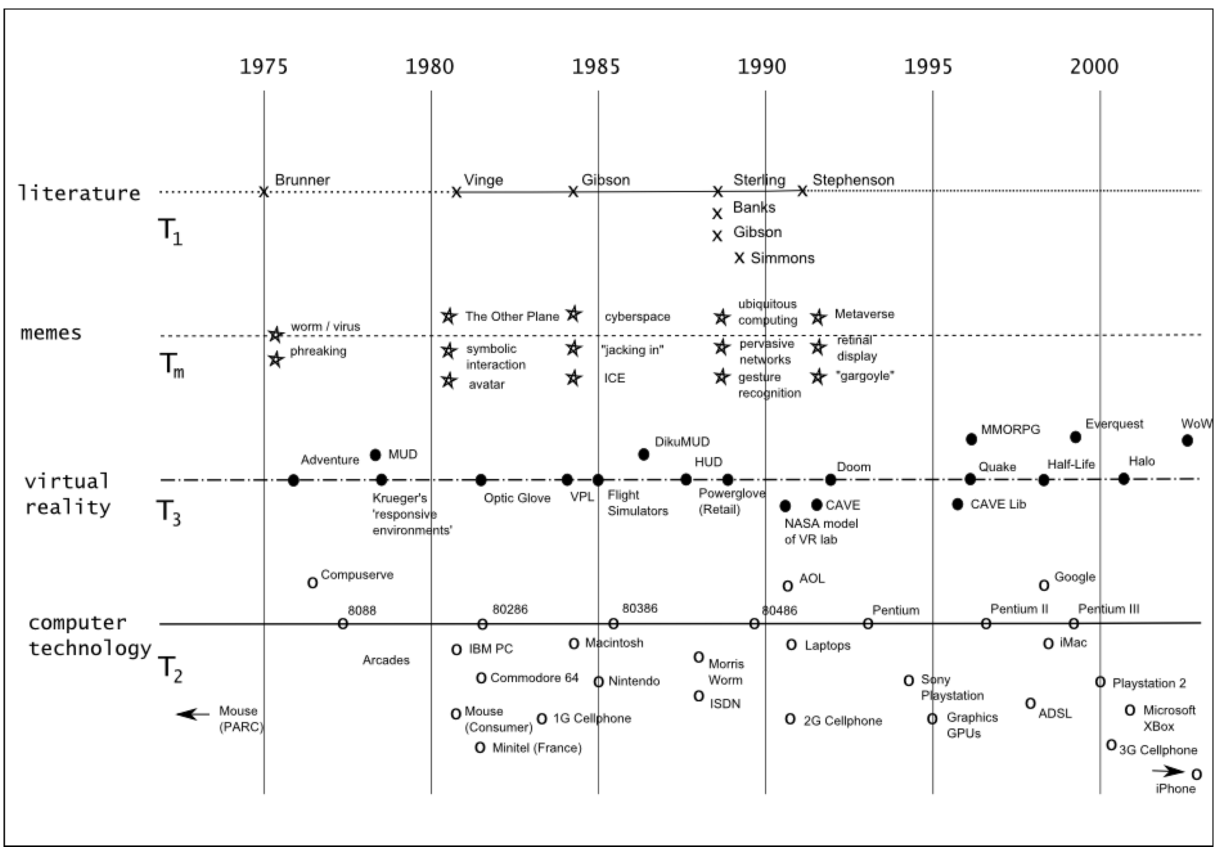

Figure 4.1: Timelines - Overview

4.1 -::-Pre-History-::-

With the 1970's it seems that the techno-futurists such as Toffler (1970) and McLuhan (1964) had much in common with the science fiction writers in their ability to capture the change that was to be brought about by their visions. The science fiction of the time—when not concerned with thinly-veiled allegories for the cold war or racial identity politics—occasionally deigned to deal with the plausibility of the near future of our own planet, and reflected and reached for the techno-futurists prophetic visions. John Brunner's *Shockwave Rider* (1975) is one such example. While much of Brunner would be familiar to a modern reader in 2010—the prevalence of gated communities, urban decay, the persistence of computer viruses, and problems with identity theft—the computer interaction is accomplished largely through hacking the national phone system; hacking a computer system which is connected to the phones—similar to the Minitel system of France. The protagonist, an escapee from a government-run research program, 'hacks' into the government databases via the phone lines, and uploads 'worms' into the automated control systems that virally replicate through the network to ensure legitimization for his new identity. There was little to no sense of anything approaching what a modern audience would consider 'virtual reality'—no emergent 3-dimensional space that would challenge the senses. Brunner's vision is cognitively bound, occuring in the minds of his characters.

While Brunner clearly has external influences— his protagonist's pseudonym is drawn from Alvin Toffler's influential *Future Shock* (1970), it is the number of innovative ideas—memes—that sprang from his work that provide the greatest impact. As Hafner notes:

> Brunner became a cult figure, as the book swept through the worldwide community of science fictions readers. It had a strong influence on an emerging American computer underground—a loose affiliation of phone phreaks and

> computer hackers in places like Silicon Valley and Cambridge who appeared simultaneously with the development of the personal computer. (Hafner and Markoff, 1991, p.281).

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Technologically, the late 1970s saw some interesting innovations in the Information and Communication Technology (ICT) sector. Phones were becoming more prevalent, and the capabilities of touch-tone systems were being explored. Video tape and cable television was being deployed, and about to impact the then-dominant paradigm of broadcast television. Computers were beginning to be available to the home consumer, though many of them still consisted of kits that required home assembly and construction by the user, and were thus restricted to the thinnest edge of lead users, those willing to undertake a do-it-yourself approach to computing.

During this same period, virtual reality was largely a theoretical construct. VR existed at high-end university labs such as existed at the Arch-Mac Lab at MIT, Chapel Hill at UNC, and in Utah, or they existed as part of research projects funded by DARPA or by corporations such as Xerox's PARC. Consumer-grade virtual reality did not exist. The early game systems that were starting to become popular did not have the technical capability to meet Sutherland's hardware requirements for a VR system.

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From a memetic standpoint, the reason for Brunner's inclusion in the overview becomes apparent. Chief among the memes that emerged from *Shockwave Rider* was the concept of the 'worm', a computer virus that is uploaded into a system and replicates copies of itself throughout the system. While not directly related to VR, it is an important concept in two ways: one, it gets picked up again and again by every other author

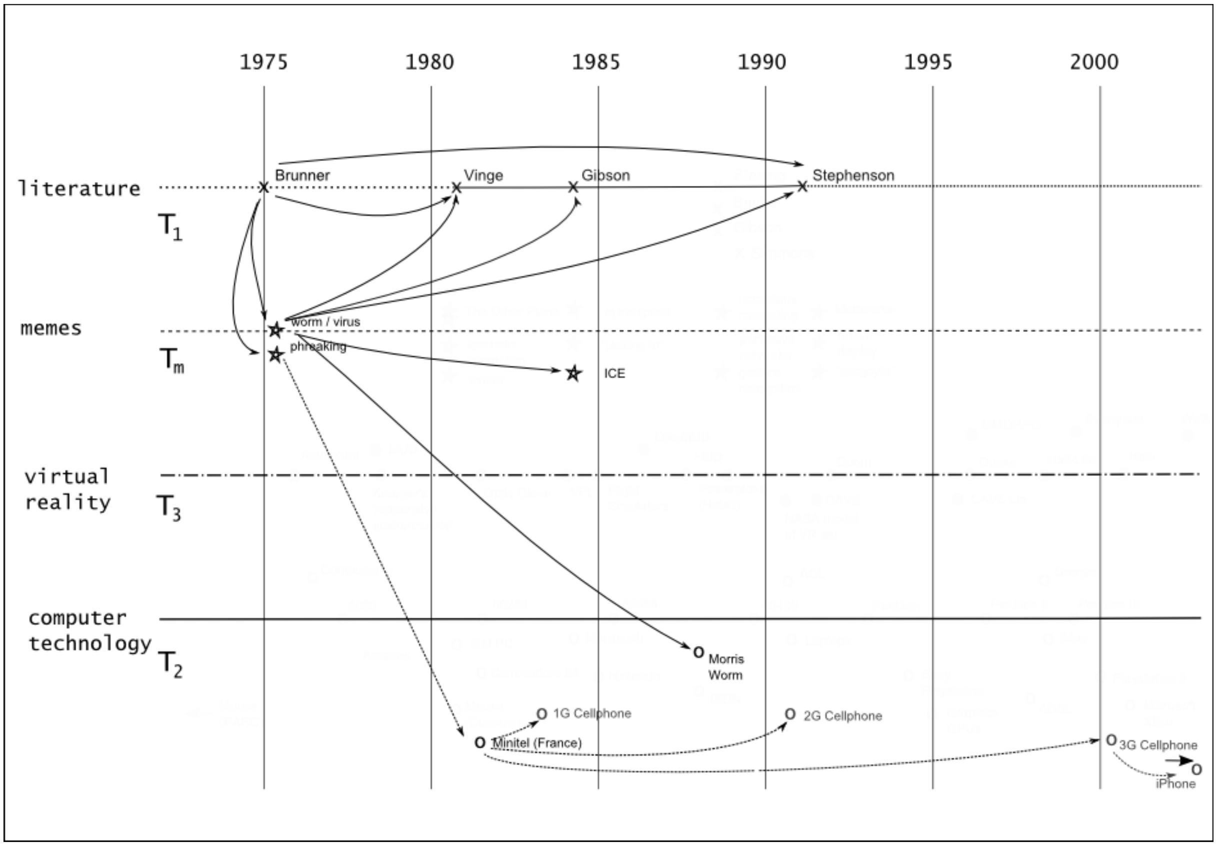

Figure 4.2: Connections - Brunner

in the study, showing evidence of the literary influence (see Figure 4.2), and two, there is direct evidence of the meme's influence on the world of computing. The infamous Morris Worm of 1988 was directly inspired by Brunner's work.

In 1988, Robert Morris released a piece of code from his system at MIT whose nominal purpose was to "gauge the size of the internet", but in reality ended up corrupting systems and using up processing cycles as it exploited vulnerabilities in the Unix systems that were at the backbone of the internet. Hafner & Markoff write:

> Newspaper reports and magazine articles suggested that he [Robert Morris] got his inspiration from *The Shockwave Rider*, John Brunner's proto-cyberpunk novel, which Anne Morris [his mother] told reporters was among the most frequently read books on his bookshelf. But chances are that Bob Morris [Robert's father] was more taken with the story of the shockwave rider than his son was. Bob was an early admirer of Brunner (Hafner and Markoff, 1991, p.322).

While there is some ambiguity in the account, the connection is undeniable. The form and method of deployment of the Morris Worm directly mirrored that of the Shockwave Rider. But once unleashed, how can such a worm be dealt with?

> The term *worm* was taken from the book *The Shockwave Rider*, . . .
> In order to kill the worm, the government has to turn off the network, losing its power in the process.(Hafner and Markoff, 1991, p.281)

Even in Brunner's fictional universe, this was an untenable solution. By the time of the Morris worm, there was no way this could feasibly take place. Many of the paradigms of computing that would shape the next thirty years of technical evolution were locked-in at an early date.

4.2 -::-Search-::-1981-::-Discovery-::-

We move into the 1980s as we examine the second title in our selection. Vernor Vinge's "True Names" was not the first fictional representation of a virtual world, but it stands out due to its prescience and its direct influence. Originally released in 1981 in 'Binary Star #5', it was nominated for both the Hugo and Nebula awards for "Best Novella" of 1981. Due to demand, the story was re-released in 1984 as a stand-alone novella with an afterword by MIT's Marvin Minsky. "True Names" is the story of a man named Pollack, a man who leads a dual-life, with a “fake” identity online as a ‘warlock’ overlapping with his ‘real’ identity attached to his physical body. Much like the wizards in a Faustian bargain, knowledge of the real-world identity—the True Name—can provide others leverage over the actions one pursues online, as the protagonist discovers to his dismay. He is eventually tracked down by agents of the government and persuaded to turn against his online cabal under the auspices of ‘anti-terrorism’.

In “True Names”, the internet is entirely symbolic: interaction with the computer systems takes place on ‘The Other Plane’, a precursor to cyberspace where communication occurs between the various databases and networks. Entry into systems is made by interacting with puzzles and pathways; defense systems may look like mythological creatures or medieval castles; a persons avatar (online identity) may be anything at all: the true cybernetic entity is a constantly subjective and malleable form.

The technology behind this representation is left somewhat abstract in the text; outside of a few specifics, it is purposefully vague and left to the reader’s imagination (Vinge, 2001). This contributes to the text’s strength and lasting influence: when technical specifics are proposed they invariably seem quaint and naive by modern standards. Vinge recollects that the more specific he was in his predictions, the more wrong they were (Vinge, 2001, p.18). Much like Ivan Sutherland’s model of VR, a host of related technologies are required to make Vinge’s Other Plane function: a network of satellites in geosynchronous orbit; direct brain-computer connections via dermal EEG devices; and the computer processing capability itself. Vinge paints a vivid picture of how one interacts with the Other Plane:

> He powered up his processors, settled back in his favorite chair, and carefully attached the Portal’s five sucker electrodes to his scalp. For long minutes

> nothing happened: a certain amount of self-denial–or at least self-hypnosis–was necessary to make the ascent. And just as a daydreamer forgets his actual surroundings and sees other realities, so Pollack drifted, detached, his subconscious interpreting the status of the West Coast communication and data services as a vague thicket for his conscious mind to inspect, interrogate for the safest path to an intermediate haven. Like most exurb data-commuters, Pollack rented the standard optical links: Bell, Boeing, Nippon Electric (Vinge, 1981, p.250).

Here we see the genesis of the tropes of the cyberpunk genre: large corporations in control of the internet, a sense of dislocation and distance, a notion of travelling. There is also the sense that this is symbolic, that this is a game to be played, that mastery can be achieved.

> The basic game was a distant relative of the ancient Adventure that had been played on computer systems for more than forty years, and a nearer relative of the participation novels that are still widely sold. There were two great differences, though. This game was more serious, and was played at a level of complexity impossible without the use of the EEG input/output that the warlocks and the popular data bases called Portals. (Vinge, 1981, p.251).

What are these Portals? These are nodes, access points to the network. Vinge describes them as ‘popular databases’. This ties directly to the modern MMORPGs of the 21st century such as *Everquest* or *World of Warcraft*. They are virtual worlds with millions of paying customers, but they can be functionally described as ‘databases with a GUI’. In essence, Vinge foresaw the next 30 years of computer gaming, from *Adventure* of Will Crowther in 1976 through to now. But the mystical aspect of his text is simply that, symbolic.

> Responsible databases like the LA times and the CBS news made it clear that there was nothing supernatural about them or about the other plane, that the magical jargon was at best a romantic convenience and at worst obscurantism (Vinge, 1981, p.252).

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Back in our world, the 1980s began with promise and hope. For the modern consumer, a plethora of new goods were becoming available, and for those interested in the latest in technological wizardry, the age of the microchip made it nearly impossible to keep up with the state-of-the-art. In 1981 the most popular 'computer' in most homes was the Atari 2600 Video Console System (VCS), their electronic video-game console. True home micro-computers were becoming commercially available—as manufacturers recognized the market first colonized by the hobbyists of the mid and late 1970s—but their market share was nowhere near that of the smaller and cheaper entertainment systems. Personal microcomputer use had still not spread much beyond the fringe of 'early adopters'. The Atari 2600 was remarkably weak by current standards, but used a number of hardware 'tricks' which made it capable of displaying 128 colours, over a graphical 'resolution' of effectively 40x 25 'pixels'. Even with the NTSC Standard used by televisions broadcasters in North America, the Atari looked blocky and poorly-defined. Home televisions, which the VCS used as a display, theoretically had a resolution of 320x200 'pixels', but these were very blurry indeed, and the picture was noticeably fuzzy. Consumers were able to experience virtual spaces in video-game arcades, as dedicated machines with games such as *Battlezone*—a futuristic tank simulator—were able to display a 3D wireframe image, but this was still beyond the reach of consumer electronics of the time.

Networked communication between computers was commonly conducted through acoustically-coupled modems, using the tones of the phone signal, and the only modem available to most home users of the time ran at 300 Baud (or symbols per second). Most networking computer usage was restricted to university campuses and corporate research networks, and the slowly expanding 'Internet'. This was growing out of the framework established by the original ARPANET project, but its reach was still limited — Hafner and Lyon suggest that approximately 72 institutions were networked by 1981. Still, e-mail was becoming more prevalent, and was available to those willing to pay. CompuServe—the subsidiary of an Ohio-based insurance firm—began to market the networking capabilities that it had built on the back of time-share sales of its mainframe capabilities to smaller businesses. Minitel, the French national phone service, was launched in 1982, with the government subsidizing the rollout of some 9 million terminals for public and institutional use. Brunner's vision from 1975 was barely around the corner.

For the home consumer, choices were becoming available that didn't require the use of a soldering gun. The first IBM PC had just been launched in 1981, utilizing Intel's new 8088 microchip processor. It could only display ANSI characters, providing 80 x 25 characters on the screen through the system's Monochrome Display Adapter (MDA). Most computer manufacturers constructed their own closed systems at the time, as Apple Computers did with its line of Apple IIe systems which was popular with schools, but the open format of the IBM PC allowed for 3rd-party manufacturers to provide a host of competing models based on the same base system, and smaller players could afford to innovate on that platform on a much smaller scale. Even the home console companies were crossing over into 'personal computing': the Atari 400 and 800 (with 4 and 8 Kb of RAM, respectively) were launched in 1979, and each still held marketshare in 1981.

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In the computing industry of 1981, aesthetic considerations often fell to demands of functionality, and the actual capabilities of the machines were highly limited. Vinge may have had the foresight to see what was coming—as a math professor at UC San Diego he was likely well ahead of the curve—but Vinge's vision was a long way off from manifesting in reality. By 1981, Ivan Sutherland's lab in Utah had developed a system that was capable of meeting the bare minimum requirements of his conception of 'VR'. Their system allowed the user to interact with a virtual environment at the expense of wearing a bulky headset and wired gloves. At MIT, Scott Fisher's work with PLZT glasses were able to provide a stereoscopic view to the wearers, allowing them to interact more naturally with a virtual space.

Virtual reality was nowhere in the public sight, existing only in military labs and high-end academic research programs. The key components were beginning to be assembled at various labs, and the technologies were no longer worked on in isolation. Work at the Arch-Mac Lab at MIT, as well as the work at UNC, Utah, and elsewhere proceeded apace. The technologies were getting close to realizing the vision, but the equipment was still specialized, bulky, expensive, and most importantly, hardware bound.

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The memetic influences of Vinge's "True Names" are many, as seen in Figure 4.3. The ability to connect one's brain directly to a computer via electrodes has McLuhan-esque qualities of 'auto-amputation' embedded in it, and the ability to interact with a computer entirely symbolically was an important concept, though it was being developed in academia at the time. But the most pervasive meme of Vinge's was the concept of the Avatar, the disembodied persona that exists within a virtual world. Prior to the academic work by Haraway, Turkel, and others, Vinge was able to capture what the

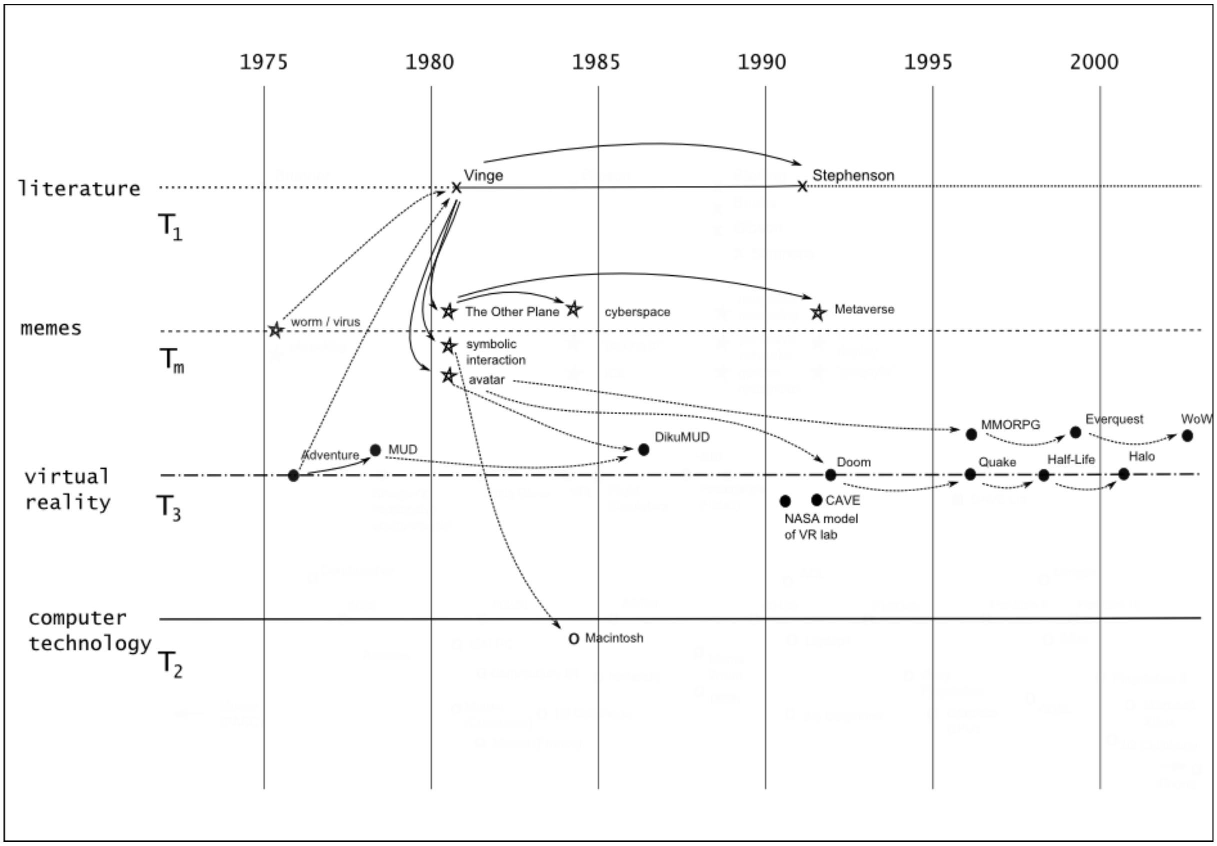

Figure 4.3: Connections - Vinge

implications of what a life online might be.

> "True Names" made the distinction between player and persona (the real-world identity of an individual being a persona's 'true name') and explored some of the consequences of identity masking that this enables. (Bartle, 2003, p.64)

Other researchers have also noted the impact "True Names" had, not just on technological design and tropes that were employed in early online communities (Morningstar and Farmer, 2001), but in the issues of freedom and security that were raised as part of the subtext in the book: the need to keep one's online persona separate from the "real world" one, lest you were compromised for actions in one of the other spheres (May, 2001).

What reach did "True Names" have? One example can be seen in Artificial Intelligence researcher Olin Shivers' account of how he was first introduced to the book:

> When I was starting out as a PhD student in Artificial Intelligence at Carnegie Mellon, it was made known to us first-year students that an unofficial but necessary part of our education was to locate and read a copy of an obscure science-fiction novella called True Names... This was 1983—the Internet was a toy reserved for American academics, "virtual reality" was not a popular topic, and the term "cyberpunk" had not been coined. One by one, we all tracked down copies, and all had the tops of our heads blown off by Vinge's incredible book (Frenkel, 2001).

Coupled with the Avatar was the meme of The Other Plane itself. An imaginary place where laws of physics and causality may not be what we are familiar with reaches back to the fiction of another mathematician, Lewis Caroll, but the meme of this place as a computer-generated space will persist throughout the remaining works, and is explored more fully there.

4.3 -::-Niche Development-::-1984-::-Foundation-::-

In the midst of the early 80's hardware proliferation, William Gibson's *Neuromancer* (1984) hit the ground like a conceptual atomic bomb. Winning every major science fiction award for the year it was released (the Hugo, Nebula, and Philip K. Dick awards), the book's impact reverberated throughout the realm of literature and beyond—into both academia and popular culture as a whole. It perfectly captured the zeitgeist of the time, and was the exemplar of the new science-fiction subgenre of cyberpunk. Despite other authors writing works on similar themes at that time (Vernor Vinge, Bruce Sterling, Rudy Rucker, et al.), it was *Neuromancer* that everyone cited when it came to cyberspace.

Part of this was due to the prose. *Neuromancer* struck the reader directly in McLuhan's 'electric nerve', evoking awe at the sublime possibilities that such a development might bring. Like Vinge, Gibson was explicit in detailing the events that led to the development of his modern virtual environments:

> 'The matrix has its roots in primitive arcade games,' said the voice-over, 'in early graphics programs and military experimentation with cranial jacks.' On the Sony, a two-dimensional space war faded behind a forest of mathematically generated ferns, demonstrating the spacial possibilities of logarithmic spirals; cold blue military footage burned through, lab animals wired into test systems, helmets feeding into fire control circuits of tanks and war planes. (Gibson, 1984, p.69).

Neuromancer's plot revolves around the attempts of a former 'console cowboy' named Case to regain some of his past life, his ability to interface with the matrix, as he is hired by shadowy forces to undertake some undefined espionage work. Case tackles the work with gusto, and soon finds himself the pawn in a Machiavellian game. Shortly after Case regains his ability to access the Matrix, we are treated to Gibson's famous definition of cyberspace:

> A consensual hallucination experienced daily by billions of legitimate operators, in every nation... A graphic representation of data abstracted from the banks of every computer in the human system. Unthinkable complexity. Lines of light ranged in the nonspace of the mind, clusters and constellations of data. Like city lights, receding... (Gibson, 1984, p.69).

This is the core of Gibson's vision. Another place, one where the physical laws need not apply, and the only limits were one's vision and skill. Gibson later remarked that cyberspace was just a metaphor, that it existed "at the point where a telephone conversation takes place"–essentially nowhere, in the middle of the wire.

The lasting effects of *Neuromancer*, and to an extent the whole cyberpunk genre, were felt within various realms. Within engineering and computer science, it became a holy grail, a light in the darkness pointing the way forward. Within academia however, it had a divisive effect: it created a new paradigm of the 'cyber', and snatched it from the hands of the computer scientists and AI researchers, and attached it to everything else. 'Cyber' became delinked from Weiner's original concept of feedback ('cyber' coming from the Greek word 'Kyber', for steersman), and instead attached it to anything constructed from chrome and electronics. Cyber became a prefix that could be applied to anything and used to connote that this was a whole new field, that things had changed. As Jack Womack notes: "even those at least partially in the know who debated, defended, or denigrated Gibson *didn't have the faintest idea of what Gibson was actually doing*" (Womack, 2004, p.359, emphasis in original).

The net effect of this was obfuscation: with a plethora of cyber-studies, be it virtual geography, cyber-identity, virtual democracy or cyber-flower-arrangement, the original technical focus became lost amongst the trees of data that had little to do with the technology itself. (For an example of the profusion of theories, see Benedikt, 1992). Meanwhile, those with a technological focus either proceeded with working towards the vision, or looked for a different voice.

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By 1984, the home computing industry was beginning to change. Computing power was becoming more affordable and accessible. Atari had been supplanted in the home market, by both the video game industry crash of 1983 brought on by a glut of inferior product, and the 1982 introduction of the Commodore 64 (C64) by Commodore International. The C64 was an 8-bit system with a full keyboard and relatively robust 64k of memory, capable of filling a screen with 40 x 25 rows of information, or a 16 colour, 320x 200 pixel bitmap image. Not as impressive as the older IBM PCs, but at a $299 price point the C64 was a lot more readily available and in line with the average middle-class family budget. Consumers could rationalize the expense as 'educational', something that was difficult to do with a pure gaming system like the Atari. Commodore's low barrier to entry effectively introduced computing to millions of middle-class kids, in contrast to those who learned computing in the 1960's and 70's, typically the privileged youth of the well-off (see Gladwell, 2008), or those already in the university or corporate research sectors. Commodore soon had an estimated 30-40% of the home market. The true payoff of the development of this generation of computer-literate kids and teenagers wouldn't become apparent until the late 1990's.

At the same time, the IBM PC was gaining in market share with home users due in no small part to the open nature of their hardware platform. By allowing third parties to market their own 'compatible' machines based on the IBM specifications, these 'PC clones' proliferated, and smaller companies were able to innovate on specific pieces of hardware, rather than having to design a complete system from scratch. The PC was also gaining in power – Intel had launched an upgraded chip, the 80286, which ran twice as fast and could address 16 times as much memory as the earlier 8088 chips. The most powerful modem was 1200 BAUD – a networked computer could display a screen of text as quickly as you could read it. Many of these home-based computers began to eschew the television as their primary display device, opting instead for the high-end display monitors which could provide a 640 x 480 resolution, with 4 or 16 colours instead of the comparatively paltry 320 X200 NTSC viewing experience. More powerful display products were available to the university or corporate clients, naturally, but at an order of magnitude difference in price.

Apple's Macintosh was also making waves in the marketplace and tempting consumers, following the release of its iconic ad campaign during Superbowl XVIII, featuring director Ridley Scott's memorable '1984' commercial. This brought the concept of a GUI (Graphical User Interface) based on the WIMP (Windows-Icon-Menu-Pointer) design philosophy to the home market. Originally born out of Xerox's PARC (Palo Alto Research Center) labs in 1973, the same labs which developed the 'mouse' and the laser printer, the WIMP design stressed the symbolic nature of the processes and actions that the computer could undertake. The symbolic interaction echoed some of what Vinge was hinting at earlier in "True Names". Commodore was also readying their own next-generation system with a WIMP interface at the time, prepping the Amiga for a 1985 launch.

There were more games that presented a complex three-dimensional perspective, but these were still largely confined to dedicated arcade machines, utilizing vector-based graphics, etching lines of neon against a black background. The *Star Wars* arcade game—a product that licensed the intellectual property of George Lucas to let players recreate the space battles from the hit movie—followed in *Battlezone*'s footsteps. Text-based Multi-User Dungeons (MUDs) also started migrating to the home market. Home networking was being further developed by IBM, some company called Microsoft, and other hardware manufacturers. A company by the name of Control Video Corporation of Virginia was developing a method of delivering gaming content to the Atari VCS via the phone line, though that project was put on hold with the aforementioned video game market crash. Modems were now increasing in speeds, with 1200 Baud modems available to home users, albeit at a significant premium. CompuServe retained their position as the largest single provider of internet services to the general market. Mobile communications were introduced to the North American market, as Ameritech's first analog mobile phone network was deployed in Chicago in 1983.

By the mid 1980s the capability of consumer hardware was increasing. Wireframe 3D virtual realms had moved out of the arcade and were now available as software for home systems. Crude 3D flight simulators were also available to the civilian enthusiast, even as the American military was developing fully simulated cockpits for its fighter pilots. The high-tech solutions that focussed on immersion and interactivity were still in the labs, but here too they were being refined: reduced in size and bulk and increased in resolution and responsiveness. Jaron Lanier's datagloves, Scott Fisher's goggles, and other key technologies were available. However, the technology differed from that shown in the literature—both Gibson and Vinge suggested a very direct form of human-computer interface. What the technologists were doing was attempting to implement that vision using the technologies that were available to them at the time. There was still a sense of disconnect between vision and reality.

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As hinted at above, the memetic influence of *Neuromancer* casts a long shadow over the entire field of computing that follows. It is best to break it down into several areas: these include cyberspace, the ability to 'jack-in' or physically connect one's brain to the computer, and the concept of ICE, or intrusion counter-measures electronics (see Figure 4.4). A brief summary of each follows.

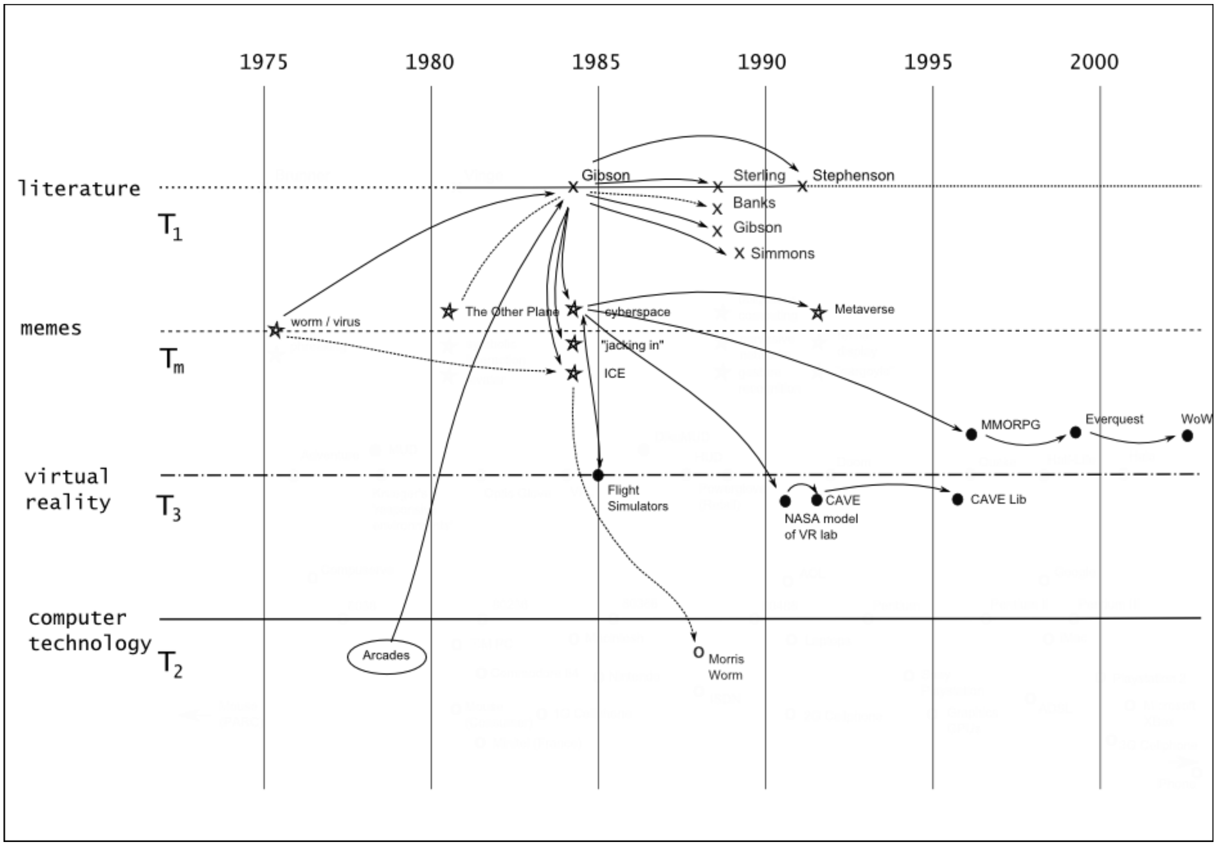

Figure 4.4: Connections - Gibson

Cyberspace is the giant in the room. As noted earlier by Jack Womack, the gravity of the term tended to draw all manner of things into its orbit, even when the connections were tangential at best. Looking at how cyberspace began being deployed amongst the developers and researchers is instructive:

> Commercial enterprises adopted the technology of the network to create their own private versions of the network based on the same set of communication protocols. The corporations also used the Internet itself to stay in contact with operations spread around the world. The Internet in turn was

> connected through gateway computers to hundreds or thousands of other networks. Some began to speak of an even broader concept of interconnected networks. They referred to it as the Matrix, taking the name from the all-encompassing computer network in William Gibson's *Neuromancer*. (Hafner and Markoff, 1991, p.279)

With the development of the ARPANet, and its deployment to more and more institutions and corporations during the late 80s and early 90s, the terminology from science fiction found a broader uptake. It crystalized the meme:

> When Cyberpunk brought new meaning to the term "cutting edge" in the Science Fiction literary scene of the mid 1980s, the future of virtual worlds immediately seemed laid out with neon clarity.(Bartle, 2003, p.64)

The second major meme specific to virtual reality was the concept of 'jacking in'. Where Vinge has earlier described the method of human-computer interaction as using dermal EEG electrodes, Gibson takes it a step further with implants surgically grafted to the cerebrum allowing the user the quickest of connections, side-stepping the biological mechanisms of eyes and fingers that only slow one down in the virtual realm. The echoes of McLuhan persist, and the concept of being immersed within this new reality is born.

The final meme is the crystallization of the concept of viruses in the network—something that both Brunner and Vinge touched on as well—and the development of defenses against those invaders. But these 'intrusion countermeasure electronics', or 'ICE' for short, are not passive defenses such as firewalls, but *active* defenses that seek out and destroy the invaders. Prior to the existence of the Internet, and four years before the release of the Morris Worm, the first widespread computer virus, echoes of much of the current culture of hacking, viruses, and computer defense can be seen. And here the influence is rather direct. Within Hafner and Markoff (1991)'s *Cyberpunk* we see some hints of the influence that the novels had within the computing community. Though 'Pengo' and the other hackers were not directly involved in the creation of VR, they were (somewhat) representative of the computing underground at the time, and were to a degree, aspirational figures. 'Pengo' is the pseudonym of a hacker who was arrested on espionage charges for dealing secrets to the Russians via the computer network:

> *Neuromancer* became Pengo's personal cyberpunk primer. After reading it, Pengo decided that if he hadn't already established himself with a nickname, he would have chosen Case. In Pengo's reality, working for the Russians held its own justification. It was something Case would have done. (Hafner and Markoff, 1991, p.195)

> Pengo then decided to bring up the science fiction that had inspired him in this esoteric enterprise. He described John Brunner's *Shockwave Rider* and William Gibson's *Neuromancer*, and their cyberpunk anti-heroes.... 'The chief thing for me was the adventure, suddenly being inside a movie.' (Hafner and Markoff, 1991, p.245)

4.4 -::-Proliferation-::-1988-::-Exploitation-::-

In the interregnum between the release of the grand narratives of the cyberpunk era—Gibson's *Neuromancer* and Stephenson's *Snow Crash*—there was a figurative flood of titles in the newly-created literary niche. The glut of new 'cyberpunk' works was like a cultural Precambrian explosion for literate representations of personal computer use. Amongst the flood of this time, no single work stands out as iconic as those which preceded it. The following selections represent a broad swath of literary sci-fi of the period, including not just cyberpunk novels, but traditional science fiction as well. Several were award-winners in their own right. Regular science fiction (i.e. not from the cyberpunk subgenre) was also influenced by the cyberpunk vision, and how computer use was represented in regular science fiction borrowed heavily from cyberpunk's themes and tropes, as can be seen in the works of Iain M. Banks and Dan Simmons. But within genre cyberpunk tales, such as Gibson's *Mona Lisa Overdrive* (1988) and Bruce Sterling's *Islands in the Net* (1988), the vision was becoming more refined, evolving to something new. This section will briefly explore each of these titles before returning to the technology and the memetic influences of the texts.

Long considered one of the founders of the cyberpunk movement, Bruce Sterling's *Islands in the Net* (1988) looks at the convergence that is happening between electronic goods, as all devices become subsumed within the computer. "Computers melted other machines, fusing them together." (Sterling, 1988, p.17). Sterling also looks at the implications of the increasing portability of technology, as portable video phones are ubiquitous amongst the major characters. However, much like Dick Tracy, these phones are still bound to the wrist as extension of a multi-function watch, rather than the handheld units now in common use. Sterling also comments on the effects of citizen living in a pervasive network, and the content that was available there: "The net was a vast glass mirror. It reflected what it was shown, mostly human banality." (Sterling, 1988, p.17).

Gibson's *Mona Lisa Overdrive* (1988) is the conclusion to the 'Sprawl' trilogy he began with *Neuromancer*. Virtual spaces are still a topic of interest, as seen through the eyes of Gentry, a 'hacker' who lives in an abandoned factory and searches for the elusive patterns of creation. The tools by which one can access the net have changed in form, becoming closer to something achievable in reality: "Gentry went to the big display unit, the projection table. 'There are worlds within worlds' "(Gibson, 1988, p.108). Virtual constructs also abound, such as the tutor for a young Japanese girl and the avatar of a cancer-ridden billionaire. For all these characters, interaction within the virtual space is key. The virtual spaces themselves have grown difficult to handle. "...'It's a matter of scale. If this is an aleph-class biosoft he literally could have anything at all in there. In a sense, he could have an approximation of everything.' "(Gibson, 1988, p.154).

Dan Simmon's *Hyperion* (1989) is representative of the more traditional form of science fiction. Receiving both the Hugo and Locus Awards in 1990, *Hyperion* is set on a massive human-colonized planet that houses a massive alien ruin that requires a team of disparate individuals to investigate it. All-in-all, classic science fiction. But within the story, the cyberpunk tropes seep in. *Hyperion* follows a structure similar to that of Chaucer's *Canterbury Tales*, and through one of the traveller's tales we are given glimpse of a pure cyberpunk story set within the larger narrative, the noir flavour that many cyberpunk authors drew inspiration from seeping through at all corners.

We find the new model of computer interaction as prevalent throughout Simmons *Hyperion*, such as when the character of Colonel Kassad is in a virtual reality simulator, replaying the 1415 AD Battle of Agincourt: "He was impressed with the unbelievable realism of the experience – the Olympus Command School Historical Tactical Network was as far beyond regular stimsims as full-form holos were beyond tintypes – but the physical sensations were so convincing, so real," (Simmons, 1989, p.121). We see here the sense of Immersion that is so critical in Heim's typology of the Virtual Reality characteristics.

Also in the traditional science-fiction genre, Scottish writer Iain M. Banks' novel *The Player of Games* (1988) shows evidence of a similar incorporation of cyberpunk conceptions of VR. Telling the story of a post-singularity galactic civilization called simply 'the Culture', and the lives of the citizens within it, Banks weaves a tale of intergalactic civilizations in conflict. Within the Culture, vast artificial intelligences have arisen to sentience, and are treated as full citizens of the civilization. Computer interaction is often obfuscated, hidden behind the wall of ubiquitous technology that is supported by a complete intergalactic network. This network was interfaced via 'terminals', in a fashion more familiar to an audience in 2010: "A terminal, in the shape of a ring, button, bracelet or pen or whatever, as your link with everybody and everything else in the Culture."(Banks, 1988, p.71)

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Power was the watchword for the late 1980s, for both computing and society as a whole. By 1988, the Commodore 64 had been supplanted by more powerful machines, though it still enjoyed a large established base in the market. Commodore's successors, which included newer versions of the Apple Macintosh such as the Mac Plus and Mac II, more powerful PCs built on Intel's 80286 and recently-released 80386 processors, and Commodore's own Amiga platform, which could combine computer graphics and video for a fraction of the price that major commercial vendors could provide, were all engaged in competition for market superiority. At the time, no one vendor held dominance, though the combination of Microsoft's DOS operating system and the cheap Intel-based microchips was starting to see gains. Home video game consoles had made a post-crash return to the living room, with Japanese playing-card company Nintendo entering the North American market in 1985 and revitalizing the industry. Nintendo's machine offered an 8-bit processor and 256 x 224 pixel display, which was a sufficient improvement over the old Atari VCS that it could now allow consumers to play arcade classics at home.

Online services were also available to most home users. Control Video Corporation was now Quantum Link, and it provided a 'home page' like-portal with a menu of options to choose from to its users on the Commodore and Apple systems. Quantum provided a number of portal-like games and virtual spaces for its customers, such as LucasArts' Habitat. Despite these innovations, Quantum Link remained well behind market leaders CompuServe and Prodigy. The WIMP GUI philosophy was starting to filter into all software products. MUDs were gaining in popularity, and there was a plethora of choices available. Most services charged hourly pricing, and it was not uncommon to hear of stories of users with monthly bills in the thousands, over and above the charges for the phone lines themselves. Hard-core devotees would install a dedicated phone line for the modem, so as not to be interrupted by those annoying voices on the phone service. By 1988, a 4800-Baud modem could be purchased, and the 9600-Baud modem was already in the development stages. Finally, mobile telephony was being rolled out across North America. The Internet was not yet mobile, but plans to move to a digital signal for voice transmission were being considered by various developers.

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The late 1980s represent a pivotal point in the development of the virtual reality systems. By 1988, as cyberspace became reified and subsumed into science fiction of every variety, even those works that were not wholly devoted to virtual reality mentioned it at some scale. Moreover, the capabilities of the computers in the real world began to converge on the representations within the texts. Capability was drawing closer to imagination. 3D visualization was improving. While state-of-the-art graphics were still out of reach of the average user, the wireframes of the earlier 3D games were now filled in with solid colours in titles such as Microsoft's original *Flight Simulator*.

It was here in the late 80s that cheap, consumer-grade computing hardware was finally capable of forming a semblance of VR. The increased capabilities of newer Intel chips such as the 80386, and higher display resolutions on the monitors allowed for many of the sub-components of Sutherland's model to be constructed within a single system. One of the leaders in bringing this low-cost revolution about was NASA, with their Cyberspace research project out of their VRLab in Moutain View, California. Using off the shelf hardware, "NASA's demonstration of the feasibility of near-garage-scale virtual reality research set-off a wave of commercial and academic interest." (Rheingold, 1991, p.133). NASA showed that the vision of cyberspace was achievable and within reach. The science fiction vision still drove many of these users to seek out paths for development, of which NASA presented a working model.

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The multiple refinements of virtual reality that came from the era of proliferation present some problems for the 'imitation-only' version of memetic transmission. To be sure, imitation is occurring, as can be seen quite readily in Simmons' works, where the influence from Gibson's earlier work shines through. We can see references to the Black ICE of the defense systems, the hazards of virtual space now assumed and ever-present. The same sense of limitless vista's also abounds within the following two quotations:

> Frozen fountains of fireworks. Transparent mountain ranges of data, endless glaciers of ROMworks, access ganglia spreading like fissures, iron clouds of semisentient internal process bubbles, glowing pyramids of primary source stuff, each guarded by lakes of black ice and armies of black-pulse phages. (Simmons, 1989, p.395)

> You know all about the terrible beauty of the datumplane, the three-dimensional highways with their landscapes of black ice and neon perimeters and Day-Glo Strange Loops and shimmering skyscrapers of data blocks under hovering clouds of AI presence.(Simmons, 1989, p.394)

Despite the imitation, a recombination of the elements is also taking place. Whether through VR being interpreted in different genres, with their own stylistic elements, or in the artist's conception of VR converging on real-world implementations and the problems of providing a sense of versimilitude in the diegetic lifeworld of their texts, the artists' depictions of VR and computer use are more grounded in reality than before. This strongly suggests that the combinatorial evolutionary mechanisms as outlined in Chapter 3 may have some utility in explaining the methods of memetic change.

Another of the changes that started to come about during this proliferation was that the initial furor that surrounded the field of VR in the mid-80s subsided, and new approaches to the subject began to take hold. This was most readily apparent in the field of computer game design. As the systems were improving, there was room for development of the virtual spaces represented on the screen. This can be seen in a series of quotes from game designer Richard Bartle:

> Cyberpunk was the envangelizing prophet of virtual reality, but, once the hype died down, other authors were able to look at the new reality and use that as their starting point for speculative work. (Bartle, 2003, p.65)

As Bartle notes, "the influence of fiction on virtual worlds [occurs in] three types":

> Direct (an implementation of an existing fictional world); Partial (inspired or derived from a particular work or genre of fiction); and Indirect (inspired by some other work which is itself an adaptation). (Bartle, 2003, p.63)

> There is, however, a fourth category of fiction that has the subject matter *in itself* of use to designers. These are books that are *about* virtual worlds [in a speculative way]... Books of this kind are of great interest to the designers of virtual worlds because they actually involve consideration of design issues.(Bartle, 2003, p.64)

Bartle also notes that "designers tend to approach novels analytically, deconstructing them for their form rather than their content." (Bartle, 2003, p.63). This analytical approach would persist into the future, as more attempts were made at actualizing the vision.

4.5 -::-Apotheosis-::-1992-::-Optimization-::-

> The only difference is that since the Street does not really exist—none of these things is being physically built (Stephenson, 1992, p.25)

Snow Crash, Neal Stephenson's 1992 breakout work, was lauded as either the glittering epitome of the cyberpunk genre, infused with every stylish trope available, or the beginning of the post-cyberpunk era. With the wry postmodern references suffusing its pages, there is no doubt that it left an impression on the audience who had grown up in the video arcades of the early 1980s. More technically precise than any of its predecessors—owing to Stephenson's background as an electrical engineer—*Snow Crash* began to tie the metaphors and the imagery of VR with the hows and whys of "getting things done". Also, given the release date of 1992, *Snow Crash* straddled the edge of the birth of the internet IRL (in real life), and was provided with the place of privilege of being the most recent work in people's memory as they became exposed to the World Wide Web—it sparked the imaginations of those who thought "this is how it should be".

And what was it that Stephenson envisaged cyberspace as? As mentioned, *Snow Crash* was a more technologically detailed work. The interface and actual method that the computer employs is spelled right out:

> In this way, a narrow beam of any color can be shot out of the innards of the computer, up through that fisheye lens, in any direction. Through the

> use of electronic mirrors inside the computer, this beam is made to sweep back and forth across the lenses of Hiro's goggles, in much the same way as the electron beam in a television paints the inner surface of the eponymous tube. The resulting image hangs in space in front of Hiro's view of reality. (Stephenson, 1992, p.23)

Stephenson's metaphor for cyberspace begins with the Street, the main thoroughfare of the architecture of the virtual world, the Metaverse:

> The dimensions of the Street are fixed by a protocol, hammered out by the computer-graphics ninja overlords of the Association for Computing Machinery's global multimedia protocol group. The Street seems to be a grand boulevard going all the way around the equator of a black sphere with a radius of a bit more than ten thousand kilometers. That makes it 65,536 kilometers around, which is considerably bigger than earth. (Stephenson, 1992, p.24)

But he clearly informs his readers what the reality of the situation is: The only difference is that since the Street does not really exist – it's just a computer-graphics protocol written down on a piece of paper somewhere – none of these things is being physically built. They are, rather, pieces of software, made available to the public over the worldwide fiber-optics network. (Stephenson, 1992, p.25)

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With the close of the 1980s and the dawn of the 90s, consolidation was beginning to occur in the computing industry. Options still existed for the consumer, but they were slowly becoming more focussed, more centralized, more consistent. Quantum Link had rebranded itself as America Online (AOL), and had shifted its support to the Microsoft-Intel platform, which was beginning to dominate the PC market. Based on advances in modem technology, AOL was now offering connections at up to 14,400 characters per second through a multiplexed 2400-Baud system, though its servers could rarely sustain that much throughput. AOL's servers started hosting the first graphical MUDs as the titles began to appear, such as SSI's *Neverwinter Nights*. These combined the earlier text-only games with a graphical engine, to provide a visual online universe that mirrored Vinge's description in "True Names" from a decade earlier.

Intel had released its next-generation processor, the 80486, whose on-board floating point unit (FPU) allowed it to handle the complex mathematics required for 3D visualization more easily than any of its predecessors. SVGA video had proliferated since its introduction in 1987, and most PC users could now obtain resolutions of 1024x768 and 16-bit high colour, approaching the minimum specifications for 720p hi-definition television common in 2010. True 3D gaming was also right around the corner: *Ultima: Underworld* had just been released in March of 1992 by a company in Cambridge, MA, and a company in Austin, Texas named id Software had released a 3D maze game entitled *Wolfenstein 3D* to some acclaim, and were working on their next title, something ominously called *Doom*.

Nintendo also released a next-generation system, doubling the capabilities of the old 8-bit NES with their Super Nintendo in 1991. Nintendo were facing a challenge from their rival, Japanese arcade manufacturer SEGA and it's own line of branded consoles. Consoles had effectively diverged from the PC market and were now functionally discrete, unable to match the computing power, but instead capturing marketshare through their lower price-points. Portable computing was becoming more viable as an option with the release of the first Macintosh PowerBook by Apple in 1991, and the continuing improvements being made to IBM's line of laptops.

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By 1992, all the necessary components were in place for the development of virtual reality systems to begin in earnest. The technological pieces were largely available to the home consumer, though they were rarely all together in one place. Graphics were constantly improving, and the Internet and its associated technologies were deployed widely enough that access was within reach. Sutherland's requirements moved from being doable on a single system, to being available on a single chip, as the first GPU (Graphics Processing Unit) add-ons were being released to the high-end market.

In the early 1990s, two parallel strains of VR technologies began to be assembled. First, due to some side-effects of Moore's Law, the computer hardware became smaller, faster, and cheaper. This meant that higher-resolution displays and the technologies could develop along both strains—one bound to hardware, and one simulated within the computers themselves.

The inaugural demonstration of the CAVE system at SIGGRAPH 1990 is indicative of this change. With increased power, a return to earlier visualizations took place — in this instance Myron Krueger's virtual space, as influenced by the memetic aesthetics of Vinge & Gibson. With computers powering a set of linked projectors, displaying a contiguous image on every surface of a room, a sense of being in an Other Place was provided. This was still a bit out of the reach of most consumers, however.

The other emergence from this period *was* within range of consumer's pocketbooks. Smaller, more personal virtual worlds held within the confines of a personal computer were being developed at a growing rate. With more powerful processors in the new generation of machines, it was easier to construct and display a 3D space on the 2D monitor.

A boom in 3D and 3D-like games followed.

It is unlikely to be coincidental that Stephenson's vision of VR also more closely hews to the memetic lineage that followed from the other authors. The form follows the mythic creation, and failed implementations are cast down like false idols. How these would contribute to the actualization of the science fictional visions would show up in the works of those lead users, who were designers and developers in addition to being consumers, of both the technologies and texts.

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Stephenson provides the closest example to Drout's rule-based model of memetic change. His technical precision about the implementation can be seen as prescriptive. Indeed, as Abrash's quote "I know how to do 80 percent right now – at least theoretically" demonstrates, it was this prescription that enabled some of the technologists to figure out what already existed, and what had to be invented, much like Ivan Sutherland had done before them. Stephenson represents the apotheosis of this development process, as *Snow Crash* presents the design aspirations of the developers of virtual reality in the real world in the most true-to-life form, but at the same time Stephenson rejects the technologist's vision, and casts it down. The VR paradigm of datagloves and a head-mounted display is cast as a pejorative in it's employment by the 'Gargoyle' within Stephenson's world. This user is a pariah, not something to be emulated, and with it the version of VR interface design that had been developed to date by researchers such as Brooks, Lanier, Rheingold, and others is dismissed. The other paradigm, that of unrestricted interface, as used by the novel's protagonist Hiro, and more in line with Krueger's work, is the form of the technology that is to be the blueprint for the future.

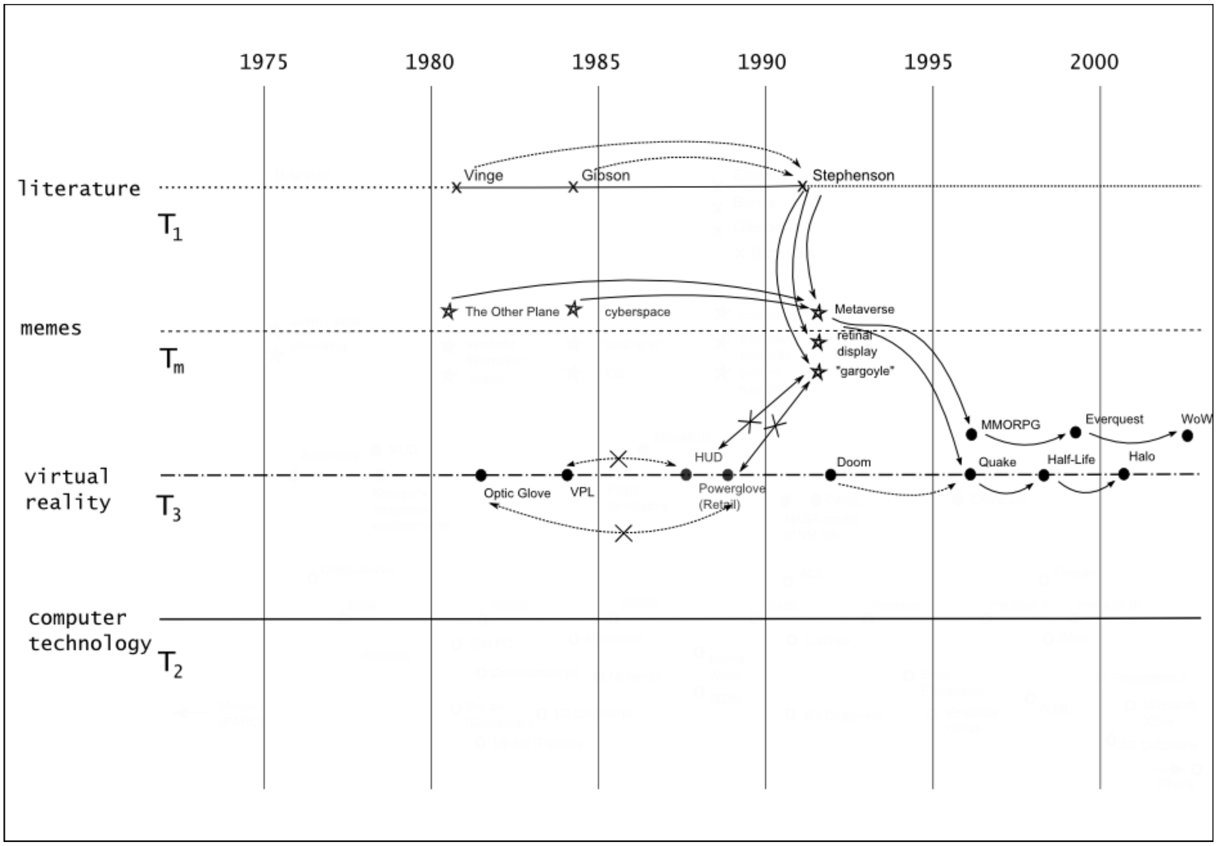

Figure 4.5: Connections - Stephenson

Stephenson's explicit rejection of several of the current technologies of VR, such as the 'gloves & goggles' approach, can also be interpreted as rule-based. It is explicit in its condemnation of that approach to VR through framing the implementation as a pejorative. Though a single work is not enough to 'slay' the meme, it does provide enough of a reason—Drout's '*justificatio*'—for not proceeding down that path.

So what effect did Stephenson have with *Snow Crash*? Because much of the wave of cyber-hype had passed as noted earlier by Bartle, the direct connections *Snow Crash* had with innovation are more obvious. [Stephenson's] technically precise voice made it easy for those with a technical background to see what needed to be done to actualize the vision. Michael Abrash, who worked with id Software in 1995 recalls a meeting with id lead programmer John Carmack:

> Like most graphics programmers, he often theorized about virtual worlds. When [Michael Abrash] read Snow Crash and the description of the Metaverse, he'd thought 'I know how to do 80 percent right now – at least theoretically'. There was no question in his mind that he was sitting across from a twenty-four-year-old [in John Carmack] who had the skills and confidence to make it happen." (Kushner, 2003, p.189-90)

> The challenge, as Abrash heard it, was to increase cyberspace through 3-D graphics and a persistent online world—an alternate world that would live and breath around the clock, waiting for players to cohabit. (Kushner, 2003, p.189)

For developers like John Carmack this was serious business. Upon reading *Snow Crash*, his words to his coworkers at id was that: "It's a moral imperative that we must create this" (Kushner, 2003, p.178) id software had first worked on a game to achieve this called *Quake* in the early 1990's, but had given up because the technology in the consumer market was not yet powerful enough to do it justice.

> The problem, [Carmack] found, was that the PC was not powerful enough to handle such a game. Carmack read up on the topic but found nothing adequate for his solution. He approached the dilemna as he had in the Keen [a previous game released in 1990]: try the obvious approach first; if that fails, think outside the box. (Kushner, 2003, p.82)

Again we see echoes of Sutherland's design process come to the fore. Assemble what exists and develop what is needed to get the job done. This continued process drives innovation, as existing technologies are co-opted into new forms as developers strive to implement their literature-inspired vision.

> Abrash chose Carmack over [Bill] Gates. The potential at id was too great, he thought; he wanted to have a front-row seat to see that breakthrough virtual world, that networked 3-D world, evolve. (Kushner, 2003, p.190)

4.6 Virtual Reality into the Nineties

Stephenson marks the last major literary work of this study, but the development of virtual reality has proceeded in the two decades since its publication. The memes that were born in the various works—cyberspace, avatars, hacking black ice, and wiring in to the computer—have persisted over time, with new attempts being made to realize them as the technological capabilities of modern computing increases. This development has been conducted down three paths.

The first development path has been that of constructing virtual rooms—systems such as the CAVE & VIDEOPLACE. It is the refinement of Myron Krueger's original conception of a "responsive environment", and the number of sites where these rooms have been deployed has grown significantly since the 1990's. The technology is still priced out of the reach of the average consumer, and we can see how this has slowed its adoption.

The second technological path is related to the first. Though framed negatively by Stephenson in *Snow Crash*, the data-glove and goggle approach continues to be developed. Aspects of the technology are key components of the CAVE and related systems.

The influence can be seen in the current proliferation of 3D film technologies, and the slow adoption of home systems that do the same. The key factor of these newer implementations is how much they've merged into the background. The bulky equipment of yesteryear is mostly gone, and the new forms are much more intuitive to use.

The final technological path of virtual reality development is the largest. The proliferation of virtual worlds that attract a paying audience of consumers has grown exponentially in the last 20 years, with revenues equaling and surpassing Hollywood blockbusters, and games such as *World of Warcraft* have monthly subscribers numbering in the millions. By shifting development inwards, by making sure that the virtual world that a customer visited was as engaging as possible, the developers were able to build small, and then grow as the other required technologies matured. Foremost, as the games (and the worlds within them) increased in detail and resolution, the need for goggles and gloves became less apparent.

> Players didn't need virtual reality goggles to feel immersed. In fact, the sense of immersion was so real many began complaining of motion sickness. (Kushner, 2003, p.114)

With the release of what has been termed 'fifth-generation consoles' (Wolf, 2008) starting in 1993, the market for theses smaller virtual spaces had grown. The hardware was able to do more of the tricks, and even though the Intel-dominated personal computers far surpassed the consoles technologically, the consoles were able to render 3D images for display on home televisions. Work on the PC still led the way in creating these new environments. id Software, one of the early leaders, began exploiting the hardware capabilities:

> "We should focus on doing a generalized infrastructure. . . and doing a

> game as one element of this generalized infrastructure which can have a lot of the 3-D web environment that people always are thinking about and wishing about. We can do it now." This was it—the culmination of his work, his engineering, the dreams of science-fiction writers from Aldous Huxley to William Gibson. The HoloDeck, Cyberspace, the Metaverse, the Virtual World, it had been called by many names, but the technology was never ready to bring a true glimpse of that place—however primordial—to life. That time, Carmack concluded, had come. (Kushner, 2003, p.283)

The developers at id Software returned to their earlier attempt at a virtual space, *Quake*, in order to push those limits. The influence behind it was clear:

> The idea [for *Quake*] came straight out of their old Dungeons and Dragons games.... Id had first worked on a Quake game back in the early Commander Keen days [about 1990] but gave up because they felt the technology was not yet powerful enough to do their idea justice. Now, Carmack said, the time had come. The technology was ready to make the most convincingly immersive 3-D experience yet.... (Kushner, 2003, p.178-179)

The actual method that was undertaken in the development of these products more closely resembles the processes of technological development described earlier by Raymond Williams and Ivan Sutherland. Now that these versions of virtual worlds were able to be constructed entirely in software, existing solutions could be adapted to the problem, and new software solutions developed where necessary. "Carmack's research into 3-D graphics was on a more intuitive level... his focus was not on chipping away at some grand design of such a virtual world but, rather, on solving immediate problems of the next technological advance" (Kushner, 2003, p.81).

That the solutions to these problems tended to be in consumer products that sold large volumes and spurred countless competitors changed the dynamic of computer development. "His [John Carmack's] innovations in graphics programming were among the reasons why, as MIT's *Technology Review* magazine put it, 'video games drive the evolution of computing' (Kushner, 2003, p.294). The rise of virtual worlds became a significant factor in the development of computing technology in the 1990s.

These development paths do not exist in isolation, however. There is an incredible amount of overlap between them, and development in one area invariably will show up in the others. The rise of consumer-grade, ultra-large flat screens has meant that wall-size displays are more affordable than ever, providing an ever increasing CAVE-like situation in the home. The motion-sensitive input of datagloves can be seen in the latest videogame controllers such as Nintendo's Wii and Sony's Sixaxis. And the audience for videogames themselves have grown significantly, with more people taking part in them on a daily basis.

The outline of the four parallel threads in this historiography displays how the parallel streams can be connected, how the technological development and literature parallel each other and engage in an act of mutual co-creation, through the memes that are shared through the science fiction literature and technological artifacts. The implications of this co-creation has for technological studies follows in the concluding chapter.

Chapter 5

Endgame

Attempting to chart the influence on the development of a technology, removed in both time and space from its genesis, is fraught with perils. The complexity of the task is apparent when viewing virtual reality as a technological system, distributed over multiple locations and evolving over time in the form of its implementation. However, as with Raymond Williams' investigation into television, much can be said about the development of VR from charting its history. In an effort to mitigate these challenges, taking a broad perspective and returning to first principles with an evolutionary theory such as memetics proved fruitful. By adapting memetics to the textual analysis of a cultural product such as literature, an answer can be given to the original research question of how contemporary designers of virtual environments have been influenced in their design by literary examples in science fiction.

5.1 Analysis

The manner in which the memes related to virtual reality—specifically cyberspace, avatars, interfaces, and hacking—came to be embodied in the technological artifacts and systems presents an interesting example of the influence of literature on technological development. By untangling these threads, the traces of their deployment can be shown. Each of these threads weaves its way through the warp and weft of the timelines, appearing and reappearing in many places along the way. The major thread is that of cyberspace itself. From its early representation as a place of symbolical interaction in Vinge's The Other Plane (p.52), to the now-reified concept of the matrix as presented by

Gibson (p.59), through to Stephenson's Metaverse (p.74), the meme of cyberspace has been remarkably consistent and stable through its iterations. Observing Figure 4.3 and 4.5, the development path of cyberspace can be seen. There clearly is some imitation going on, and as the chief method of memetic transmission this is to be expected, but the vision of cyberspace was not static—there was some variation over time, highlighting the evolutionary nature of the process. What is notable is the manner in which the meme became more technically precise as it incorporated ideas from the technological realm. At first, hardware limits restrained the ability of the developers to implement the meme as envisioned (p.52-53). As graphics programmers became able to realize the earlier visions of Vinge and Gibson, later copies of the cyberspace meme such as those of Simmons and Stephenson incorporated the developers' attempts, and were more representative of what could be achieved. This can be seen in the quotes of Carmack and Abrash (p.79), where the technical capability of the hardware and software began to align with the vision of the authors.

The other major thread woven throughout the narrative is that of the interface. The means by which one engages with a virtual world featured prominently in all the stories, even though there was a high degree of variability over time. Figure 4.5 shows the most complete example of the path of interface meme. Here we have two parallel threads, as the actual technical hardware—be it Krueger's rooms, Sutherland's systems, Fisher's goggles, or Lanier's datagloves—had its roots in the development work done in the labs of the 1960s and 1970s. The meme as presented in literature was quite different as the level of mediation was reduced through direct-brain (p.65) or EEG connections (p52-53)—an auto-amputation of the self as it is connected to the virtual world. The technical developers were not able to recreate that meme with the technology available. The interesting thing in this thread is the rejection of the hardware by the literature, as seen in the pejorative framing of the Gargoyle by Stephenson (p.77). This rejection is something that is unaccounted for in memetic theory, nor was it accounted for in Drout's sub-memetic typology (p36-37). This rejection also provides an interesting counterpoint to the spread of memes by imitation—it highlights the aspect of Differential Fitness that is a key component of evolution, and suggests that the hardware lacked the "fitness" for the environment.

The popularity of the meme of the avatar grew immensely during the period observed by the study, as more people came on line, or began playing games that situated them in a virtual space. However, the avatar as a memetic concept changed relatively little since it was mentioned in "True Names" (p.52). The meme was adopted wholesale, and reproduced with a very high fidelity in future works of both literature and technology. Figure 4.3 shows the path this thread has taken. Gibson's version of the avatar differs little, if at all. The author focuses more on the existence of human-like avatars, whereas Vinge left open the possibility that non-human creatures or inanimate objects could also represent an avatar in the virtual space. Gibson's later work incorporates these changes, and by *Mona Lisa Overdrive* (1988), the full range of avatars was once again explored. Other titles in the era of proliferation also copied the avatar meme. As every title had an instance of cyberspace, they all required some way to represent the stories protagonists or other characters within the virtual space. Stephenson rounds out the portrayal of avatars in much the same way that they began (p.73-74). Like Gibson, he too focuses on anthropocentric forms, but they behaviour and actions are largely the same as that presented by Vinge.

The other meme, of the hacker and console cowboy, was not original to science-fiction, representing archetypes more familiar to the noir or western genres, and as such represents a injection of new material into the meme pool. This meme also enjoyed a remarkable longevity—in this study it first showed up in Brunner's work (p.48; see also Figure 4.2). The degree to which the meme was taken up by members of the computer community, from Morris (p.50-51) to Pengo (p.66) and others, is indicative of how influential the hacking meme was in the real world. This meme also differs to the others to a degree because it is the least hardware-bound of the memes. Obviously, to hack a network requires technological system on which to act, but the act of hacking is relatively agnostic as to what is being hacked. The meme is simply applying similar activities in a new environment.

Finally, some of the new memes that first saw light during the era of proliferation—concepts such as pervasive networks and ubiquitous computing—have since evolved within their own technological spheres, outside the realm of virtual reality. These were only shown on Figure 4.1. They have different histories that need to be written, histories that are beyond the scope of this current project, but indicative of how intertwined the evolutionary landscape of computing is.

5.2 Media and the Development of Virtual Reality

The first thing to note is the obvious: did science fiction literature influence contemporary designers, and the answer is an emphatic "Yes!". But the degree to which this influence plays in the design is more difficult to quantify. So rather than engaging in a potentially fruitless quest to measure the 'gravity' of any given 'idea', the thick description born out of the textual analysis of the historical period shall inform the extent to which cultural influence plays a role in the development of a technology.

Within this process, it is not technological determinism that is occurring, but rather the memes are *technologically bound*. There are limits to how they can appear, and these limits are imposed by other components of the technology. If each new technology is based on assemblages of previous technologies, as per Williams (1974) and Arthur (2009), then the current technical landscape provides an environmentally-imposed limit to the capabilities of a new technology.

Whether this specific instance of VR development is evidence of a general process of "media influence on technological development", only an inference can be made. Obviously, if there is evidence of a specific case then a more general model must also occur, but the field is too broad, and too little was answered here to theorize on a general process at this point in time. This question must be tabled for the time being, and returned to at a later date.

5.3 Memetics and Innovation

Using the memetic theory to explore the role of technological development has been both a blessing and a curse. The curse first: the theory as it is commonly understood is fraught with problems, but a close examination of the underlying assumptions behind memetics suggests how these may be remedied. The misconceptions born from the popularization of memetics have inhibited actually doing research with the theory as a guideline, and too much time gets spent on steering the discourse back on topic.

However, as Michael Drout has shown with his historical approach, there are ways to apply memetic theory to a literary source. By using a variant of his approach, I was able to chart the interactions between various cultural products. A genealogical approach focusing on the memes (i.e "memealogical") may also prove informative for future studies in this area.

That this breakthrough in using memetics came from scholarship in the humanities should be a revelation to those within the hard sciences that have tried to make memetics workable as an empirical science, or those within the social sciences that have scoffed at the very proposition. Sometimes rolling up one's sleeves and getting down to business is the way to move forward, and memetics may prove fruitful for future explorations of epistemology.

With respect to Edmonds three requirements for a full theory of memetics—a conclusive case study, when to use memetics, and a simulation—Drout's study (2006) has largely handled the first objection, and partially answered the second, as memetics clearly worked for his specific case study of literary archives. As I hope to have demonstrated, memetics may also be useful when looking at the intersection of cultural and technological evolution. The third objection of Edmonds is outside the scope of this current project, though it may become clear how such an undertaking may be conducted.

5.4 Conclusions

What then, are the main results of this study? Five things are apparent: media's influence, fiction's role, technology's lag and path dependency, the mutual co-creation of technology and culture, and memetics' role as a bridge. Does media influence the development of a new technology? Yes, however, it is hard to quantify the degree to which media—mass or otherwise, and specifically science fiction literature in this case—plays a role. The important thing to note is that the media *does* play a role; this has been underexplored except in rare instances in much of the work done on Science and Technology Studies to date. While media does fall under the umbrella of the social realm, it has rarely been the explicit focus of research, and the processes by which media influences the social realm are varied enough to constitute a field of study in its own right. An investigation into the social practices surrounding the innovation and development of a new technology must take media influence into account.

Secondly, the way that mass-media, especially fiction, accomplishes this agenda-setting is through invoking the sublime in the audience that consumes it. This allows the authors to invoke visions of what the technology may be capable of, even though it has not yet come to pass. This was evident in Bainbridge's work (1986), and it is evident here as well.

Third, due to the nature of the development cycle, the technology will lag behind the vision that has been set forth. By the time the technology has caught up, it is has become subsumed into the background (Borgmann, 1984; Mosco, 2004). Occasionally, it may appear that a technology has caught up to the vision, but it is possible for the particular implementation of that vision to either be accepted or rejected—as was seen with Stephenson's *Snow Crash* (1992)—and the development may continue in the desired course. This is also indicative of how path-dependant technolgical development is—regardless whether the path is real or imagined.

However, the fourth finding shows how neither culture nor technology develops in isolation—they are *inextricably intertwined.* There is a process of continuous interplay, of *mutual co-creation* that occurs during the development cycle, and this interplay between the two is incredibly dense. The science-fiction literature itself is often informed by leading-edge scientific and engineering breakthroughs. The literature provides the "development space" by which the possibilities of a new technology can be explored, and can spur the development of the technology by those who echo Jack Womack's thoughts of "That's so cool" that opened this thesis.

Fifth, and finally, a broad and agnostic approach to memetics holds some promise, but a larger data-set needs to be employed to fully explore the process. Finding the rejection of certain approaches in the interface meme and the combinatorial effects that occurred in both the interface and hacking memes is different than what the normative memetic theory would suggest. Asking "how ideas breed, not how ideas spread" is like trying to bridge the difference between Darwinian descent with modification and abiogenesis: related, but separated by a vast gulf. More needs to be done in this area.

5.5 Problems and Drawbacks

There were a number of problems with the study that need to be addressed. These fall into four categories and include the paucity of evidence, the spread of the evidence across multiple mass-media types, overcoming problems with the theoretical model of memetics, and lack of access to first-party sources.

The paucity of evidence refers to issues with the specific mentions of the literary texts within the source material mentioned in Section 3.2. While many sources would cite William Gibson's *Neuromancer* as an influence, for example, this would often be done in a very off-hand and indirect way. While those sources that did provide direct linkages were informative (e.g. Hafner and Markoff, 1991; Kushner, 2003 and Bartle, 2003), they were few and far between. For some of the other texts that made up the timeline of development (e.g. Simmons, 1989; Banks, 1988), there was almost no mention at all within the development literature. This might be due to the sources chosen (though they were award-winning titles in their years of release), or due to the questions that were being asked by those exploring the secondary sources.

The second problem with the sources that soon became apparent was how porous the boundaries between media are to the memes. This presents an interesting problem in and of itself, as mentioned above, but is also challenging when focusing on a specific media-type as a "substrate" in which to study cultural evolution. One must choose whether to focus on the media or the meme, and it appears that one might need to return to Dawkins' "meme's-eye-view" to see the path travelled, or be content to watch the memes flit in an out of existence in a given media over the course of time. As it stands, charting memes in one media is akin to paleontology, hypothesizing on a creature with only sporadic appearances in the fossil record, without the benefit of a Burgess shale analogue to unlock the mystery.

This leads into the third major problem, that of systemic problems with the theory of memetics itself. It appears that the objections of Edmonds—lack of a conclusive case study, deciding when to use memetics, and no predictive simulation—were well-founded, but it is possible for each of them to be addressed going forward. The solutions of Leskovec et al. (2009) to charting the transmission of specific memes, and the textual solutions of Drout (2006) in viewing historical archives both point to a way forward, and the potential that memetic analysis may have for future investigations of cultural products.

Lastly, directly interrogating some of the developers involved in the creation of virtual reality, either through interviews or other methods, may clear up some of the ambiguity involved with charting memes based on third-party sources. As very few of the data sources directly answered the questions of whether media influence played a role or not, this may prove fruitful. There are still problems with using interviews, as a degree of *post hoc* rationalization may occur as the events fade into memory, and other issues of recall may abound.

5.6 Future directions

While this study can only be considered an initial exploration of the process of media influence on technological development, the potential for future development should be self-evident, and fall into three categories:

<u>More media.</u> As mentioned above, charting a specific tech through *all* media appearances would provide more evidence for the evolution of a given cultural meme. This is suggested with the full knowledge that it would be a much larger undertaking than this study, and would likely need a more narrowly defined focus to be feasible.

<u>Different technologies, different eras.</u> Other technologies which have been heavily represented in science fiction are now in development and deployment, including robotics, nanotechnology, ubiquitous computing, and human-computer interface design. Any or all of these could prove fruitful for study, and increasing the amount of 'stuff' being studied may allow for interesting effects to come forth from the interplay between various technologies in their development.

<u>Non-technological cultural evolution.</u> Do the general principles of cultural evolution hold true if applied to a non-technological cultural object? Alternatively, how well can cultural

entities such as ideas, ideologies, cultural tropes, etc. be traced through the media? While there has been preliminary work done on this subject, from both an evolutionary and epistemic or textual framework (Drout, 2006), there could be more work done on this subject.

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