The poetics of digital media: a model for interaction, representation, structure and algorithm articulated via a system for human-computer expression

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Declaration

I certify that except where due acknowledgement has been made, the work is that of the author alone; the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; and, any editorial work, paid or unpaid, carried out by a third party is acknowledged.

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TABLE OF CONTENTS

TABLE OF FIGURES

Abstract

This thesis investigates the poetics of digital media via a practice-based research methodology. It aims to articulate its endemic properties and unique characteristics through a model that is based in a poetic system for human-computer expression. It draws upon game studies, semiotics, ontology, systems to explore media creatures, audio-visual syntax, world as language, and process as communication. Its poetic language is used to develop a set of relations, interactions, processes, and expressions articulated across interaction, representation, structure, and algorithm. These are analysed in relation to time, multiplicity, adaptation and transmutation—resulting in sixteen aspects of digital media. A series of case studies that demonstrate the model in action in play, development and analysis lead to speculation on the further application and evolution of its poetic language.

1 Introduction

What is digital media? More importantly, how do we use it to communicate and express ourselves? Each generation of media has particular modes of operation and codes of understanding that evolve to form the conventions of that particular medium. They become its language. Digital media has been evolving for a few decades and has marked out a diverse and wide-ranging territory of human communication and expression. The thesis will explore this territory via a decade of practice-based research. The thesis aims to articulate *its own* particular modes of operation and codes of understanding in terms of a poetic language. We will begin with the mediasphere that permeates our world.

Media and communication have undergone dramatic change over the last century. In a mediated world, such change makes significant impact on both personal and cultural identity. New modes of communication enabled by digital media have transformed the way we understand our world and how we express ourselves. The rate of change and extent of its effect have marked this most recent revolution in communication as particularly significant. Technologies such as the World Wide Web (the Web), email, digital games, DVD and digital photography have had widespread effects in mainstream, everyday life within the developed world. This has occurred in almost all aspects of life: business, recreation, social relations, and the arts. These uses of technology are largely driven by socio-economic factors: wants and needs rather than the technology itself. With a significant proportion of the world population offline, many other uses of this technology may go undiscovered—as digital media is not exposed to the variety of cultural experimentation and interpretation offered by communities and societies without access to it.

This revolution in communication and media is also significant in that it ‘affects all stages of communication, including acquisition, manipulation, storage, and distribution’ and ‘all types of media-texts, still images, moving images, sounds, and spatial constructions’ (Manovich 2001, p. 19); meaning that practically everything is open to redefinition, hybridisation and transformation. It has ‘engendered a radical reorientation in the way that people write and read, and hence think’ (Lunenfeld 2000, p. 44), suggesting that it is not only our communication technologies that are changing, but also the logic and process of constructing meaning. The idea that digital media are new processors and generators of meaning can be seen in the view of ‘the computer as a symbolic system, a machine that traffics in representations or signs’ (Johnson 1997, p. 15). The significance of this can be seen in the ways in which digital media has become embedded within our everyday reality, becoming second nature to us as humans augmented by, and dependent on, technology.

These new systems have become an integral part each of us as a posthuman being—'a material-informational entity whose boundaries undergo continuous construction and reconstruction' (Hayles 1999, p. 3).

Although the history of digital media is relatively short, it is characterised by rapid evolution featuring multiple shifts in its use and capabilities. Inside every computer are the basic elements of a radically different way of communicating information and expressing meaning. However we are far from understanding digital media on its own terms. Analysis is typically translated through older models of communication and media. While these models do not deny that digital media has its own properties, there are inherent limitations to using models that emulate the past.

This thesis aims to identify endemic properties and unique characteristics of digital media within a model for its articulation, analysis and design. It aims to identify and articulate processes of communication and forms of expression that are unique to digital media. In this aim, the approach is twofold: firstly, to develop a model informed by digital media forms such as entity, icon, world and code; and, secondly to use this model as a more general tool for analysis of a wide range of its past, current and future forms. In this sense the approach is diachronic: it aims to develop a flexible, adaptive model sensitive to change over time rather than a closed or prescriptive system. Likewise, while developing a model is by its nature a structural approach, the emphasis is on an open structure that may vary in interpretation depending on context, rather than on a formal system. Examples of work may include new analysis of some of the more established forms of digital media, through to works that push the boundaries of the form—such as digital games, experimental interaction design, electronic art, and alife research. In summary the goal is to provide a continuum of activity across generations via a model that may be applied in a variety of contexts ranging from experimental works to more established forms of digital media.

At its inception, this investigation had two goals. First of all, it began as a broad theorisation of digital media that could be applied to many different applications and contexts. However, its secondary goal was to present a novel view of digital media forms and practices—a goal connected with my own idiosynchratic digital media arts practice. As a result, along the way two developments were significant: digital media became less generic and increasingly fragmented into specialist areas of practice, and my own practice became more tightly focussed and particular to my own idiosynchratic view of digital media. Subsequently, this became the overarching goal of the investigation: to find a model that works in conjunction with my own creative work to articulate this particular viewpoint.

This is not so much about digital media itself, but what can be done with it. Particular forms of expression are enabled by its unique combination of elements, and this is the subject of this thesis—making worlds, building alife, creating languages of interaction, and constructing systems. All of these activities may be traced to individual media histories, but have found a single form of expression in digital media. This is not to suggest that there can be a single definition of digital media. Far from it—what is presented here is a specific vision that is drawn from experience in the development of digital media art. New forms are emerging and will continue to do so with each evolution of technology and audience. For example, the line between creator and player is becoming increasingly blurred as systems for user-created content are developed. The thesis will outline this particular vision in terms of a practical and pragmatic model.

In this way, the approach begins with my own art practice. Via a series of artworks, the nature of digital media and in particular its language has been explored via a model for its development and analysis. The model outlines the system used in these works; it opens them up for further work—either theoretical, practical, or like this document, a coupling of theory and practice within one ongoing process of investigation. This process is heuristic, the production and analysis of each successive work being informed by that which precedes it. Every iteration of the model documents the successes and learns from the failures of each artwork, and those elements of digital media language identified and explored during production.

1.1 What is digital media?

Humans have used technologies to enable and augment communication and expression for generations. Developments such as the alphabet and related technology for writing had a significant impact on ancient civilization. The capacity to cheaply duplicate and distribute written texts enabled by the advent of the printing press had a similar effect. These two moments in history are often described as the first and second revolutions in communication. We are currently living amidst the third major communication revolution enabled by networks, computers and digitisation (Toffler 1980).

There are many media that predate our current generation of digital forms of communication. For several generations the telephone has allowed interactive communication over a distance. Sound and image have been instantaneously broadcast to millions of people for several decades via radio and television technologies. Elaborate fictions have been constructed in cinema for over a century. However, many aspects of the current generation of media signify a shift in the nature of these new forms of communication and expression.

We have computing machines that can operate autonomouosly, fictional worlds that may be shared across global networks, and new literacies grounded in computation and process.

Although, in its short history it has been named ‘digital media’, ‘multimedia’, ‘interactive multimedia’, ‘new media’ it is difficult to find any definitive denomination. The term ‘interactive media’ describes the essence of the medium: media that requires input from another agency to be properly experienced and understood, and which provide reaction and feedback to that interaction. However, the term does not specifically describe the interaction as computer-mediated—an important factor, as the computer itself is the source of many attributes of the medium. I do not seek to establish a definitive name, but for the sake of this document I shall use the term ‘digital media’. This is inclusive of the computational nature of the medium, and not as general as the term ‘multimedia’.

In order to establish a holistic understanding of digital media, we need to define a set of properties for this definition of digital media that spans all genres and delivery platforms. This definition may be broken down into a number of criteria. It is based on common features observed in practical experience during play, development and analysis of digital media; it draws upon terminology and language used in existing texts outlined later in this chapter. Digital media:

- is *electronic* in that the content, or data, is stored in an electronic medium
- uses *dynamic storage*. The data can be stored, accessed and updated
- is not defined by *a specific delivery platform,* such as a personal computer or gaming console. The data may be translated across a range of different forms
- includes an aspect of *computation*, typically expressed in terms of algorithms and programs that can manipulate and generate data
- has *connectivity*—sharing data across a network or other connection
- includes *interaction,* usually facilitated via an interface that allows the data to be manipulated, navigated, changed, or for new data to be generated
- has a *hybrid nature*, in that it includes elements from a range of disciplines or a number of different media types
- is *technology dependent* because it is affected by the constraints of the current generation of technology.

Using these constitutive elements digital media may include virtual reality, computer-based training, electronic art, video games, virtual pets, interactive video, computer games, CD-ROM, DVD-ROM, the Web, information kiosks, virtual communities, site-specific installations and digital media art. In order to test this definition we must put the question, what doesn’t fit these criteria?

Static forms of digital data storage (such as Audio CD, DV tape and DAT) lack the dynamic qualities of digital media. The data cannot be changed; they have no software and only a simple interface. However, in the very act of becoming dynamic digital media such forms gain the potential to be duplicated, copied, edited and distributed—even though initially stored in a static form. Once the tracks of the audio CD are digitised into files, the possibilities change dramatically. Digital files may be easily transferred across a network. In the case of music this practice has become so popular that it has become a major issue for music publishers. Once digital, the music can be easily remixed, edited, combined with other media such as animation and video, and so on. One thousand songs (or more) may be randomly accessed during play and each song assigned a category and rating by the listener. The songs may be sorted and selections stored in playlists: each collection of files is stored in a database. Simply by becoming digital, the way that music is played, distributed, and listened to has been changed. Although generally digital data is not digital media, in the act of becoming digital it gains the potential to become digital media.

Video has undergone a similar transformation through its transition from analog to digital distribution on DVD. Videotape is linear and interaction is limited to spooling backwards and forwards through the tape. However, even the simplest DVD interface allows instant access to a number of index points throughout the video content. The soundtrack is remixed for 'surround sound'. Often the interface allows the selection of multiple points of view or other variations in the viewing experience. Typically, the primary content of a DVD is extended through the inclusion of other media, such as images, text, audio and animation. Most films presented on video are approximately ninety minutes in duration, but this time can be extended through the extra layers of data that can provide context and additional meaning. Therefore digital video may be classified as digital media if suitable data structures and opportunities for interaction are established to facilitate this.

One of the first media to be transformed by digital media was text. Hypertext creates networks of meaning through linking key words and phrases to other parts of the same document or to other data altogether. Different media types, such as images and sound, may be embedded in the text. On the Web this process of linking is extended to the possibility of directly linking to any other document that is online. Books may be opened and read at any page, but well written hypertext makes sense wherever you start. Footnotes and references are included in books, but the data itself is not directly accessible. More recent forms of hypertext have allowed for the manipulation of the text itself and connection to live sources of data. So, a digitised text in itself is not digital media, but one that includes links or other media is included in this definition.

More radical forms of digital media can be seen in digital games that use realtime simulation and rule systems to generate complex interactive experiences. Games existed before digital media, but in the electronic space of the computer they become worlds in themselves. These worlds are made of data and routinely combine many different types of media in a fusion of interaction and storytelling. The behaviour of characters in these worlds is often driven by Artificial Intelligence (AI); aspects of the environment, such as atmosphere and lighting, are generated by computation. The new experiences offered by these games are one of the most obvious examples of the potential of digital media.

This model is ambitious in its aim to be relevant to all forms of digital media that fit these criteria. However, it does have its specific origins and interests. While it aspires to be a general, all-purpose model it starts with a specific vision of digital media. What are the particular forms of human-computer expression that demonstrate its specific codes and modes of operation? This set of ideas creates and articulates a particular vision; in doing so it also provides an alternative way of looking at all digital media as these properties and characteristics are common to all forms, simply expressed in different ways.

A general definition of digital media has thus been provided, based on its most commonly recognised properties and characteristics. In themselves they do not provide significant insight into its nature. The definition encompasses not one medium, but a number of different media that share common attributes via their digital nature, and the effect of aspects such as computation and interaction. By exploring other possible meanings and aspects of these criteria we can gain a fresh perspective. Let us look at each of the digital media criteria in turn.

As an *electronic medium* it is made of fundamentally different material that in itself has its own properties and aesthetics. This materiality is fabricated from units such as pixels and samples, vectors and polygons, datablocks and logic circuits.

In particular, the aspect of *dynamic storage* means that the content of digital media is not fixed. It may be updated, filtered, mutated and replicated. New content may be generated, recombined, collated or even created by players themselves.

As it is not experienced via a *specific delivery platform* digital media may be expressed in any number of different ways. It may cross over different media, each offering alternative representations of the content that may occur simultaneously or be linked via a flow of content that traverses different media.

The aspect of *computation* allows operations that produce varying output based on the definition of logic and parameters to generate output. Digital media has a 'decision-making' ability (although this is very different from the capacity of the human brain to make decisions): developing its own logic via its capacity to perform complex processes and develop alternative ways of being, via alife and genetic programming.

Via *connectivity*, digital media can be collaborative, decentred and create a multitude of networks—each defined by their own rules of operation. These may be social networks, online worlds, or vast databases of information and content managed by knowbots and web crawlers.

The aspect of *interaction* enables people to manipulate, create, explore, experience, play with and participate in digital media. It may take many forms, ranging from free play and participation through to practical use and operation. As a result, a diverse range of hardware and software systems have emerged to explore the possibilities of interaction design; motivated aspects such as playability and usability.

The *hybrid nature* of digital media allows aspects such as this wide range of interaction, and a high degree of flexibility. Digital media may emulate many other media and develop new combinations of these media, often with a novel twist or subversion of the original form.

While being *technology dependent* causes many problems with archiving and access to content from as recently as five years prior to the current generation of technology, it also drives innovation. The development of new gaming platforms—currently in their seventh generation—is a case in point. Developments in video game hardware can drive innovations in game design, for example by providing developers with a new hardware interface. The technological possibilities are constantly changing, therefore the forms of expression also change. However, this dependence also exacerbates the issues created by limiting access to certain socio-economic groups that can afford to upgrade.

So: how do we explore the potential of digital media? What does this potential show us about digital media in general?

1.2 Consumers, creators, and critics

This exploration of digital media is firmly grounded in practice. It is about digital media itself. Many of the ideas articulated in this thesis begin as an intuition while immersed in its experience or construction—by working as a reflexive practitioner playing with digital media. Essentially, the study aims to document these discoveries and articulate a particular vision relating to the potential of digital media as an expressive system combining all of the aspects outlined above. In particular, its potential has been explored through a series of ten major works and eleven minor works that use iterations of this system in design and development. At first, the system was relatively simple: each work contributed to its refinement and evolution into the current version articulated by this thesis. Various modes of engagement with digital media such as play, development and analysis draw attention to different aspects of the model. Drawing upon its roots in practice, the system uses these different experiences in an integrated or hybrid approach. As a result, this investigation of digital media will take a three-tiered approach referring to consumers, critics and creators.

As author of the present study my experience encompasses all three of these areas and is used to inform the investigation. Within the three domains, different levels and types of knowledge are needed. The current generation of consumers have basic digital media literacy. This is typically required for their work or recreational activities such as surfing the web or playing games, as many technologies that were once experimental have relatively quickly become mainstream and part of everyday use. Critics add to this basic literacy with specialist knowledge and experience, and with models for the analysis of digital media. As outlined above, many models exist for this purpose, although typically they have a bias toward analysis through the perspective of previous generations of media. However, critical digital media literacy may not always be based in textbooks. Those who grew up spending hours playing digital games may develop an innate sense of good and bad game mechanics, an insight into the process of interaction, or other intuitive senses. Creators need to empathise with the experience of both consumer and critic and understand the mechanics of communication via digital media in order to craft their creations. While creators and critics both represent smaller groups than consumers, they have a significant impact on digital media—by introducing new insights and understandings, and by shaping the development of the form itself. Clearly, there is crossover between the three areas, and many individuals will play different roles at different times.

The ideas presented in this thesis draw upon experiential, theoretical, and practical examples of digital media. It is intended that consumers, critics, and developers of digital media will benefit from an understanding of the ideas and arguments presented. At the most basic level, *consumers of digital media* do not necessarily need to know its inner workings and unique characteristics in order to understand it. However, consumers do need to be able to recognise conventions in the use of digital media that signify meaning, so that these conventions have meaning to them. On another level, in the process of analysis and deconstruction the *digital media critic or analyst* does need to be able to identify and articulate the way that digital media work. Critical analysis from the point of view of digital media language may be used to complement other models or theories. Finally, the *digital* *media developer, designer, producer, and artist* need to have a working knowledge of the medium and be able to use it for effective communication and creative expression. Most likely, during the development process they will need to articulate what they are doing to others through established terms and models.

As mentioned my own experience has included the roles of consumer, critic, and developer. I have been a digital media consumer since my early teenage years, using computer software and digital games on a range of personal computers and game consoles. This developed into a curiosity about emerging technologies experienced through conferences and symposia. I have explored several generations of both web design and gaming consoles. My digital media art practice started in 1989 with a number of experimental, collaborative works that combined animation with video art and installation. While working in a multimedia design studio in the early 1990s I developed interactive works exploring the nature of electronic space. In more recent years this practice has produced a number of major works that specifically explore the 'language of computers' and its intersection with iconography, alife, game design, electronic music, and computer animation. During the past five years I have held an academic position at Monash University, writing, analysing and educating in a multimedia and digital arts department.

For more than ten years, I have been developing my own understandings and internal models for deconstructing digital media and searching for its endemic properties. During the process of production I have formed models for design and production of interactive projects. This experience is integral to the ideas that will be presented, some of which may have been through several iterations as they have been tested through my eyes as consumer, critic and developer. This thesis articulates a model for the analysis and development of digital media that places an emphasis on its endemic properties and unique characteristics, with a view to identifying a particular application or applications that express these qualities. As this model is rooted within my practice it draws upon a number of works, such as *Iconica*, *Semiomorph* and *lifeSigns*, that demonstrate this approach to digital media. These works vary from prototypes to more resolved realisations of a novel method of communication and expression that the model aims to identify and articulate.

This body of work is central to the investigation as it demonstrates and makes tangible ideas articulated in later chapters. In this sense, these works present the outcomes of the research process in their primary form: the analytical text of this thesis is a reflection on these outcomes. The creative works are the raw form of the research process and constitute the source of the model for a poetics of digital media.

1.3 A context for digital media

Many creators and critics (and hopefully audiences) have been inspired to respond to the challenge of understanding, defining and articulating the ‘how and why’ of digital media. Activity in this area grew exponentially through the nineties, digital media becoming pervasive at the beginning of this century—embedded in the culture and mechanics of contemporary communication. Within a relatively short period digital media appeared to take centre stage, where previously it had been a fringe activity practiced almost exclusively by hackers, experimental artists and academics. Digital media is now an integral part of culture and communication within the developed world. This is, in part, what makes this particular moment an interesting point at which to look both backwards and forwards. There is a need to assimilate and decode recent digital media history and to imagine where this moment will take us.

In order to define digital media in context I will draw upon a number of themes have emerged over the past decade. What follows is a brief survey of some existing ideas in the area to demonstrate their diversity and map the current field of play. An in-depth analysis of current digital media theory would be beyond the scope of this thesis. What follows is a broad sampling of recent work in game studies, formal taxonomies or surveys and approaches based in media language. Many key texts are omitted; those cited have been selected because they appear to be motivated by similar goals to this investigation, even though the outcomes are often very different.

First, let us revisit the quotations cited earlier in this introduction. Manovich (2001) articulates a language of new media that blends database and cinema, to provide an understanding of storytelling in a digital context. He articulates structures and relationships that are particular to the ways in which digital media is constructed and experienced. Johnson (1997) argues that the interface itself is the site in which new meaning and communication is generated. Deciphering the interface design and developing the interaction design become the equivalent of reading and writing in the new media literacy. Bartle (2004) describes the process of designing a virtual world that extends into the development of rules for social, economic and political management. Players become participants in the construction of an alternate reality that generates meaning through their play.

Enabling comparison with the forms that prefigure its arrival, cultural studies and media histories, are rich sources for developing theoretical understandings of digital media. Cubitt (1998) articulates a view of digital aesthetics by situating digital media within cultural theory, connecting it to a long history of established media forms. Digital maps are related to the concept of ‘virtual realism’ that draws upon the theory of the simulacrum to demonstrate quite literally that the map becomes the territory. This is one of many examples in which established theories and ideas are expressed in new ways through digital media. The idea of reading digital media as ‘ergodic literature’ is introduced by Aarseth (1997), who draws heavily on the study of games. The term ergodic is borrowed from physics and used to describe the way in which digital media (particularly games) build meaning through short episodes of engagement and interaction—in contrast to the larger structures, typically built on narrative, of traditional media such as the feature film and novel. This kind of new media literacy features heavily in the theories put forward by Tofts (1998), who has traced the history of new media that connects cyberculture with the avant-garde art, experimental writing and shifting cultural conditions that allowed it to germinate and grow. In this sense his theory becomes an archaeological study of the medium’s origins and evolution that in turn demonstrates the complexity of the formation of digital media and the scope of its impact on contemporary communication.

Analysis from a technological point of view that draws upon the formal qualities of digital media offers another approach, that typically culminates in the definition of categories for classifying and comparing works. Wilson’s (2002) survey of the field of ‘information arts’ includes robots, kinetic art, telecommunications, information systems, biology, algorithms and mathematics. It is indicative of the scope of activity that occurs at the intersection of art, science and technology. Interdisciplinary practice is typical in this medium, as often the development of digital media projects involves the fabrication of hybrid forms that freely roam across boundaries and disciplines. Another perspective, offered by Paul (2003), defines digital art in terms of areas such as telepresence, browser art and hacktevism. She outlines the scope and range of experimentation in the field, demonstrating once again the diversity of forms and approaches that have emerged in contemporary practice. Lunenfeld (2000) captures the essence of digital culture by documenting his own discovery of the field through conferences, exhibitions, symposia and technology demos. Looking at an eclectic mix of works and projects he draws out key aspects of the culture such as the concept of ‘demo or die’ and the decentred nature of network art. Within network art there are few masterworks that define the medium on their own, but rather many significant works that contribute to its gradual formation. For example, Lunenfeld identifies enduring forms such as the ‘electronic corpse’ and the ‘digital questionnaire’ in his analysis of networked art.

Approaches inspired by philosophical models largely focus on the processes of perception and cognition that relate to the experience of digital media. In contrast to approaches based in semiotics and literary theory, Massumi (2002) introduces a phenomenological view of digital media from the perspective of embodied experience. A wide range of media, including television, film and the net, are explored in terms of their capacity to generate sensations and experiences that are outside the scope of traditional models of understanding meaning. Hansen's (2004) 'new philosophy' also explores the embodied experience by examining the cognitive processes that occur when engaged with digital media. Focussing on the moment of perception as key to understanding what is unique about this experience, he suggests that the interactive process creates a heightened state of perception. These more recent texts may be compared to earlier writing from Heim (1993) in which he outlines the 'metaphysics of virtual reality' as it relates to disembodied experience. He explores the changing nature of our understanding of reality as we interact with virtual realities that offer alternative ways of being. These new realities offer increased sensation and perception but at the risk of cognitive overload and disinformation.

More radical approaches highlight the significance of change introduced by new technologies of communication and expression. De Landa (1997) also looks at the nature of our reality by exploring the common patterns and processes apparent in different historical time frames—geological, biological and cultural. The same 'abstract machine' that shapes rock formations can also be seen in action in the evolution of life and cultures. This systems-based approach is then in turn applied to digital media in order to demonstrate its nature as a process-driven medium. Our role as cyborgs within this information machine is eloquently described by Hayles (1999) in her account of cybernetics, literature and informatics. She argues that in the permeation of our lives with communications mediated by computers our selves become part of the system itself, and so to understand the system we need to understand the ways in which it has changed ourselves. Another scenario is posed by Kelly (1994) who looks at the twofold effect of computational systems by firstly becoming more lifelike through the introduction of innovations such as evolutionary computing and alife; and secondly the real world becoming more programmable through such developments as the manipulation of DNA, nanotechnology and augmented reality.

These ideas led to approaches based in a more formal analysis of systems and the ways in which the generative capacity of interaction within these systems draws attention to the performative aspects and processes of digital media. Maturana & Varela (1972) introduce the concept of autopoiesis as a way to understand living systems as sets of processes and relations from the inside out. These ideas resonate with the systems embodied within digital media that are constructed and function in similar ways. Whitelaw (2004) articulates various approaches to creating worlds and systems using models adopted by artists from the field of alife. These demonstrate distributed, dynamic, open and participatory systems in which digital media is simultaneously generated and experienced. Another embodiment of these ideas is described by Fuller (2005) as a media ecology. Once again a network of relations and processes is established to generate digital media—in this case the system is not a computer program but a set of social relations, variable media and electronic networks.

Overall, digital media is characterised by complexity and diversity, as demonstrated by the range of existing approaches and understandings. Some of these texts are explored further in the subsequent chapters and other key references, not included here, are introduced at a later stage. Digital media can be almost anything, particularly now that it has become embedded as a central form in contemporary communication. However, as outlined above, some key ideas have emerged that will be explored further through the ongoing broader dialogue on the nature of digital media.

1.4 A fresh approach to digital media

The various authors discussed above make their own critical, political or social arguments in relation to digital media. This thesis aims to add another point of view to the discussion. Its goal is the articulation of a model for the analysis and development of digital media language in terms of the elements of the medium itself. The challenge is to develop this model so that it reflects the developments that have occurred to date and responds to current developments and changes in the field. For example, the term 'multimedia' has become meaningless—as almost all modes of communication use a combination of different media types, and it becomes increasingly difficult to make the distinction between what is and what is not 'multimedia'. Interdisciplinary practice is now the norm, rather than the exception. A new generation of artists and designers who have not known a world without digital media are approaching the medium with a new sensibility and their own assumptions. The needs of tertiary education are shifting from software training and skills acquisition to an increased focus on ideas, design and analysis of digital media. Cultural institutions, such as the Australian Centre for the Moving Image (ACMI), are introducing digital media art to a wider audience. It is an important time to capture knowledge before it is forgotten and to articulate it in a way that is suitable for dissemination into diverse areas.

Various methods of understanding digital media already exist. These include collections of definitions and terminology that describe an *elemental model* that simply lists the basic components of digital media. The *technological model*, based in technical jargon and technology, is another common approach: typically used in the early stages of defining new media developments. Laurel (1993) introduced the *theatrical model* through the combination of notions of performance and construction of characters and events on the stage with the principles of agency and representation described by the field of Human Computer Interaction (HCI). This field is another approach in which the mechanics, logic and behaviour of interactivity are described as a science, complete with rules and functions for making interaction work. This approach may be described as the *HCI/usability* model.

Inspired by the language of architecture—with its spatial metaphors and structuralist nature—another approach is the *architectural model*. Digital aesthetics are articulated via the *aesthetic model* that explores the expressive potential of data and information. Other approaches, such as the *emulation model*, examine the ways in which previous media become embedded and consumed by digital media through their simulation. Another related approach is the *remediation model* that is based on the ways in which past media are processed and re-represented within digital media. The *cinematic model* is popular as it builds upon the many existing theories relating to the language of film and television.

All of these existing models are reviewed in detail in the third chapter. They all make significant contributions to our understanding of digital media. Some represent necessary stages in the development of that understanding. Others demonstrate the difference between digital media and other media by showing the impact of digital media on these earlier forms. Some models articulate new understandings and methodologies for analysing the medium. Based on this existing understanding of digital media, an alternative approach becomes apparent. Digital media can go further—it has other things to say. This thesis argues for a model that describes digital media on its own terms in relation to its endemic properties and unique characteristics, and how these enable new modes of communication and creative expression. While clearly digital media is human-designed and many of its qualities are artefacts of its artificiality or have cultural origins, by positioning this investigation within the internal view of the systems described we can look at these as being situated within an autonomous world.

Therefore this model is developed from the perspective of the computer. When considering the endemic properties and unique characteristics of digital media it is important to explore it in terms of the codes and structures that come with its architecture and design—rather than impose others from the outside. The model adopts an internal view of the systems explored—be they those expressed via software or construction of artificial worlds, or networks of digital devices such as game peripherals, synthesisers, computer-controlled lights, speakers and mobile phones. The system comes first: understanding that system in terms of its expressive and aesthetic potential when interconnected with the author—in this case an artist—and the player is primary. Subsequently, many of the terms adopted have different connotations than those with which they are usually associated. By way of example, expression is used to describe the manifestation of a system in a tangible, perceptible form to be experienced by a player, such as the rendering of a game world to screen accompanied by spatialised sound. These terms are discussed in detail later in this chapter.

1.4.1 New systems, new forms

It is true that much of the form and language of digital media has in fact evolved or been derived from a multitude of other preceding generations of media. However, there are structures and forms of expression that are unique—both in how they are experienced and how they communicate. They have been the major focus of my work for the past ten or more years. These structures may be novel combinations of familiar forms, or they may be less familiar forms generated by interaction or computation. In order to arrive at a deeper understanding of these more complex forms we need a new way of looking at things.

Consider a mature form of the virtual world that integrates elements such as multiplayer interaction, simulation, new iconography, nonverbal language, autonomous entities, media evolution and locative media into a single coherent experience. To understand and articulate complex forms such as these, it is likely that we will need a model that describes digital media on its own terms, without the baggage of past media. This raises new questions, for example:

- How do we 'read' a virtual world?
- In what ways is data translated as it traverses across a media landscape?
- How do you create digital media for an audience with 'systems' literacy?
- Can code be used as a language of communication?
- How do you design worlds whose ontology is part of their message?
- What is the meaning of language in media where anything can emulate anything else?
- How does the role of the audience change when they can participate in the media themselves?

These are questions that are specific to the forms that emerge from digital media's properties and characteristics such as computation, interaction and connectivity. A new approach that is grounded in these aspects and embedded in its particular audio-visual syntax is better suited to understanding digital media on its own terms (that is to say exploring these properties and characteristics from a systemic perspective). The system has its own agency in digital media experiences such as those described above. How can we explore the potential within the interaction of digital and human players whereby they are considered on equal terms?

1.4.2 Moving beyond old media

Therefore there is a need to move beyond older media models. It can be argued that, at this stage, digital media has only just asserted itself as a unique form in terms of both the concepts and methods used in its production, or in the audience's perception of what it can be. It has yet to evolve from the borrowed ideas and structures that it has inherited from its multimedia heritage. While this in itself does not mean that existing approaches are invalid, it does suggest that they may be incomplete. Existing methods of definition are genre-based, technology-based, or a hybrid form of another medium. For example, we refer to a '3D shooter', a 'CD-ROM work' or an 'interactive book'. When we say this, we are not referring to a genre or style of digital media, but a particular mode of interactivity and method of modelling the media elements.

Many of the existing approaches have not been developed for the discovery of new properties. The articulation of a model and language that is specific to digital media should also reveal some of the unique, and possibly new, characteristics of the medium. Its strengths and weaknesses can be identified, and new forms of communication that it enables can be analysed and deconstructed.

Consider how we may analyse or make comparisons in this eclectic list of digital media:

- a static website versus a blog, which is dynamic by definition
- an interactive movie constructed from video clips versus a digital game driven by narrative
- a game with bad gameplay
- an interface that does not provide feedback
- linear interaction design that does allow for choice in the user experience
- works that overlook the use of sound
- virtual worlds that construct confusing spaces
- electronic spaces that don't consider the third and fourth dimensions.

Some of these are examples of digital media don't work simply because they may be poorly designed, while others may work but do not take advantage of the medium: they may be an effective piece of design or filmmaking but there is no intrinsic need for them to be digital. There are some aspects of their design that simply do not work or are flawed, for example the static website that is really hard to update and goes out of date the moment it is created; interactive movies that often create annoying interruptions in the flow of the narrative.

Therefore in order to move beyond old media the ways in which digital media communicate differently may need to be considered. To understand meaning production in digital media it is necessary to consider all aspects of the system, including the roles of consumer, critic and creator defined earlier. Some of the examples of digital media listed above construct meaning differently. This is not the construction of meaning that takes place in a linguistics or sociological context but rather from the point of view of systems and computation. Within generative and complex adaptive systems, for example, meaning may emerge by associating terms with specific icons and entities. This is a dynamic process that involves negotiation of a shared agreement on ‘meaning’ between digital and human players, mediated by the system itself. An approach that takes this into account is needed in order to analyse and understand this process. With this understanding new strategies for creating meaning can be developed.

1.4.3 Articulating digital media on its own terms

This thesis will argue that current models, while providing useful tools for analysis, are not best suited for articulating digital media on its own terms. The reasons for this are threefold. First of all, models that originate in other media are based within the terminology and structures of that medium. While aspects of these other media may exist within digital media, it is typically only a partial mapping occurs in the application of older models. Furthermore, digital media consists of multiple media and so the approach should avoid being media-specific. The second reason is the systemic nature of digital media. Aspects such as interaction and computation result in a different form of engagement with the player than that which occurs with film or print. The player becomes part of the system—and so digital media communicates differently. A flexible model that works within a set of constraints based on this system nature can articulate these points of difference, making clear the ways in which digital media function differently from other forms of expression. Thirdly, it is important that any model or approach not be defined by technology. This is especially the case with digital media in which the technology is subject to rapid change. Digital media is dependent on technology and issues such as screen resolution, processing power, speed of data transfer, obsolescence of old media mean the parameters of the system change. While these factors need to be taken into account in any study or analysis, it is important not to let technology issues define the model.

As a result, it is often difficult to articulate specific details of digital media, because the concepts are still in their formative stages. As digital media develops its own styles, conventions, systems and logic in terms of processes of communication and expression, these need to be articulated in a way that allows their analysis and discussion. There are few ways to describe these new concepts. For example, the word ‘gameplay’ describes the abstract concept of the dynamics that emerge from playing within the rule systems of digital games. But what words do you use to describe a piece of media that has no start or end, a system of rules that keeps recreating itself, and how do you measure or define terms such as ‘interactivity’ and ‘gameplay’?

A general structural approach that addresses the systemic nature of digital media will allow a way to analyse and find properties of digital media that cross over genres, successive generations of technology and a variety of applications. The approach needs to include methods of identification and analysis that are not technology or application dependent. Specific instances of digital media require that these be given materiality with audio-visual parameters specific to that expression so that players may experience and participate in it. However, a model for the presentation of code in a material form may be generalised by studying this process of expression and using it to guide the development of a systemic approach. This will acknowledge the participation of the player within the system and the issues associated with constructing a reality for the player to allow that participation. Once again, the system comes first, so that digital media is articulated on its own terms.

1.4.4 Media generations

A constant and rapid rate of change characterises the technologies that deliver digital media. However, the key ideas and underlying concepts do not change as dramatically. There are two key issues here—first, the need for an understanding of digital media that can adapt to new generations of the technology; and secondly, the transfer of insights across these generations so that key findings are not lost with the appearance of new technologies. It is important to develop an approach that can translate from past digital media into this current generation, and that can grow into whatever may be coming next. By way of example, three key challenges follow that represent current innovation and opportunities.

Firstly, new ways of working with interactivity have emerged in recent years. The creative possibilities of the 'point-and-click' mode of interaction that dominated CD-ROM and web based projects in the 1990s have been exhausted. Artists and designers are developing novel methods of interaction using other possibilities such as augmented reality, multiplayer game environments, machine vision and passive interaction. While most of these technologies have been in existence for some time, it is only recently that they have reached a level of sophistication where they may be explored in a wider range of applications, outside dedicated research labs.

Secondly, digital games have reached a wider audience in the past five years, alongside the development of new models for gameplay, more sophisticated content, and networked environments. The field of game studies has emerged with its own terms, such as ludology, the study of games, journals, books and research centres. Experimental game design and the practice of game art use game engines and other software to make artworks that are based on game structures or to critique game culture. The practice of using game engines to make films, called 'machinima', combines the realtime performance of players in a game world with editing and postproduction software to provide an inexpensive method for digital film production.

Thirdly, artificial life (alife) is a field of computer science concerned with the modeling of complex systems and ecologies in computer software. It investigates what makes living systems alive and the emergence of complex behaviour from simple rules, typically embodying adaptation and evolution in the simulation. Computer science has established a number of formal languages for manipulating symbols—many of which may be expressed in generative systems. These ideas have been applied to a wide range of areas in recent years, including animation, multimedia design, digital art, and the generation of game spaces. In these applications, digital media itself has agency in the interaction—it goes beyond the model of a database to a more fluid structure that is reflexive and adaptive to patterns of use.

These three areas of practice may all be described as networked human-computer systems. Some involve players in complex rules of engagement; others have involved the author in an extensive process of collaborative authorship between human and machine. Understanding these systems from the point of view of the computer means understanding this process and consequently its shared language—where code is expressed via digital media so that it is human-readable. This is not to say that code and computers have somehow evolved on their own. They are designed and manufactured by people and any agency they may have is part of that design. However, this design places constraints and limitations on them so that they are different to us and to other media. Insight into the processes of mapping and translation that occur in networked human-computer systems will provide understanding of both sides of human-computer expression – both from the perspective of the player and the system being played.

1.4.5 Play, development, and analysis

Finally, in taking a fresh approach a method is needed that may be informed by different modes of engagement with digital media. Play, typically the act of the consumer, gives an experiential understanding and allows discovery through experimentation and exploration. Development, the core activity of the creator, involves defining the building blocks of this experience, their construction, design, and internal system of logic and interaction. Analysis, usually the activity of the critic, connects these two processes as play informs development and vice versa. The model that underpins these connected views is critical as it articulates exactly what is being played, developed and analysed.

These three areas (play, development and analysis) cross over one another, and in fact the design and production process typically involves switching between all three, as outlined above. This thesis is informed by experience in all three areas and draws upon examples where this hybrid approach has been used in practice. The result is a method for play, development and analysis of a system. While the end product is a finished digital media artefact, it is this live process of design and production within which my practice is based. Typically, there are several ‘final’ works as the process is further informed by audience interaction and participation. Each work may be exhibited a number of times, with feedback and observation of play from each exhibition being analysed and then informing the development process.

By featuring interaction and computation as a significant element in many of these works a further emphasis is placed on the live or dynamic nature of the systems. Players are encouraged to participate in the system itself by evolving entities, mutating spaces, communicating via constructed languages, or generating sound. In this way, aspects of the play/development/analysis cycle are left open to the audience as they develop an understanding of the system through play, reflect on its relationships and logic through analysis, and then develop a new approach to interaction based on this knowledge. The system itself is central both to the development process, the play of the work, and subsequently its analysis and understanding.

The system is also common to the consumer, creator and critic. Play requires reflection on the rules and possibilities of the system—a gradual learning of its language through participation and experience. Understanding digital media from the point of view of a system is critical to the developer, who must find engaging ways to express that system in a form that can be experienced. Analysing how well the entire human-computer system operates likewise benefits significantly from understanding the processes that are occurring in both the human and computer during play.

1.5 Poetics of digital media

Digital media is easy to understand when it emulates familiar media or works within known rules and systems. This is why much of what appeared in earlier generations of digital media used existing models such as the book or the movie as their base. Without due care these models would become broken by becoming digital: some aspect of the emulation would not work the way it should and the illusion would be lost. Another more significant aspect of such emulation is that it limits the possibilities for communication and expression that digital media has to offer. Digital media can be a world with entities, new languages and modes of interaction, or a narrative moving across media that involves the participation of many players simultaneously. It can live in a disparate range of environments, ranging from online communities to site-specific installation, or from networks of mobile devices to digital game spaces.

A poetics of digital media—a formal system and structure that articulates this system of human-computer expression—is proposed to articulate this potential. This approach can move beyond older media models, articulate new forms, and situate itself within past, present and future media generations. This poetics articulates the ways in which meaning emerges from a system. It is not concerned with poetics in a verbal sense but rather as a formal structure for the audio-visual language of digital media. The structure articulates a system in which both human and computer participate to collaboratively and interactively construct meaning. In this system both human and computer have agency, although the nature of this agency is different for each. The poetics of digital media articulated here describes the forms by which the human and computer exchange information in a complex system of interactions. The specific meaning of terms such as expression and communication will be elaborated on throughout this chapter.

Issues referred to above identify specific needs that have emerged from a more general understanding of digital media. They start to point the way toward the unique possibilities of the medium. A model is required that addresses the general issues of defining the medium, but also expresses current developments that relate to specific innovations. Therefore a formal language for describing digital media is required so that we may understand what it is, more clearly articulate its potential, and situate the discussion of new developments within a digital media history.

This model is based on countless hours spent in virtual worlds, digital games, computer software, browsing the web, experiencing streams of media on location, and otherwise being digital. Now, how to identify the terms, tools and functions of a digital media poetics?

1.5.1 Defining terms

It has been established that a digital media poetics is required that can be understood by a broad audience and applied to a range of different genres and applications. It needs to map the territory of digital media and articulate its unique, constitutive properties. First of all, what should be included in a 'digital media poetics'? Important areas of investigation include the nature of electronic space, the question of a unique digital aesthetics, media hybrids that combine several languages, and new elements such as interactivity and gameplay.

It is widely accepted that digital media is a new communication medium. However, its development is an evolutionary process: new potentials often render past assumptions obsolete, and there is a general state of flux due to rapid change and shifts in technology. A poetic language for digital media can define and map this territory.

Use of the word ‘language’ in this context refers to a set of rules, structures, and elements that provide a formal system for describing a means of communication. As a poetic language it is defined broadly as a ‘method of expression or communication’ (Thompson 1995). Whether that communication is concrete, in the case of a written language such as English, or abstract, such as within the aesthetic and conceptual conventions of abstract painting, it follows codes and modes of operation that are consistent in the expression of that language.

This digital media poetics is concerned with expression, communication, meaning and reality. In the context of this investigation these terms have a different meaning than that with which they are typically associated.

Expression in this context refers to the manifestation of the digital in a material form, usually so that it is human-readable. A typical example of this is the mapping of code into various types of media such as image and sound. This is often a participatory event in which feedback causes the expression to change in response to human input. Expression may be considered on the micro level: each digital media experience consisting of potentially thousands of instances of expression such as the synthesis of sounds, the rendering of a 3D model, or the generation of an image from code. Alternatively at the macro level digital media represents a form of expression—a digital game, for example, may be considered in this sense.

Another important concept associated with this is the idea of communication. This is not considered in the conventional sense of top-down communication in which a specific message is conveyed to a receiver, often separate to the mechanism of communication. Rather, the term is introduced to highlight the aspect of digital media that functions to make information and data tangible. This communication takes place on many levels and in a range of modes; it may be performative, participatory or experiential and occur as part of the dynamic process of interaction with digital media itself. Once again, communication can be identified on the micro level—for example as information about the status of parameters in a game or labelling of items in an interface—or on the macro level, where a virtual world communicates using text, image and sound or alternatively where an art installation communicates equally through interaction and audio-visual media.

This is a poetic language not only used for humans to communicate with other humans, but also to govern the design of systems of communications between computers and players. The exponential growth of computers and related technology means an increase in computer-mediated communication, and a greater diversity in the applications of this technology. So this should not be a language limited to the expression of spreadsheets, online shopping, office memos and desktop metaphors. It should be a language able to convey subtleties of human emotion and complex, abstract ideas: a language that inspires as well as informs. Video games, electronic art, interactive multimedia, the Web, HCI all qualify as points from which different elements of this language can evolve.

1.5.2 Poetic language as system

Primarily, this is a systems-based approach. At various levels existing systems may be examined to provide a framework for the investigation. Within the field of computer programming game studies, semiotics, ontology and cybernetics describe formal structures for identifying systems of expression and communication. When developing computer software, everything must be formally defined and so these systems by necessity provide formal structures for this process.

Using this framework a generative matrix of terms will be used to explore the range of expression and communication within a digital media poetics. This matrix draws upon properties and characteristics of digital media that are endemic and therefore appear to be naturally occurring phenomena. As the context of the investigation assumes a position located deep within the digital realm these properties and characteristics are accepted as the natural forms of digital media.

The term human-computer expression is used to describe this system. This draws our attention to another point of difference in this investigation. It sets out to articulate a system that does not privilege the human or the computer but rather looks at digital media from both sides of the interactive process. It describes forms of expression that are generated by the interaction between human and digital entities; it provides an analytical tool for understanding the process of meaning production (again for both human and digital entities) that occurs during and as a result of that interaction. Subsequently, the term 'meaning' in this context does not necessarily describe the complex processes of the formation of meaning in the human mind, but simply data that is meaningful to the processes of interaction that occur in human-computer expression itself.

In summary, this approach sets out to demonstrate new opportunities for communication and expression using digital media; and to map, articulate and understand its properties and characteristics across play, development and analysis. Its emphasis is on digital media as a poetic system for human-computer expression. Where do we begin to look for these properties and characteristics?

Within the poetics of digital media, this systemic model may explore novel aspects of interaction such as 'media creatures'. The entities within the system may be seen as creatures made of media who play and communicate using constructed languages with their own conventions and grammar. These may be highly formal and abstract in their nature – built from digital elements such as machine language, pixels and bits. Alternately, they may remap existing codes of communication and interaction such as those entities that assemble texts or use gestures to converse with the player. These ideas will be explored further in the discussion on interaction.

The audio-visual syntax of the model is a rich source of possible languages, often subject to multiple interpretations with many meanings. Again, this syntax may be constructed from elements endemic to digital media or via the emulation of pre-digital media. It may also be a hybrid consisting of blended aesthetics, visual styles and multiple media. In this case, signifiers and modalities are often mutated by layers of sampling and cross-reference—resulting in a complex system of meaning production. This offers an opportunity for rich audio-visual languages which, when coupled with interaction, offer many possibilities for novel forms of human-computer expression. In the exploration of representation, these concepts will be articulated further.

Within a system that is open and participatory, structure provides both a framework for the construction of that system and also embodies it: players are embedded within and operate in the structure itself. The world is an index, the index is a language, the language is the ontology, and the ontology is the world and so on. This language is not necessarily textual but may be expressed via an audio-visual syntax of icons both visual and sonic. With the world as language, it may be read on many levels: via its visual codes, its sonic landscape, the behaviour of its entities, its systems of communication, its signs and symbols, or the conventions of its spatial design. This will be explored further in the section on structure.

The logic that connects these various components of the system is an expressive form in itself. Code and process offer novel methods of communication. First of all, the logic of a world, its relationships, parameters, conditions and behaviour—is expressive of its nature. What the player can do and what happens as a result tells them a lot about what is meaningful in the world. Activating participation in processes such as generating a musical composition or influencing the evolution of an artificial lifeform involves another level of engagement with the system. In this case the player becomes coupled with the system, thereby forming a system of human-computer expression. The element of algorithm is explored further in a later chapter.

1.5.3 Research questions

This thesis will establish a common method for analysing a wide range of applications, looking for common properties and characteristics of the medium. In doing so, it intends to investigate the processes in which new meanings and modes of communication are generated in digital media. It is intended that this alternative approach will reveal further potential in terms of a 'language of computers'. In summary, there are five main threads to this investigation, posing the following questions:

1. What are the unique characteristics and endemic properties that define digital media?

2. Can these characteristics and properties be articulated in terms of a digital media poetics?

3. How can this language be modelled in terms of its actions, alphabet, grammar and logic?

4. What new methods of communication and expression may be demonstrated by using the model in the analysis and development of digital media?

5. How is meaning constructed within a system of human-computer expression?

Responding to these questions involves moving from a general understanding of the nature of digital media through to a model that is able to identify and articulate specific aspects of its nature. This model is then put into practice to describe the new forms of media and experience enabled by the medium.

1.5.4 Methodology

Central to this investigation is the definition of a model for digital media that can be used to analyse existing works within the themes and concerns established earlier. A new model enables a fresh perspective on the field, inspired by the unique characteristics and endemic properties of digital media.

Particular focus will be placed on the work of digital media artists, designers, and technologists who are consciously experimenting with digital media. Works that focus on the development and exploration of new ideas and applications feed into the multimedia industry at many levels. Individuals push technical boundaries; they develop innovations in interface design, new production methods, and modes of representation in their creative digital media works.

This poetics proposes a new approach to digital media, which as much as possible, is free from assumptions of past media models. The approach reverses the process by allowing for structures to be first observed in digital media. These observations can then be understood either by making a parallel with an existing medium, or flagged as a unique, new property of the medium. The validity of the association can then be tested, or the unique property further explored. In this scenario comparisons can be made with established media in order to assess the effect of the addition of interactivity.

The evolution of a poetics of digital media is therefore a balance of two streams of research. Firstly, the identification of existing elements that work and putting them into the right place, and secondly, the discovery of new elements that demonstrate unique features of the computer medium.

In examining these ideas, I will draw upon existing models and theories on the nature of digital media, personal observation and speculation; and analysis of digital media applications such as games, CD-ROMs and websites. In order to provide context, Chapter 2 summarises the history of digital media, including a list of the many other media forms that it draws upon. Chapter 3 examines a number of models currently used for describing digital media and analyses the advantages and disadvantages of each. Chapter 4 proposes an alternate model that describes a new language for digital media. This model is specific to digital media, but also has the flexibility to be applied to a number of applications and genres. It describes digital media in terms of the key elements and properties that those elements may have. Chapter 5 examines interaction, including established ideas of interface design, the range of experiences caused by different types of interactivity, and how interactive media differ from linear media. Chapter 6 explores the many different forms of representation possible in digital media, and the specific issues of time, mutability, and the way that meaning is signified. Chapter 7 examines the relationships and experience made tangible by various structures of digital media, and specific manifestations of those structures such as electronic space. Chapter 8 examines the various ways that algorithm, code and data are used in digital media and how these interact with structure and representation to create new experiences. Chapter 9 re-evaluates the model proposed in Chapter 4 in light of the issues explored in Chapters 5—8. Chapter 10 concludes the study by speculating about the future directions of digital media and analyses the model from this long term view. Throughout this document, the deconstruction of working examples of digital media (using the model proposed in Chapter 4) will be the key method in establishing a new language for digital media.

2 Historical background

This poetics of digital media is inspired by the endemic properties and unique characteristics of digital media. It blends a multitude of ‘natural’ data forms such as codes, glyphs, geometric primitives, links, networks and topologies of information into a single form of expression. Inspired by the sonic landscapes of electronic music, the aesthetics of rendering artefacts, and the plastic reality of simulation, its landscape investigates a ‘new iconography’ that draws on the history of the icon in pre-linguistic cultures, and its function in digital media communication strategies.

Although the focus of this investigation is the identification and articulation of things new and unknown, it is grounded within the context of known digital media history. Many different fields of study inform it. Cybernetics informs the study of interaction and artificial lifeforms; self-organising systems are used to generate virtual worlds. Likewise, viewing these as media ecologies assists an understanding of intermedia constructs and virtual worlds. This systemic approach captures the complexity of relationships between play, space and language. Discerning the process of the production of meaning in these environments draws upon the history of semiotics. The study is also concerned with the aesthetics of digital media through an understanding of both the technological and cultural factors that have shaped its audio-visual syntax. Deciphering the nature of a digital media reality is based on an articulation of its ontology. To gain an understanding of what it is like to experience the illusion of that reality I will explore the phenomenology of that experience.

The main goal in articulating a model for understanding digital media from a fresh perspective is to focus on innovation and novelty rather than going over old ground. This chapter is based on a survey of digital media, primarily touching on the principal themes and events rather providing a comprehensive historical account of the emergence and establishment of digital media in itself. This brief historical survey serves mainly to provide a context for situating my arguments within the proposed digital media language.

2.1 The emergence of digital media

Communication via digital media has become commonplace in the developed world. The Web, DVD, digital games, mobile phones and personal computers have become integrated into our society and culture. During the final decade of the previous century the significance of digital media increased exponentially as this revolution in information and communication gained momentum.

To better understand its potential, we need to explore the origins of digital media. If we are dealing with a major revolution in media and communication, we need to understand the driving factors of that revolution. Understanding the history of digital media will provide insight into how our current understandings have emerged, and provide a solid base on which to build new knowledge. Furthermore, our perception and use of digital media are affected by popular ideas on its effect on media and communications, such as digitisation, convergence and new communication.

A common thread in all digital media developments is the idea of the computers as universal symbol-processing machines. Once digitised into the realm of the computer all media, including images and sounds, can be manipulated using the same rules and logic. These digital streams of data can be translated into virtually any other type or form of media—demonstrating the capacity of the computer to emulate any media, even itself. It is a kind of 'meta-medium' that emulates established media, borrowing from their language as required for particular applications. Digital media is 'the latest phase in the history of mass media and so it is implicated in the history and culture of telecommunications and broadcasting institutions' (Wise 2000). This developmental process then goes further as the emulation itself is manipulated, modified and translated.

Digital media is often described as a hybrid or convergent medium. This idea is expressed in a very literal sense in the combination of many different media types into one form. However, it is also apparent in the fusion of different fields and disciplines into a hybrid that combines many different media languages. This view is well established in digital media history, often described in terms of 'parallel developments in fields as diverse as art, film, television, telecommunications and computer science' (Cotton & Oliver 1997, p. 11). This view can be traced back to Negroponte's vision for the MIT Media Lab in the late 1970s, where he described a convergence between broadcasting, publishing and computers. At the time he stated that 'all communication technologies are suffering from a joint metamorphosis', and that the convergent medium can 'only be advanced properly if treated as a single craft' (Brand 1987, pp. 10-1). So, the idea of hybrid media extends beyond simply digitising and combining different media types in one medium, into an interdisciplinary approach to the way that medium is used for communication and expression.

As digital media has matured, its potential as a new form of communication has emerged. The impact of properties such as computation and interaction on the communication process justify the argument that digital media is an entirely new form. This view is supported by creative, technological, and cultural innovation with digital media that facilitate novel experiences. This new form is described as a 'new 21st-century multi-sensory, non-linear, digital medium' (Cotton & Oliver 1997, p. 11). Although there are many different views on where this potential lies, it is widely accepted that such potential does exist.

Some concepts that have emerged in the evolution of digital media are now accepted as some of the key understandings of the nature of digital media. However, this is only the beginning of digital media's history and there are many developments yet to unfold. Some glimpses into the future may be seen where the emulation breaks down; where the source languages of the media fusion become unrecognisable as they are absorbed into the whole; and where languages of interactivity, non-linearity and electronic space begin to be articulated.

What follows is a brief digital media history that captures the formative stages of the medium. This provides a background and context for the articulation of its properties and potential in later discussion.

2.2 A model for digital media history

The ideas and methods used in digital media can be traced back through the history of human communication, and in some cases predate written language. Pre-linguistic communication (Jean 1998), for example, uses systems of pictographs and icons that employ similar principles of communication to iconographic systems in a graphical user interface (Horton 1994). The history of digital media technology has a much shorter history, originating largely in the 1950s and 1960s in parallel with the evolution of the computer. As a mass media form of communication this technology has an even shorter history, and it has only been the recent popularity of the Web that has given many people their first experience of digital media.

The evolution of digital media is a complex story, with many different threads and influences. For the purpose of this analysis, the primary forces that have shaped its history will be defined as:

(a) *Technology.* Key developments in software, hardware, and new delivery platforms. Inventions and discoveries that enable new possibilities, for example, the Internet, CD-ROM, Nintendo Entertainment System. Essentially, what the digital media machine can do

(b) *Content.* Development in terms of what is communicated and new applications that expand the audience for software and hardware. The inheritance of other media structures/languages such as print, film and video, and music. The emergence of ideas for the application of digital media such as computer-based learning, word processing, intranets. These are all shaped by audience demands, expectations, and level of understanding. In essence, what digital media is used for

(c) *Language.* New ways of understanding digital media that advance its development and analysis. Technical jargon, production models, naming of new discoveries, critical discourse. Concepts such as remediation, convergence and cyberspace provide paradigm shifts in understanding new media. Basically, models and theories for understanding digital media.

We can now look at the evolution of digital media: identifying links between delivery platforms and technology, the language used to describe it, and content, applications and audience. A brief history of the formation of digital media based on these threads will inform the development of a model for understanding and analysis. Throughout the timeline, the term multimedia is often used, as this was current at the time: however, the term ‘digital media’ is used in all other sections of this document.

2.3 Digital media timeline

	Technology	*Content*	*Language*
1800s	Telegraph and telephone	Communication at a distance	
	Photography	Capture images directly from the world	Artists explore new forms of representation eg. impressionism
	Cinematography	Shift in perception as narrative moves beyond theatrical experience	New narratives of time and space
1900—1950s	Television is invented	Patrons visit movie theatres	Languages for cinema and photography mature
	USSR launches Sputnik	Photography is commonplace	Design is formalised in the Bauhaus
	First working computers		Cubism and Futurism respond to the media of the time
	Vanevar Bush proposes the MEMEX machine		
1960s	ARPANET (forerunner to Internet) is planned	Colour television broadcasting	Marshall McCluhan proposes his 'medium is the message' concept
	Space War is first computer game	Music and television are major elements of popular culture	Pop Art emerges
	Ivan Sutherland proposes his 'SketchPad' concept	Computers in use in scientific and military applications	Experiments in electronic art take place
	Douglas Engelbart invents the mouse		
	Videotape technology becomes available		
	Robert Moog invents the synthesiser		
1970s	Magnavox Odyssey, the first consumer video game system, is released	Video game Pong is a hit	People are exposed to new visual languages through video games
		Atari and other game systems are popular	
	Arcade version of Space War is released		Computer hobbyists proliferate, introducing the concept of the hacker

	Home computers become available	Accessibility of home computers expands the application of the technology	Books on computer media start to become available
	Birth of the Internet: hosts set up on ARPANET for email and other electronic communication	Personal computer used by business as an office tool	Research centres exploring various aspects of new computing technology appear
	Consumer video cassette recorders become available		Experiments with non-traditional forms of art such as installation, multimedia events, and happenings
	Laserdisc, the forerunner to CD-ROM, is invented. It allows random access to audio-visual content	Laser disc used in early multimedia applications	
1980s	Internet protocols such as ICP/IP established	Over 100,000 hosts on the Internet	Nicholas Negroponte introduces his theories of convergence
	Internet Relay Chat introduced	Newsgroups are introduced	Cyberpunk author William Gibson establishes the idea of cyberspace
	CD-ROM format invented	CD-ROMs of a variety of genres are published	
	MIDI becomes available for computer music	Networked MUDs proliferate	Human Computer Interface ideas developed
	Digital sampling Compact disc audio	Business embraces computing technologies for productivity	Multimedia is a hot topic for research, but nobody can coherently explain what it is
	Virtual reality	Desktop publishing revolution	
	Apple Macintosh and IBM Personal computers are introduced	Microsoft is founded	
	Other multimedia platforms such as Amiga, CD-I, CDV are available	The video game industry grows with the establishment of Colecovision, Atari systems, Nintendo Entertainment System, Sega Master System	
		8bit video games and home PC games industry grows	
1990s	Multimedia technologies grow exponentially	Multimedia authoring technologies vastly improve	Many theories and models proposed for understanding digital media
	World Wide Web is invented at CERN	Multi-user networked 3D worlds and other new forms	Digital media becomes widely

	DVD-ROM format is established Interactive television, Intranets, and e-commerce emerge Four major generations of HTML are developed HDTV broadcasts begin Other delivery formats include: Nintendo Game Boy Sega Mega Drive Super Nintendo Entertainment System Sega Saturn 3DO Sony Playstation Nintendo 64 Sega Dreamcast High resolution sound, 3D graphics and full motion video become commonplace on Windows and Macintosh systems, including Apples iMac—the Internet appliance.	of multimedia appear Web goes from academic obscurity to mainstream consumer culture over a period of five years Video and computer games start to rival cinema and television as mainstream forms of entertainment Internet hosts reach 72 million, with registered domains heading to the 2 million mark Web browser wars see Netscape and Microsoft battle for supremacy Computers are commonplace in all business applications, and there are many simultaneous desktop audio/video/multimedia/web authoring developments CD-ROM development becomes an art form, then the Web takes over from CD-ROM as the primary form of electronic communication The audience is now as big as that of television and other mainstream, popular cultural forms	accepted and consumed: the sophistication of the audience increases Various threads of discussion about digital media are identified: • multimedia computing • information management systems • multimedia design • the multimedia industry • HCI • intermedia art
2000s	DVD-ROM becomes popular PDAs and other portable computing devices are commonplace Rewritable CD-ROM is commonplace	Video game characters appear in movies Artificial lifeforms appear in the form of robots, toys and software Increase in the use of animated actors and artificial	Increase in numbers of conferences, symposia, journals, and books dedicated to digital media Diverse genres of digital media art emerge Graduates from courses

	MP3 established for music distribution led by the iPod and iTunes Sony Playstation2 Nintendo GameCube Nintendo DS Xbox Mobile phone becomes ubiquitous Realtime 3D graphics card standard in many home computers ADSL and other hi-bandwidth technologies allow fast, uninterrupted access to Internet Consumer digital video/still editing and presentation HDTV via digital television broadcast Playstation Portable Xbox 360 Nintendo Wii Sony Playstation3	environments in cinema Digital media art established in contemporary art scene Internet radio, multi-user shared online games, interactive cinema, 'small screen' content on mobile phones and PDAs Mobile phone art Crossmedia entertainment Alternate Reality Games Second Life permeates popular culture World of Warcraft reaches 10 million players worldwide Web 2.0: blogs, social networking, wikis and other media with user created content	dedicated to digital media appear in industry; course content is refined Artists and designers have experience with previous technologies to assist with decoding new forms Audience demonstrates increased sophistication in their understanding of digital media Further specialised roles identified, such as information architects and multimedia designers Game studies expands understanding of digital games Increasing atomisation of digital media using specialised terminology 25th anniversary of Ars Electronica and ACM Siggraph conference

2.4 Threads of digital media history

A number of threads emerge in this history. In this study, the origins of digital media can be traced, and elements inherited from previous media histories identified and evaluated. However this is by no means an exhaustive study or comprehensive history of digital media, as such a study is beyond the scope of this investigation. What follows is a summary of threads in the development of digital media that provide a wider context for the investigation of its forms and language.

This history can be viewed in terms of precursors to and previous generations of contemporary digital media ecology. Threads of interest include the evolution of iconographic language, emergence of the virtual world, generations of artificial lifeforms, and game design. What emerges from this history are clues and pointers to the origins of the more advanced forms of digital media that we are familiar with now. Within this history we can see the appearance a poetics of digital media via its new forms of communication and expression.

2.4.1 The personal computer (PC)

The speed, memory, and storage capacity of PCs increase exponentially in each new generation of technology. The technological possibilities for digital media are constantly changing through upgrades, new software and hardware. This has provided challenge, frustration and opportunity for developers and audience as they struggle to keep up to date. By way of example, a decade ago PCs that could play digital media titles were rare, specialised systems. Computers that could display realtime 3D graphics were supercomputers in dedicated research labs. A standard computer's memory would have been around 16MB, running a processor clocking about 33Mhz. Now, practically all computers are configured for digital media as standard and a graphics card suitable for realtime 3D gaming is affordable. Most machines come with 1GB of RAM, with a processor in excess of 2Ghz.

This rapid development of technical specifications does not come without a cost. Numerous 'dead media forms' (Sterling 1995) may be observed in this development, characterised by the obsolescence of superseded media. The typical lifespan of a PC is two to three years. Most of the major gaming consoles are moving into their fifth generation; for example, Nintendo has gone from the NES to the SNES, the Nintendo 64 to the Gamecube on to the Wii, with speculation about a new system to arrive soon. Much older media is no longer playable on new systems due to the incompatibility of the operating systems. Museums and other institutions are beginning to archive and preserve old software and hardware for its cultural and historical value. These projects include those at dedicated institutions in the United States such as the American Computer Museum in Montana and Computer History Museum in California. Established museums such as the Musée d'art contemporain de Montréal have undertaken media art preservation studies in collaboration with the DOCAM Research Alliance (Depocas 2004) concerned with the documentation and conservation of media arts. Emulators of old hardware, such as MAME (Salmoria 1997), an arcade game emulator and CCS64 (Sundell 1995), an emulator for the Commodore 64 computer, have been developed so software developed for older generations of hardware can still be run on current systems.

While it is still a moving target, the PC has become an established piece of domestic hardware alongside the television, home stereo and telephone. In fact it has come to integrate most of these forms within itself through technologies such as *youtube* and *skype.*

2.4.2 Digital media in education

Educational uses for digital media have involved almost every generation of digital media technology, beginning with the PC and later embracing laser disc, CD-ROM and the Web. Educators were 'early adopters' of the methodology of hypertext and have driven innovations in content through research into the augmentation of traditional teaching through technology. This development has extended beyond the classroom with the publication of educational media, often called 'edutainment' on CD-ROM and the Web. The content and language of digital media has in part been shaped by these developments as educators find new ways of using digital media to communicate ideas and knowledge. The Web began as a technology for sharing research and knowledge, and it has grown to become a significant educational resource used at all levels of education. This is an indication of the level of integration of digital media into the world.

2.4.3 Delivery platforms

Prior to the development of digital media and interactivity on the Web, evolutions of disc-based media have introduced digital media to a wider audience with formats such as CD-ROM and laser disc. Laser Disc technology introduced the possibility of random access to streams of video and sound, although its application was largely limited to the presentation of movies. Early experiments during the 80s with digital media and interactivity used laser disc technology. CD-ROM made it possible to distribute this kind of content during the late 80s, but generally the relatively small market limited CD-ROM applications. A mainstream audience for interactive applications did not exist until after the mid 90s. This often led to the reduction of interface and content to simple indexes to information, or the use of CD-ROM purely as a format for simply distributing large video and sound files.

However, many innovative CD-ROM titles and artworks were produced during this period by developers who explored the CD-ROM as a medium in itself. Experiments with interactivity, combining media, generative systems, non-linear narrative, database, and world creation all took place on CD-ROM. Publishers such as *Voyager* (Stein 1985) developed catalogues of innovative CD-ROM titles—for example those developed as art and music projects such as *Puppet Motel* (Anderson 1995) and *Freak Show* (Residents 1995), in addition to 'expanded books' such as *Society of Mind* (Minsky 1994) based on the book of the same name. Journals such as *Mediamatic* (Lovink 1985) regularly published artist's experiments such as *jodi OSS/**** (jodi 1997) and Innocent's *Idea-ON>!* (Innocent 1996a). Survey shows of CD-ROM projects such as *Burning the Interface* (Leggett 1996) took place at galleries such as the Museum of Contemporary Art in Sydney. By the late 90s CD-ROM was primarily being used as a format for software distribution. Some applications of CD-ROM pushed the boundaries further, but this activity has largely migrated to the Web, which has developed the capacity for high degrees of interactivity and media integration.

In addition to laser disc, there are a number of other obsolete technologies such as Philips CD-I, and a range of CD-based game console add-ons. The most recent generation of disc-based media, the DVD, has been established as an alternative to videotape for the presentation of high quality digital video and sound. It also has huge potential as an interactive format, although only a small number of titles released go beyond simple chapter selection and extra features. Tools for creating DVD are relatively accessible, making this a common format for both home movies and digital arts.

Currently, many different media formats and platforms coexist, each one addressing a particular need or purpose. These include online delivery, storage on a mobile phone, purely disc-based CD or DVD, and many hybrid forms. In fact a huge range of formats are available—such as the iPod, various game consoles, portable drives and any number of wireless devices. Each format offers its own opportunities and limitations.

2.4.4 Virtual reality (VR)

In the early 90s, developments in VR established the idea of interactive and immersive simulations of real or imagined worlds that used methods such as stereographic imagery and 3D sound to create the illusion of literally being inside another world. However, although VR was a popular idea, the technology was not developed to a stage beyond use as a research tool and for specific applications. Although not seeing mainstream use, VR, Gibons's 'cyberspace' (Gibson 1984) and the work of other writers such as those in the *Mirrorshades Anthology* (Sterling 1988) and films such as *The Matrix* (Brothers 1999) established the idea of another world of the virtual within the networked space of the computer. VR is present in digital games and online worlds. In more recent years, there has been a shift from the idea of projecting the user into the space of the machine to almost the opposite: integrating data into the everyday, material world of the user. Wireless networks, mobile communications and augmented reality thread streams of data into the world. These include programmable and networked objects and devices: what Sterling calls 'spimes' (Sterling 2005). Greenfield (2006) outlines the implications of ubiquitous computing in the design of spaces and cities, via the creative application of technologies such as Bluetooth, QR codes and RFID tags. Bluetooth enables the ad hoc connection of mobile devices with each other or local sources of data; QR codes can be placed anywhere and read by a mobile phone camera or other device, to be translated into a web link or other data. As a result the virtual worlds of the computer have become more closely linked with existing networks of media, human interaction and communication.

2.4.5 *The Internet*

The technology enabling computers to share information across a network originated in Arpanet, a US Department of Defence project for information-sharing developed during the 1960s. As PCs became available in academic and business worlds during the 1980s further protocols were developed that enabled the wider network of the Internet to emerge. At CERN[1] in 1989, Tim Berners-Lee developed the foundations of the Web and wrote the first web browser. Methods of non-linear writing and structuring information from the earlier development of hypertext were adopted into the formatting of 'web pages' for this new form. The development of the Web gained momentum in the early 90s; it was at first adopted for research purposes, and then later for commerce and business. Artists and designers were eager to experiment with the potential of this new form. Its use grew exponentially during the late 90s as the audience grew to include almost everyone with a PC.

It is perhaps now hard to imagine a time when computers were not connected to the Internet. Over the last decade the Web has become a mainstream, mass media form of communication. People socialise, conduct research, sell products, play games, build communities and share data. Developments in wireless telecommunications have enabled the connection of mobile phones, PDAs, and other portable devices to the Web. Massively multiplayer online role-playing games (MMORPGs) accommodate thousands of users in persistent virtual worlds. Networks for sharing information have become ubiquitous.

Generations of web media can be observed in the rapid development of the Web from academic obscurity to a mass communication medium over less than a decade. At first only text and images could be included in a web page. Later versions of the web protocols introduced more controls for the layout of pages, allowing artists and designers to explore a wider range of expression and improve the quality of online content. Technologies such as Java and Shockwave introduced interactive content to the Web in the mid 90s. This content was able to draw upon earlier developments with CD-ROM and other digital media formats, and interactive content for the Web was refined in the late 90s along with the development of many data-driven protocols that generate web pages in response to user queries. Search engine technology has also improved, and with so much information online, finding the right tools to make sense of it all has become increasingly important. The Web has become a mainstream media form, integrating technology and content from almost every aspect of digital media. Video, music, games, text, animation, and virtual space are all possible in the latest generation of the Web, with an audience of millions. This has extended to include the Internet as a medium for virtual worlds. Popular MMORPGs such as *World of Warcraft*

1 *European Organisation for Nuclear Research*—formerly *Conseil Européen pour la Recherche Nucléaire,* which is where the acronym CERN originates

(Pardo, Kaplan & Chilton 2004) and virtual communities such as *Second Life* (Linden Lab 2005) have populations in the millions and demonstrate something close to the late 80s vision of cyberspace.

2.4.6 Electronic media art

The *Cybernetic Serendipity* (Reichardt 1968) exhibition in 1968 is widely recognised as a milestone in the formation of 'electronic art'. For many years a small international network of innovators working with art and technology developed this new area of practice. However, it was not until the late 80s as PCs and other technology became more accessible that the discipline started to form a critical mass. This was also a time when a generation who grew up with computers were starting to experiment with creative expression using technology.

During the early 90s electronic art was an experimental activity with a relatively small, but enthusiastic and dedicated audience. Organisations such as *ANAT* (the Australian Network for Art & Technology) formed in 1988 and supported these developments; and publications such as *Leonardo*[2], founded in 1968, provided a forum for the discussion of ideas. Many works were about exploring the technology; others were expressions of cyberculture; and there was an eclectic mix of methods and styles as individuals from diverse backgrounds converged through the expressive potential of art and technology. Now numerous exhibitions and conferences include electronic art works, it is an established form of artistic practice, and some forms of digital media have merged within the contemporary art world. Histories of the development of this field, such as *New Media in Late 20th-Century Art* (Rush 1999) and *Information Arts* (Wilson 2002) have been published.

A large part of the development of this aspect of digital media history occurred at events such as *ISEA,*[3] Siggraph,[4] and Ars Electronica[5]. *ISEA*, which began in the Netherlands in 1988, combines performance, video, sound, installation and theory in a dialogue relating to the specialist issues that relate to electronic art. *Siggraph*—first held in Colorado in 1974—has included an art and design exhibition as part of its collection of trade show, technical and creative discussion, animation, and special effects screenings each year. *Ars Electronica*, held annually in Austria since 1987, provides a competition, exhibition and conference exploring installation, animation, sound and computer graphics. Many other similar events have emerged in recent years, contributing to the development of new

2 <mitpress2.mit.edu/e-journals/Leonardo/> Leonardo / the International Society for the Arts

3 <www.isea-web.org> ISEA: International Symposium on Electronic Art

4 <www.siggraph.org> ACM SIGGRAPH is dedicated to the generation and dissemination of information on computer graphics and interactive techniques

5 <www.aec.at> Ars Electronica: annual festival and competition for works in computer graphics, interactive art and digital music

understandings of digital media and demonstrating its potential in many different expressive forms.

As this discipline has matured it has spawned other fields and specialised forms of digital arts. A new generation of video artists has emerged; numerous sound art subcultures have relentlessly experimented with digital sound; and many artists have used computer animation and realtime visual systems in their work. The possibilities of web art have been rigorously explored, ranging from art online to art that uses and manipulates the online environment itself as its content. Artists using generative systems and alife, and many other art and science exchanges, have provided new methodologies and viewpoints. Galleries and museums have been the site of installation works, as have other locations outside the established institutions. Artists have experimented with robotics; VR; game mods working with aesthetics of the material and real; and those working with the virtual and abstract. In just over a decade, electronic art has evolved from a relatively self-contained experimental discipline to a diverse range of practices and approaches that defy a singular classification. This can be seen in the variety of events and exhibitions, and the assimilation of digital media into contemporary art and design.

2.4.7 Multimedia design

Theories for human-computer interaction (HCI) were established during the 80s primarily for the development of interface design in software applications. This field combined psychology, behavioural and cognitive studies, design and software engineering to develop principles for the design of interaction. Many of these ideas are documented in the landmark book *The Art of Human-Computer Interaction* (Laurel 1990), first published in 1990. HCI principles were applied to CD-ROM development, and then later to web design—where usability has become a key issue.

The Web has also been the domain in which the discipline of 'multimedia design' has matured. This field of creative design is concerned with the process of developing concepts for effective communication using time-based and interactive media. Originating as an offshoot of the 'desktop publishing' revolution, graphic designers were joined by animators, architects, sound designers, illustrators and product designers to contribute to the emergence of a new creative discipline. During the late 90s many tertiary institutions developed degrees in this field, while magazines and online studios also adopted the term multimedia design. As the Web matured many designers were able to experiment with animation and interactivity using PCs, developing a diverse range of styles and working methods.

Many of these developments have been made possible by key software tools that enable particular paradigms or methods of production. Much CD-ROM development was enabled by software such as Macromedia Director: a production environment introduced in the early 90s that combined digital media, animation, interactivity, and an accessible scripting language. Apple Computer has introduced many key technologies such as Quicktime that enabled the playback of digital video. Several innovations in digital video, DVD authoring and sound software have followed in recent years. Web protocols such as HTML and VRML have made the construction of online content possible for professional and amateur alike. Other online technologies such as Java and SQL require more specialised knowledge, but are also in common use. Macromedia Flash has become a standard for interactive design on the Web, with its Java-like scripting language and animation tools. Game engines and game mods have also been tools of choice for applications beyond the design of games.

Multimedia design is an established creative discipline with its own areas such as interaction design, information architecture, motion graphics and so on.

2.4.8 Digital games

Arguably, the digital game is one of the most mature forms of digital media: its history dates back as far as the 1960s. For many years it has enjoyed popular success as entertainment in a number of forms: the game arcade, portable games, video game consoles, and the PC. It developed its own conventions and audience alongside forms such as CD-ROM and the Web.

Digital games have also been through several generations of development. The first games used simple mono-colour, pixelated displays or were text-only adventure games; however they still managed to engage an audience with their gameplay and ability to create alternate worlds. Successive generations of technology during the 80s introduced better quality imagery and sound and established a wide range of genres and models for gameplay. During the 90s these games were refined through further developments in the representational technologies of games, and also through innovations in narrative and content that extended the depth of the game worlds. Most recently, sophisticated 3D graphics engines and developments in AI have resulted in game worlds that immerse and engage the player on many levels. This is extended by the integration of network technologies that allow multiplayer scenarios where players share large game spaces and online communities.

The audience for digital games has expanded through these successive generations. Digital games are no longer a fringe activity played exclusively by teenage boys (although such players remain a large percentage of the market), and as a result a wider range of genres has developed. As an industry, games have grown to rival the mainstream cinema market, and characters such as Super Mario, Sonic the Hedgehog and Lara Croft have become widely recognised in popular culture. Much like the Web, digital games have emerged from the 90s as a mainstream mass media form.

Game engines have been used to create other types of experience such as poetic, contemplative spaces; intense, abstract audio-visual experiences; or deconstructions of game language. The emergence of 'game art' has seen experimentation with alternative aesthetics and gameplay outside of the commercial games development arena. Curated exhibitions of this specialist form of new media art such as *reactivate!* (Ivanova 2004) and *Plaything* (Starrs 2003) have documented its development. Melbourne-based *select parks* (Cannon 2002) hosts an international game art archive, which comprises more than thirty experiments and artworks using computer game technologies.

Game studies includes specific fields such as ludology (Frasca 2003) that explores how the interactive processes of computer games create meaning. This 'game art' activity has coincided with the development of game studies as a field of investigation led by research centres such as the Center for Computer Games Research in Copenhagen. Aarseth's seminal book *Cybertext* (1997) introduces the notion of ergodic literature; Juul's *Half-real* (2005) articulates a theory of the same name; and in *Unit Operations* Bogost (2006) outlines an approach inspired by the computational operations from which games are constructed. A significant and lively discourse relates to the content of games in the cultural studies area and analysis of narrative structures in computer games. The development of digital games presents the ideal form for exploring media ecologies and digital media poetics.

2.4.9 Digital media theory

Terminology and critical theory has changed during this short history. In the early 90s the analysis of digital media was a specialist activity undertaken by a small percentage of academics and writers. Now almost a hundred conference and symposia on the topic are held every year, and numerous journals, books and other publications appear. Many different areas of investigation and topics of research have emerged, and articles published in specialised academic press through to popular magazines. Digital media has shifted from a fringe area in the early 90s to the mainstream form of communication (in the developed world) today. The growth and acceptance of the area has led to the establishment of a large number of diverse disciplines and forms, each with their own terminology and theory. Discussion of digital media may take place on a number of levels, from general concepts down to specific aspects, and may focus on cultural, technical, production, design or other issues. This is an indication the extent of its assimilation into culture and effect on society at large.

Many different approaches to digital media have been established, including the various models outlined in the first chapter. These will be discussed in more detail in the following chapter.

2.5 The naturalisation of digital media

From this brief history we can identify some significant shifts that have occurred over the past decade. Firstly, there has been a general naturalisation of digital media. It has become integrated into daily life and familiar to a mainstream audience, who use it for recreation, work and social activities. This has resulted in a basic digital media literacy that is common to this audience. Secondly, there has been a shift from the 'wow' factor of technology for the sake of technology through to increased significance placed on the uses of that technology. It will be still a little while before a mainstream audience acquires literacy in digital games, virtual worlds, iconographic languages and generative music. However there is a growing community involved in experimentation and development in these fields, generating a steady stream of new developments in areas such as game design, crossmedia, and interaction design. So although we have a basic literacy this is simply the starting point towards a more sophisticated and eloquent form of digital media expression. Finally, there is an increased blurring of the virtual and the real: they are becoming one and the same, through technologies such as wireless networks, mobile communications and augmented reality. These new technologies have allowed for digital data to permeate the contemporary urban environment and often that data is perceived by players to be as real as material components of the same environment. The use of socially mediated spaces such as online games as regular sites of both work and social activity demonstrates the other side of the collapse of the virtual into the real, as virtual worlds become an everyday part of life. Likewise virtual objects from these worlds come to have social or monetary value despite consisting only of information.

The 'naturalisation' of digital media technologies and their blending with the everyday can be traced back to the development of the PC in the 70s. Systems that previously occupied entire rooms and required dedicated technicians were reduced to the classic workstation configuration of monitor, keyboard and beige box. PCs were able to process realtime input, unlike the batch processes of computation that were characteristic of previous generations of technology. These systems were also embraced by the business world for word processing, database and accounting tasks. Apple computer made the GUI popular in the 80s through their Macintosh system that made computers easier to use, and introduced the mouse to the workstation. However, it was not until the 90s that PCs saw widespread use outside the information technology industry, gamers and hobbyists. Developments in digital media on the PC attracted artists, designers, filmmakers and other creative individuals to the technology. Later, communication technologies such as email, newsgroups and chat programs became popular, driven largely by the emergence of the Web and its growth as a medium for business, recreation, socialisation and communication across almost every aspect of culture and society.

The surge of interest in digital media created a new domestic context for the technology that has furthered the process of 'naturalising' digital media. Within the developed world digital media has become a mainstream form of communication, with technologies such as email, the web and DVD coexisting with older technologies such as the telephone and television. However, some aspects of digital media, while established, are still evolving. Digital games are a popular form of recreation, but their audience is still limited, as the main genres of these games are based on gameplay driven by action and violent scenarios. Digital media developers have been able to produce engaging, interactive content for the Web for a number of years, but until the recent introduction of more affordable broadband connections this content has been inaccessible to a large percentage of the audience. The content has been limited by technological constraints. So while some aspects of digital media have become part of everyday experience, other aspects are still developing in terms of technology, content or language.

Integration of digital media into the domestic environment also means growth in its recreational use, predominantly in music, video and gaming. This shift can involve a change in the method of delivery, hybrid forms that combine different media, or new forms altogether. Compression technologies such as mp3 combined with file sharing networks have opened up new ways of distributing music, thus challenging a music industry that previously relied on physical networks for the distribution of music on CD. It is not only the increase in sound and picture quality that attracts audiences to DVD, but also its interactive qualities and the additional material such as music and games that expands the format beyond film and video. Digital games feature interactivity that involves the audience in new forms of play such as adventure and exploration, sports simulations, and immersive interactive environments. More recently, hybrid forms of gaming have emerged that involve the player in different ways, for example the Sony *EyeToy*[6], the street games of *Blast Theory*,[7] and involve the growth of online communities surrounding MMORPGs[8]. Overall,

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6 <www.eyetoy.com> camera based interface for Sony PlayStation 2 that tracks the movement of the players body

7 <www.blasttheory.co.uk> UK based performance group using mixed reality technology to construct game scenarios that link street games with virtual environments

8 MMORPG: Massively Multiplayer Online Role-Playing Game. Games such as Anarchy Online, www.anarchy-online.com, allow huge numbers of online players to interact with one another in persistent worlds

there is a discernable shift to the digital delivery of media simultaneously with the facilitation of interactive forms of entertainment.

2.6 Summary

This is only a brief overview of the development of digital media. In the past decade it has been established as a mainstream form of communication across the workplace, social situations, the domestic space, and as a site for recreation. It has demonstrated its capacity to adapt to a wide range of applications and new possibilities quickly emerge (and sometimes quickly disappear as well). Parallel histories in areas such as the business world, street culture, electronic media art, multimedia design, digital games, cyberculture, education, scientific research and entertainment all contribute to and inform its development.

Within this large scope, some common themes emerge. Issues relating to the interaction of technology, audience and language are common across all areas. Technology in itself is not successful—the survival rate of new technologies is relatively low—it needs an audience willing to give it meaning and useful purpose. In many cases new applications for technology have come from the communities that use them rather than the developers of the original hardware. In the early days of video game development, independent developers would push the hardware to meet the needs of their game design even if this meant performing software hacks or tricks to modify its functionality. Musicians and sound artists found new sounds in early Roland analog synthesisers such as the TB-303 and TR-808. Originally designed to emulate real instruments such as bass guitar and drums, their synthetic sound was adopted in the formation of new musical genres such as acid house and techno. Likewise media artists and creative designers have found new ways to use technologies outside of their functional design. This application of technology is dependent on adequate language and models of understanding to articulate both the nature of technology and what its audience is using it for. Ideas may emerge and be given life in terms of language and theory before they can be realised; in this way theoretical research may drive the development of technology. All three forces—technology, audience and language—push the evolution of digital media along a constantly changing and multiplying path.

This background serves as a context for the discussion that is to follow on models of understanding digital media. The scope of change and its impact on human communication is clearly significant. Its technology, audience and language continue to change and evolve, providing new opportunities and challenges. One of those challenges is the articulation of modes of expression and communication that reflect the nature of digital media in terms of the opportunities offered by its endemic properties and unique characteristics.

3 Literature review

This chapter surveys existing models used for the analysis and understanding of digital media. Different approaches are compared and evaluated, and their strengths and weaknesses highlighted. They provide a starting point for the establishment of an alternative model, as well as serving to illustrate the difference of that alternative. Each of the nine ideas represented capture a particular point of view on digital media, from a wide range of sources. Finding common ground between them presents part of this investigation in a different context: a language for digital media that is interdisciplinary and shared across a wide range of genres and applications.

Current approaches to digital media include the popular *elemental model* that breaks digital media down into its constituent components to examine the properties of these individual media components. Some approaches such as the *theatrical model* (with its narrative base) are based on human interaction; some on usability (the *HCI/usability model)*; in contrast the *architectural model* is based on spatial relationships. Some models look at the new possibilities of digital media (the aesthetics of information and data, in the *aesthetic model*); or the idea of encoding meaning into a 'hypersimulation' within the *emulation model*. The *remediation model* builds on previous media theory through an analysis of changes in existing media when they become digital. The language of film informs the *cinematic model* that adapts the familiar conventions of narrative filmmaking to digital media. Finally, the *technological model* is also explored in terms of technical language and terminology.

3.1 Existing models of understanding digital media

As mentioned above, a number of different approaches to digital media have emerged during its relatively short history. Some build on the language of existing media; some are based on understandings derived from the nature of the underlying technology; some are based on the idea of properties endemic to new media; and finally some mix a number of diverse concepts together to create a hybrid model. This survey examines nine models for digital media.

3.1.1 The elemental model

Many early views of digital media provided a model that used recognisable media types such as text, sound, image, animation and video as the basic building blocks. These often comprise long lists of terminologies and technologies such as those found in *Understanding Hypermedia* (Cotton & Oliver 1997) and *Digital Multimedia* (Chapman 2000). While useful reference tomes they do not provide a cohesive, integrated model. Apart from the convenience of this approach and the confidence that it creates through identification with familiar elements, there is also the fact that this links with the most common file types associated with digital media production: text files, bitmaps, digital video files, sound files. So the actual tools of production emphasise these categories through the grouping of elements by their media type.

One of the problems with this approach is that it oversimplifies the relationships that are emerging in digital media. Each element is easy to identify as belonging to a familiar media type, but what really happens in the production of digital media is that all of these elements are blended to make something that is greater than the sum of the parts. Breaking down digital media into elements does not reflect the complexity that arises in the hybrid, and has no specific terminology for describing concepts such as random access and interactivity.

Further, the elemental model does not address the relationships between different media elements or describe the effects of interaction and feedback between the player and world. For example, it may describe the building blocks of a media ecology, but not the systems and rules that make it work. However, it does provide a useful starting point for identifying potential units of meaning for a semiotic analysis.

3.1.2 Theatrical model

The theatrical model of digital media, pioneered by Brenda Laurel in her book *Computers as Theatre*, puts forth the idea that interaction with digital media can be likened to the interaction between characters in a theatrical performance. It recognises the importance of relationships in digital media by including interactivity as a key component of digital media. Digital media and its agents need to have the capacity to react and respond to stimuli from those visiting or participating within it. The structure of digital media, and the role that the user plays in interacting with it in terms of agency, are central to creating the user's experience. Laurel uses the metaphor of theatre to demonstrate the way that the user is engaged in a virtual world. The central concept is the idea of the computer desktop as a kind of 'stage' on which agents and 'other elements of the representational context' interact with the user as part of the same simulated world. This means that '*the representation is all there is*' and that meaning is shaped by both context and interaction, in that 'participants learn what language to speak by noticing what is understood; they learn what objects are and what they do by playing around with them' (Laurel 1993, p. 17).

This model contains several useful concepts for an analysis of digital media on its own terms. These include the theories on agency and context that demonstrate how meaning is created in the representation of a virtual world. They express interaction in terms of acts performed by the agents in the representation, and how established knowledge in narrative and theatre can serve as a base on which to stage those actions.

The theatrical model is a good tool for analysing relationships between the various elements that make up the design of an interface. It is one of the first approaches to acknowledge the nature of interaction within digital media as essentially a simulation in which the player is directly situated within the action. However, it was developed largely in response to a previous generation of digital media that preceded more recent developments such as the Web, online communities, alife and crossmedia entertainment. While some of the concepts scale up to the complexity of contemporary digital media and others may be adapted to new scenarios it is mainly useful as a starting point for further investigation rather than as a solution in itself.

3.1.3 HCI / usability model

Many of the conventions that we take for granted in interface design today—such as icons, the desktop, files and folders, windows and other familiar structures—have been carefully documented and crafted through the development of rules for human-computer interaction, or HCI (Laurel 1990). This approach is focussed on the interface between the abstract space of the computer and the perception of the user. Essentially, the goal of HCI is to make the abstract data of the computer visible to the user so that he may manipulate, search, edit and so on. Measuring usability—how the design of software helps or hinders HCI—provides a way to test the functionality of an interface design. Nielsen's (1993) usability engineering, for example, prioritises the functional aspects of interface.

This model recognises one of the fundamental and unique structures of digital media—the interface. Its key focus is usability, which makes it ideal for analysing business and commercial applications. However, the rules and limitations it places on articulating the interface and what it should be make it restrictive for many types of interface. It is best suited to the design of operating systems and applications, as it is a very technical language—it would be difficult to effectively explain the emotive experience of a computer game using the HCI model as it is largely concerned with functional and informational aspects of human-computer interaction rather than its more experiential aspects.

Rules for Human-Computer Interaction and methods for testing usability are an essential part of digital media development to provide a quantitative way of measuring the comprehension of an interface design by its audience. However, as it is mainly focussed on practical issues this approach limits experimentation with possibilities that may exist outside the rules. Much like the technological model, it only provides part of the picture. It simply explains the functionality of the interface, rather than the experience and process of being immersed in digital media.

3.1.4 Remediation model

Digital media include almost all previous media forms, such as text, recorded sound and video, although in a modified form. Furthermore, it may borrow elements of the languages of other media or mimic other media forms entirely through emulation. Jay David Bolter and Richard Grusin have proposed the concept of 'remediation' to describe how previous generations of media are changed through becoming digital. Through this idea, digital media is not seen as a medium in itself but is defined by this process of remediation and through layers of mediation within the space of digital media.

This process is identified in applications such as hypermedia that use the digital media context to analyse or change previous generations of media; but also in digital media that is designed to be 'transparent', in that it offers the immediacy of immersion in a digital experience. Within the context of remediation, even novel forms such as the electronic spaces of VR can be situated in a historical media context. These applications of digital media 'seek to get to the real by bravely denying the fact of mediation' (Bolter & Grusin 1999, p. 53). This denial of mediation is in contrast to the mix of content and media in hypermedia that functions 'by multiplying mediation so as to create a feeling of fullness'. By providing a media experience rich in a variety of representational forms and information another representation of 'the real' is constructed that is also in its own way a rich, immersive experience.

This is a valuable strategy for analysing the effect that digital media has on existing media, and it is also useful in identifying the strengths and weaknesses of digital media. However, this approach makes it difficult to identify properties of digital media other than its capacity to 'remediate'. Like the elemental model, it provides very useful insights into the components that make up digital media, but not the fresh approach that this investigation is seeking.

Taken at face value, the theory of remediation appears to run counter to the idea of endemic properties and unique characteristics of digital media. However, it explains the complexity of a media ecology in which the various media are interacting with one another—cinema informs digital media, digital media informs cinema, and so on. The hybrid form that emerges from all of these interactions may then be analysed in terms of novel features and developments. Remediation provides a useful counterpoint or source of hybridised digital media for analysis, but not the tool for understanding these media on their own terms.

3.1.5 Aesthetic model

Further insight into what is different about digital media may be achieved by using the fundamental building blocks of the medium, such as 1s and 0s, streams of media, pixels, geometric primitives, unprocessed slices of data, and machine code elements in their raw form. This could be described as an aesthetics of information. By way of example, Holtzman suggests that VR is 'a new medium for expression', with 'virtual worlds' as the expressive vehicles for the medium (Holtzman 1994).

This builds upon the idea of artists representing a personal vision or way of looking at the world through their work. They use 'a system of symbols to represent a view of reality' (Holtzman 1994, p. 210) and this approach may be also be applied to digital media where they may build a world from 'pure information'. Holtzman emphasises the formal qualities of virtual realities, such as iterative rules, algorithms and data structures, as 'the foundation for building these new worlds will be the explicit description of the structure of these worlds' (Holtzman 1994, p. 210).

This approach actively investigates new potential forms of digital media as they occur 'naturally' in electronic space. However, this approach is specific to particular forms of this space and cannot be applied to a broad range of applications. It is a useful source of ideas as it is concerned with the identification on an entirely new set of formal relationships that characterise digital media. A generation of artists has adopted this approach to create works that engage with digital aesthetics typically without dealing with representational content. A survey of this practice, suitably titled *Abstraction Now* (Wien, Pfaffenbichler & Droschi 2003), explored abstract art as expressed via audio-visual media and interdisciplinary approaches.

The main focus is on the formal qualities of virtual worlds as artificial constructs to be explored as aesthetic objects. The role of artists as world-builders who decide on the structure and rules of a world and therefore its outcome is explored in depth. Like the theatrical and remediation models, this approach provides many useful insights and starting points for the development of an alternative approach. It resonates with the themes of digital media aesthetics and world design, but does not address issues of meaning construction as it deals mainly with abstraction.

3.1.6 Emulation model

Just as remediation builds on the work of McLuhan in terms of his ideas of mediation, the concept of emulation is proposed by Arjen Mulder as an evolution of the idea of simulation: 'the generation by models of a real without origin or reality: a hyperreal' (Baudrillard 1994, p. 1). Emulation is different to simulation in that it not only represents the subject, but also recreates it within a digital media environment. Arjen Mulder (1999) outlines the possibilities of the everyday PC that can transmutate into almost anything through software and can potentially emulate 'all hardware from all times, and what it was, is and will be capable of';

the computer can be seen as a 'metamedium: a collection that contains all other collections' in that it includes all previous generations of media and can emulate all previous generations of software code and hardware systems.

In viewing digital media through the concept of emulation, a particular emphasis is placed on the experiential nature of the medium. This emphasis demonstrates how the combination of digital media, programming and interactivity results in a kind of hypersimulation. This simulation expands outside the realm of replicating a system, but extends the given system further by creating another world in itself that references its subject, but also exists on its own terms.

This is an important new way of understanding digital media that can be related to remediation and digital aesthetics.

Emulating other media in the digital domain is interesting, but it is where emulation mutates into a hybrid form that it becomes really interesting. Earlier forms of digital media, such as the 'expanded book' or the 'interactive movie' emulate existing media forms and augment them with interactivity or other additional features. As the audience have become more familiar with digital media, these references to earlier forms have receded into the background and hybrid forms have emerged. Many websites, for example, blend digital video, hypertext, animation and interaction into a single cohesive form. Some of these projects reach a point where they evolve past the point of emulation and become something new. At this point we need a new tool to analyse them as they have outgrown the emulation approach.

3.1.7 Technological model

All digital media technologies need to be described in terms of their function in a hardware / software system so that engineers and programmers can specify, construct, assemble, decode, and debug a given system. As a result, digital media is full of new jargon and terminology that describe new technologies, ideas and hybrids. As each new element of digital media emerges it is named and given a place in the scheme of things. Several compilations of terminology have been published, such *The Cyberspace Lexicon* where 'concepts collide and catalyze' through the convergence of diverse fields, resulting in 'vocabulary needed to deal with this phenomenon [that] becomes polyglot, even pidgin' (Cotton & Oliver 1994). This terminology varies and includes specific technical terms, acronyms, trademarks, slang, and technical terms that have developed wider cultural usage. A key theme that emerges is the range and diversity of technical terminology indicating the huge number of technologies utilised in digital media production that each have their own terminology and concepts.

These collections of new terms and definitions are designed to aid in understanding the jargon and specific terminology of digital media. As such, they are an invaluable resource for raw material. However, they are specific to particular instances of technology, and as such do not provide insight into the connections between each instance. This is demonstrated by a common approach to teaching in digital media where the tools are introduced to students prior to creative or design-related concepts. Textbooks such as *Digital Media Tools* (Chapman 2002) are structured around menus and commands, bitmapped images and vector graphics, video and audio, files and formats and so on. The resulting model of digital media is centred around functionality and utility rather than communication and expression.

This model is limited by its technology-driven approach. The thinking is 'what can this new device do?' rather than considering needs or desires, for example 'this is what we need this device to do' or 'did you know it can do this?'. Many technologies are repurposed in new applications for which they were not originally designed, so defining digital media exclusively in terms of technical specifications and functionality is only a small part of the picture.

3.1.8 Architectural model

Digital media may be analysed in terms of spatial relationships by drawing upon principles of architecture, town planning, and interior design. The built environment is designed around both the human mind and body in that it is 'reconciling our experience in the world with our mind's cognitive landscape' (Anders 1999, p. 9). Similar design principles of human behaviour and cognition may be applied to cyberspace, as it is based on the physical world in terms of three-dimensional navigation, physics, objects and entities. Successful design of cyberspace may therefore occur by 'designing from our fundamental awareness of the world' – using what has been learnt in architecture and related disciplines and applying it to cyberspace.

This model provides a methodology for translating what we know about real, constructed spaces into electronic space. Unlike some of the other models it includes spatial relationships as part of its language. These ideas emerged alongside the spatial metaphors featuring heavily in early 90s VR projects that mapped information into navigable spaces. Heim (1993) articulates the different metaphysical relationships that we have with electronic spaces on practical, sensorial and intellectual levels. Spatial metaphors work, because they are familiar; however recreating reality within the simulated space of the computer has its limitations.

Spatial metaphors also feature heavily in information architecture (Louis Rosenfeld 2006), which is concerned with creating meaningful patterns and structures in information. Raw information is rarely useful in itself, so information architectures are designed to format and interpret this information. The field combines architecture and library science, providing guidelines on effective structures for containing and communicating information. This can be compared to William Gibson's cyberspace, where the collective data of the world's computers are represented as a giant landscape of buildings, structures, entities and abstract forms.

Spatial metaphors have proven to be highly effective in a number of different applications of digital media. A number of examples that demonstrate different strategies for mapping information are documented in the *Atlas of Cyberspace* (Dodge & Kitchin 2001), including mappings that visualise data collected from real spaces and the mapping of data relating to virtual space in more abstract ways. However, a balanced approach is required to capture the whole picture without heavy bias on one aspect (in this case, spatial relationships).

So many virtual worlds, especially in the early stages of development, were simply navigable spaces without meaningful interaction. Architecture has been the source of inspiration for many developments in digital media, but like cinema and print it has become as much a part of digital media as a source for inspiration. New forms of architecture are now inspired by virtual worlds as much as virtual worlds make reference to architecture.

3.1.9 Cinematic model

Throughout the 1990s, cinema and multimedia enjoyed a close relationship. Much technological development in digital media has been towards emulating the quality, motion and experience of the cinematic image. This can be seen in the evolution of early digital video into DVD and other formats. Digital games have sought to recreate the visual quality of cinema and often include non-interactive scenes that tell the background story of the game via traditional narrative. Some digital media take this approach further by attempting to create an interactive narrative through the combination of film images and user choices along a predetermined set of paths.

As the language of the filmmaker is transposed onto the small screen of digital media there are a number of areas in which the two intersect. Both are predominately visual media in which the events are depicted by actions of characters, agents or environments. The team-based production methodology and techniques may be similar in many cases. Digital media can employ a narrative or sequence of linked events that may or may not employ interaction to communicate. Storyboarding interaction is an example of this crossover in which knowledge from the established domain of cinema is readily adapted to the new field of digital media.

Manovich (2001) in *The Language of New Media* articulates a model that relates digital media and film language. He takes this approach further through the development of database cinema and five principles of new media, identified in the first chapter as: (i) numerical representation, (ii) modularity, (iii) automation, (iv) variability, and (iv) transcoding.

However, reliance on cinema and in particular narrative as a means to understanding digital media gives rise to certain problems and limitations. Interactivity and narrative appear to contradict and conflict with one another. The author typically drives narrative as he or she guides the reader or viewer through a series of sequential events. The player usually guides interaction as they make their own path through a series of events that may be predetermined or may be generated in response to the actions of the player. A narrative may be formed by this journey, but it is the player's narrative and not that of the author.

3.2 Gaps in the current models

All of these models offer interesting insights into digital media through their particular areas of focus. However, they are specialised models for particular application areas of digital media, or in some cases they have been superseded by developments in the technology and audience. Existing approaches to digital media contain fragments and pointers to its endemic properties and unique characteristics. They provide useful ways for understanding it by using media of the past and by adapting existing theories, but this approach has its limitations. What these models don't address is the particular phenomenology of digital media, the nature of its meaning construction, relationships within its ecologies, and the complexity of interaction and feedback with artificial entities.

While virtual world design may draw upon many sources in establishing and developing its conventions for communication and expression, it has evolved to the point at which it has become something else. References to other media are deeply buried in the interface that has become the central point of focus. Consider a typical virtual world that may have a population of thousands of people, its own laws and rules of government; blend game- and community-type activities; and combine any number of different forms of representation. There is no overarching narrative or structure that can immediately be recognised using a conventional viewpoint. However, there is a structure there that can be articulated. It only becomes apparent during play or experience of the overall system, and so needs to be described in terms of this play at being in an alternate world—not watching a story situated in a fictional world, not navigating links of information about a fictional world, but being there. The ways in which that world is constructed and experienced are different as the player is situated in the process of being an active part of the world rather than a passive observer. The world knows that they are there.

Each interface can be a microlanguage in itself. Conventions have been established in user interface design, but designers often work outside these rules and develop alternative processes of interaction. This is possible because interaction involves a kind of conversation with the machine in which the meaning of certain actions, icons, sounds and so on can be established along the way as part of that exchange. This may be the case in the animated interface of a website, the design of characters and a world for a game, or the interface for a mobile phone. In each case there is the possibility of adding new elements to the language of interface design or changing the meaning of existing elements. Meaning production is a fluid process that involves human and computer in the exchange of meaning. The standard method for this interaction is the combination of mouse, keyboard and monitor; but other forms have become commonplace. Gamepad controllers have become sophisticated tools for navigating virtual worlds and offer a greater amount of expression than a standard mouse. Elaborate languages of mouse gestures and keyboard shortcuts have been developed for operating complicated simulations. Gestures, body movement, voice and location have all become methods of interaction. In these multilayered representations that are coupled with complex simulations languages of interaction are developed that connect the phenomenological experience of digital media to the semiotic construction of meaning that occurs within the machine. A way to demonstrate and articulate these relationships is needed that recognises the generation of meaning and exchange that occurs during the process of interaction.

Another challenging situation to decode is the interaction that occurs between players and entities within digital games and virtual worlds. These encounters combine nonverbal communication with dialogue, visual communication, rules of gameplay, and codes of world design. Although the AI in games and in interface agents is relatively simple, this is not always the case. Some artificial lifeforms are able to adapt and respond to changes in player behaviour and their environment. Bots in First-person shooters such as *Half-Life* (Laidlaw 1998) use an adaptive model that employs different strategies in response to human play patterns to make them less predictable. Agents in simulated environments may develop new strategies for survival using neural nets to learn new behaviour; or use evolutionary pressures such as those found in *Tierra* (Ray 1992) to produce new generations of agents that are better suited to their simulated environment. Once again the player is situated in the world and is relating to the entity in a number of ways—their spatial relationship to the entity in the world, the narrative that is being built through their interaction, and the process of engaging in that interaction, including negotiating any rules or limitations placed by the design of the world. Understanding these levels of the relationship between player and entity requires a semiotics that is situated within the artificial ecology itself.

Current approaches to digital media go part of the way in decoding the complexities of these relationships. An alternative approach that is inspired by digital media iconography, virtual world design, artificial lifeforms, and hybrid media ecologies may be able to better explain what is going on here. This will identify and articulate the endemic properties and unique characteristics of digital media.

4 Thesis proposal

Among the models examined above, a number of useful strategies and approaches to analysing digital media were identified. Generally, they were found to be too specialised, only providing part of the picture; or they relied too heavily on established media and so did not capture many new or unique characteristics.

An alternative approach to understanding digital media is the development of a new model, grounded in a system for human-computer expression. A system that is inspired by its poetic language of media creatures, unique audio-visual syntax, articulation of world as language, and the potential of process as communication. This system will express the poetics of digital media in a practical, tangible form that may be used in play, in development, and in analysis.

This approach is linked to the development of a series of artworks over a period of fifteen years that embody the idea of digital media poetics. Throughout the text these works will be used as examples that have actively explored this idea. During their development, patterns and structures emerged that could be identified as being novel forms of expression or communication. Each experiment in new forms and relationships revealed further opportunities and so each work explores in detail a particular aspect of the larger theme. It soon became apparent that digital media poetics functions as a language; it grows and evolves through use and is an adaptive system rather than a definitive structure.

Thus, the focus of this research shifted to finding a set of common elements and themes that enable the decoding, analysis and creation of new forms of communication and expression in the language of digital media. This needs to be a flexible, adaptive tool that can be applied to a range of examples and scenarios, but with its focus clearly on a particular vision of digital media. In this way it has a dual purpose—to highlight those novel aspects of digital media that are of interest to this investigation, and also to provide a way to see all digital media with fresh eyes.

This research is grounded in a free, intuitive exploration of the potential of digital media poetics to manifest new forms of communication and expression. The idiosyncratic, personal language I have developed in this series of works is one possible form of expression within the language of digital media.

4.1 A particular vision for digital media

This thesis sets out to prove two main points. First of all, that digital media is significantly different from previous generations of media in the ways in which it is used to communicate, offering new forms of expression and processes of constructing meaning. Analogous to the argument that each written language (Mandarin, English, Spanish, Hindi, Arabic and so on) represents a different way of thinking and seeing the world, digital media language allows another set of possibilities of human expression when compared to the language of print, cinema, painting, theatre, architecture and so on. The second point is that these points of difference are best understood in terms relevant to digital media itself in order to highlight them as novel and unique. While it may be useful to compare digital media to print or cinema in order to illustrate these differences, it becomes counter-productive to base our understanding of digital media in terms of print or cinematic language.

Those who have an intuitive or consciously nurtured literacy in this language are distributed across a number of levels. Most common are those who experience or play digital media – the audience. Another smaller, but still significant group are the developers of digital media, often players themselves. A smaller group again are the critics, although this number is increasing. All of these people have a vested interest in a digital media language, albeit for different reasons.

What is useful for these people is a language or model that captures these novel aspects of digital media. Working with the idea of a digital media poetics resonates with its audio-visual syntax and the many ways it communicates outside the typical understanding of language. Books have pages and chapters, movies have shots and scenes—what are the equivalents in digital media that make sense? The model will be used as a tool to discover these forms, through analysis and deconstruction of digital media on its own terms.

Although there is a long history that describes the formation of digital media—surprisingly long in fact—this thesis is based on relatively recent events. The history up until now is outlined in the second chapter; there is still much more to come. Most of the examples and discussion are based within the last two decades: from the emergence of ‘multimedia’ in the late 1980s, the popularity of the web in the 1990s, through to the naturalisation of digital media at the turn of the millennium, and the shift to ubiquitous media over the past five years.

Does digital media have a major form of expression? Writers create novels, filmmakers produce films, architects design buildings, and so on. Is there a particular form that may be identified in relation to digital media? Perhaps it is the ‘world’: that hybrid system of forms that describe an experience across many media. Or are digital games the primary form of digital media? Or the Web? Alternately, it may be seen in the systems that emerge within the diverse media ecology of digital media as it interacts with other media networks. So, its major form of expression may be the 'system'.

However, if we can locate this new form and decode it then we are able to articulate and understand new forms of expression. This will then open up novel ways to construct meaning, to tell stories, to create experiences, to design and to create art. Using the analogy of written language it will open up a new way of thinking about and seeing the world through a shared audio-visual code. During the 19th century the concept of a film did not exist, although various proto-cinematic forms appeared at this time. Now that the conventions and form of a film have been established it has become apparent what particular aspects of expression in that form are possible. It is for example a highly visual medium and through the combination of moving image and sound often highly emotive. Particular aspects of its forms can be articulated: characters, plot, cinematography, soundtrack and so on. Understanding digital media on similar terms that are unique to its particular form allows more sophisticated reading and engagement with it.

Do digital media enable alternate modes of communication or novel forms of expression? If so, what are they? What is the significance of this, if any? There is much to be gained from articulating the terms, tools, and functions of expression in digital media. Critics may use this as a tool for analysis and deconstruction, audiences may use it as a base literacy, and developers may use it as a map to understanding how to express themselves using its unique language.

This thesis constitutes a manifesto for a particular vision of digital media. This vision has emerged in fits and starts over the last fifteen years as fragments of the bigger picture have emerged. Print publishing, filmmaking, architecture, theatre and many other media have all served their purpose in translating digital media language. Most recently, the importance of interaction has become widely acknowledged via the widespread study of games—one of the most interactive forms of digital media. The vision of digital media expressed in this text is one in which it operates on its own terms of a digital media poetics.

In order to answer these questions, we will develop a model for the articulation of a digital media poetics and demonstrate its use in play, development and analysis, particularly via forms such as digital games and electronic media art.

4.2 A framework for the model

We can begin with two main starting points based on practical experience in making and playing digital media: the idea of a digital media poetics, and an intuitive vision of what this may be and how it would work. These concepts are situated across two distinct worlds; firstly, the one that surrounds us, that we are familiar with and that is already occupied by a mediasphere; secondly, the digital world that we have created within the computer, that is unfamiliar and that follows its own machine logic.

And so one focus of the study becomes the articulation of the communication between these two worlds. This process largely occurs through a player or players and a system or systems, via a cybernetic relationship of interaction and feedback.

Consider how the computer sees us and how we may reconcile that view with the human experience. A digital media poetics concerns the particular systems and expressions that are natural to a digital space – the logic of the computer and how it presents an alternate reality. In order to deal with this topic, I shall draw upon four main areas: game studies; computational semiotics; ontology and possible worlds; alife; and generative systems.

This thesis does not present a definitive analysis of these areas, but draws upon them to synthesise a new model. In fact, some of these areas may appear to be at odds with one another. In each case, relevant aspects of the field have been adapted to fit within the framework of the overall model. These adaptations and interpretations are developed through the definitions of terms that appear in the detailed text in the following chapters, and they outline individual features of the model. The model is driven by the original intuition informed by a reflexive practice based on digital media design and production, and draws upon these areas to provide a framework in which to situate the original vision of digital media.

4.2.1 Game studies and interaction design

During the last decade there has been increasing interest in the study of digital games and the ways in which players relate to them. Previously, analysis of games was limited to areas such as the sociological study of their content. The focus has now shifted to look at their rules, interface and gameplay so as to understand the particular ways in which they communicate. There are two main schools of thought: narratology, primarily concerned with games as a storytelling medium first and foremost; and ludology, the primary focus of which is the processes of interaction and play that take place within the game (rather than their representational content in terms of a narrative). This field explores the formal properties of games (Salen & Zimmerman 2003), their reading as ergodic literature (Aarseth 1997), and the coupling of rule systems with the real world (Juul 2005). These approaches are most useful in our model to articulate the ways in which meaning can emerge through play with digital media rather than through any narrative that are introduced by the creator.

To a lesser extent, the domain of interaction design also informs this aspect of the model. Over the past decade, an increasing awareness on the significance of players' actions and behaviour has emerged. Experimental interaction design approaches (Cameron 2004) are being explored, while the field is being formalised as a field of study (Moggridge 2007; Saffer 2007). This indicates a shift from the concept of interface design that focuses mainly on interaction that takes place on a screen using a point-and-click type interaction, to a more embodied view of interaction. This includes both physical actions using gestures, interactive environments and objects that may be manipulated, and the gestures, actions and presence of digital avatars within simulated worlds. All of these other modes of interaction differ from the traditional point-and-click approach.

4.2.2 Computational semiotics

Semiotics can be used to describe the ways in which the system is made perceptible to the player or players and how this shapes their interaction with it. Systems of signification and communication, codes, and sign production are the core study of semiotics. By way of example, Eco argues for processes of sign production as the core study of semiotics rather than the formulation of definitive typologies of signs (Eco 1979). Although there are many theories in the field, the basic method is the identification and analysis of sign systems in order to understand the process of communication or formation of meaning. Essentially, this translates to a formal system for identifying what is being represented, how it is being represented and who is reading the representation. As these relationships are more flexible and mutable in digital media, new approaches to the area have emerged to address this—although many of the old rules still apply. For example, an 'Umwelt' describes an organism and its world in semiotic terms. This concept and other ideas that describe semiotic models situated within an environment of signs are developed by Sebeok (1994) in his writings on biosemiotics. These ideas may be translated to describe the relationships expressed between entities and their environment in virtual worlds.

More recently, the interdisciplinary area of computational semiotics has emerged through events such as the COSIGN conference series (Lindley 2001). This field deals directly with some of the issues introduced by digital media, such as its mutability, ephemeral nature, capacity to emulate other media, and potential to include digital agents in the semiotic process. Within digital environments constructed from many different media, concepts such as the modality of a sign can assist in decoding the message that is being communicated. This may be used to identify the relationship of the sign to the overall story or world; the impact that is mediation has on its interpretation; and its relationship to other signs, both inside and outside the world in which it is situated.

4.2.3 Ontology and possible worlds

Using ontology, worlds may be defined in terms of entities, categories, and relationships. Various theories break these down further depending on their view of the world. Essentially an ontology consists of a set of statements about objects and beings that exist, including their properties and characteristics and relationship to one another. The use of the term ontology refers not to the study of nature of being but to the taxonomic structures used to construct digital systems. An ontology is a formal representation of a set of concepts within a given area and the relationships between those concepts. A database, for example, has classes, properties, relations and functions by which entries in the database may be classified and related to one another. A digital game world is constructed from a database such as this consisting of code, images, sounds, 3D models and other digital media. As each of these structures generates a possible reality—such as the way that the game world is experienced by a player—there is some overlap, as each digital world comes to represent a particular way of being.

Thus—similar to the way in which philosophical arguments on the relationship between language and reality are formulated, such as in the *Tractatus Logico-Philosophicus* (Wittgenstein 1922)—ontologies in computer software development describe formal systems that define artificial worlds. 'Entities' describe all of the possible objects in the world, 'categories' the properties and characteristics these may have, and 'relationships' the ways in which the first two may be connected to one another. This system can be used to encode knowledge in a logical system of relations. Take for example a simple three-dimensional world in which cubes and spheres may exist. They can be red, blue or green. From this we can describe a simple set of relations such as 'a red sphere on top of a blue cube'. In digital media, ontology can describe how a reality or world is modelled in terms of the system in which the simulation occurs—including a definition of how the player exists within that space. While ontology often deals with tangible, material objects, this is often not the case with digital media; and so many possible worlds (Ryan 1991) may be invented, each with their own internally consistent and logical way of being.

Some issues arise with the application of classical ideas of ontology to digital media. First and foremost is the transience of digital media—there is no tangible form or matter to be identified and so the entities identified in digital media are artificially constructed rather than real objects. Secondly, and partly because of this first point, there is not a single ontology that can relate to all digital media, but rather multiple ways of being that are particular to each individual expression and its experience by the player. While digital media ontologies are highly concrete and specific, they are also artificial and so can model different perceptions and interpretations of the world. However, ontology provides a practical framework for articulating a world. An example of this in practice is Bartle's model (2004) for different player types and their relationship to the virtual world in which they are situated. An ontology is often used in computer science to define a logical framework for an AI to operate within a game environment. It is this formal system of specification with its origin in computer science that is used to define an ontology in the context of this investigation.

4.2.4 Alife and generative systems

Within the field of alife established by Langton (1995) in the eighties, computational systems are less like machines and more like organisms or entities, albeit with their own unique logic and perception. Largely inspired by real world biology, this area of computer science typically uses the metaphor of an ecosystem populated by agents that interact with one another according to rules. Often, they have the capacity to learn and adapt to their environment and compete with one another for resources. In this way, they are able to evolve in a process similar to natural selection. Generative systems, of which many types are listed in Flake's survey on this field (1998), are typically algorithmic processes that use a few simple rules to produce many different outcomes. After many iterations these can be significantly more complex than the rules used to generate them. Such systems are used extensively in the production of visual art. Examples include Sim's *Panspermia* (1990), an animation that used artificial evolution to generate a diverse range of plant shapes; Prophet's *Technosphere* (1995), an online environment populated by artificial lifeforms and music; and Eno's *Generative Music 1* (1996), an album of compositions using the SSEYO Koan software for creating generative music. Several artists and their projects are documented in surveys of alife art (Whitelaw 2004) and interactive music (Miranda 2000; Winkler 2001).

While much alife research is focussed on the simulation of real world biology, some researchers explore the idea of other forms of life that may exist in a digital medium. These may be so different to the kinds of life that we are familiar with that we are not able to recognise or communicate with them. Likewise, generative systems may be used to explore aesthetic possibilities not usually considered by a human artist or designer, through a process of collaboration with the system in which both parties contribute to the creative process (Whitelaw 2004) in their own way. Both this potential and the richness of the ecosystem metaphor make the field highly suitable to an alternative framework for digital media—one that points to its capacity to make possible forms of expression and experience that are unique to the computational medium.

4.3 Defining language in digital media

Aspects of digital media may be described using other media languages. At its core digital media is constructed from symbolic language. Much work in digital media is focussed on constructing and decoding languages: of interface design, protocols of data transfer, translation and transcoding, and so on. Digital media is characterised by a diversity of unique terminology, culture, and authoring languages used to produce it, that are the equivalent of various modes of communication or dialects. The popular concept of the computer as a processor of symbols originates in the basic levels of its structure. These are made of symbols assigned meaning and placed into relationships[9]—they function as language. At the same time digital media assimilates and uses the vocabulary of other media, so it also transforms these into its own language.

4.3.1 Metalanguage

The shape shifting nature of the computer has been recognised as a key characteristic by pioneers such as Kay (1984) who in describing the nature of the computer writes that 'it can act like a machine or like a language to be shaped and exploited'. Digital media is essentially an abstract medium that can represent any other media, freely make connections and associations, perform a multitude of functions, and can be programmed to behave in many different ways imagined or real. As a metamedium, 'it has degrees of freedom for representation and expression never before encountered and as yet barely investigated' (Kay 1984). This concept of the computer reflects its fundamental nature as system for the manipulation of symbols—it excels at this function, but also depends on it to operate and function.

4.3.2 Languages of abstract and virtual worlds

Holtzman (1994, p. vii) recognises the computer as having a significant impact on creativity, so that 'fundamental changes are occurring in the ways we communicate, create, and express ourselves'. He makes connections between the development of abstract art and music and the language of computers, articulating how important it is 'that we think of communicative and creative processes in terms of abstract structures and the manipulation of such structures'. The nature of the computer as a manipulator of symbols suggests that its creative potential is to create works that are built upon metaphors and the manipulation of formal languages, such as those found in abstract art and music notation. Identifying the native properties and structures of digital media and articulating these as a formal language may then allow creative works to be expressed in terms of this language.

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9 There are levels below this that are only intelligible to the computer itself, but even these are structured as languages, such as the machine language used to address a computer's CPU.

4.3.3 New forms of expression

As each generation develops a greater literacy in the language of digital media, there is an increase in the sophistication of its use in recreation and communication. Digital games are an example of this process in action. Poole (2000, p. 217) demonstrates how they form a significant proportion of cultural product, and makes the case for their evolution into an artform as expressive as cinema. The cultural significance of this change is described in terms of 'the television screen reclaimed for our control' through the huge range of rich experiences that are possible through the game worlds represented on screen. The key opportunity here is the interactive possibilities of these worlds: 'you're not watching, you're *doing*'. Similarly, Manovich (1998a) extends this idea to describe the way that a new generation 'might express themselves through software design the way previous generations expressed themselves through books and movies'.

4.3.4 Signs, symbols and ciphers

Visual languages are an important part of communication and have a rich, diverse history spanning almost every culture and civilisation. Many pre-linguistic civilisations such as those of the pre-Columbian peoples (Nuttall 1975) and ancient Egyptians (McDowell 1996) used visual communication systems for the recording of history, the administration of social systems, and creative expression. Signs are powerful communicators. Unlike words, which require a level of translation and interpretation, signs are able to communicate their meaning more directly. Entire concepts may be represented in a single graphic form or gesture and hybrid meanings quickly established by combining signs. Each sign 'simulates the presence of the object or concept it represents, both communicating the idea of it and giving it form, invested with symbolic charge.' (Jean 1998, pp. 105-6) These signs, or icons, are fundamental to graphic user interface design, whether they are part of the workings of a video game, an icon on a computer desktop, or part of an interface metaphor. They quickly communicate a wide range of information assisting in navigation, labelling, interaction, program status, available functions and so on.

4.3.5 Electronic text

Digital media has radically transformed the way we read and write text. Heim and Gelernter (1999) explore the impact of digital media on the way text is written, read and processed. The act of writing is changed by the word processor, much like the act of reading has been changed by the development of hypertext. Ideas of three-dimensional text spaces and typography have also emerged. These take the idea of hypertext further by setting up structures that allow the reconfiguration of relationships between the hypertextual links. Hayle's (2002) concept of writing machines explores electronic writing further by describing the ways in which it inscribes meaning into texts via its various artefacts and mechanisms.

4.3.6 The command-line interface (CLI)

The proliferation of hypertext and its widespread acceptance in the form of the web page indicate the extent of this transformation. Stephenson (1999) provides a counterpoint to the enthusiasm for GUIs by examining the key differences between interacting with a computer via text or a highly mediated GUI. He compares text-based interfaces to books, looking at how text can be more accurate than visual communication. GUIs are compared to theme parks and other highly mediated experiences, where specific meaning and detail are lost in the abstraction and simplification of the message. Johnson (1997) demonstrates the differences in interaction between text and GUI and the reliance of digital media on text in its form and function; and predicts the revival of text in digital media.

4.3.7 Formal languages

In computer science, mathematics and logic, there are formal languages that describe both the elements of the system expressed by the language and the formulas that process these elements. They describe the symbol manipulation operations at the most abstract and fundamental level. These operations relate to a wide range of computational systems, including the generation of trees, graphs, grids, pictures and computer graphics. Formal languages include systems such as Chomsky's transformational grammars (1957) that demonstrate the generative power of these systems, and Lindenmayer's L-system (1991) that models the growth processes of plant development. Through their expression of theoretical computer science through digital media, formal languages demonstrate the potential of artificial languages that are expressed in terms of the logic and code of the machine.

4.3.8 Programming languages

While formal languages describe abstractions or generalised models, programming languages allow their expression in a working system. The development of digital media uses a wide range of these languages, each specialised to a particular application. Programming languages such as C++ are used to create complex lists of instructions that create operating systems and computer software. Digital media authoring languages such as Macromedia Director's system of drag and drop behaviours are used to create interactive media. Page description languages such as HTML and XML tell web browsers how to display web pages. Languages such as VRML describe 3D space. They often include words and grammatical structures from English to make them more readable by a human operator. However, programming languages are primarily concerned with giving instructions to the computer, and as such are full of jargon and specific terms of reference. Although some expressions, such as the IF … THEN … ELSE statement is understood by many non-programmers as one of the identifying logic structures of computer programming, these languages are largely the domain of specialists, who spend years learning the syntax of each language and its use.

4.3.9 Language and digital media

A definition of digital media poetics acknowledging these existing ideas on language and computers can be articulated within the framework defined earlier. Expressing this particular vision of digital media using the existing models is difficult. Existing terminology, models and paradigms do not accurately describe these particular properties and characteristics of digital media. The focus on language is not just about naming properties of digital media but contributes to a more structural analysis: the poetics of digital media will be explored as cinematic language or the language of painting would be.

As outlined above, language is significant to many different aspects of digital media. It could be argued that all contemporary media engage with language in a similar way, as the world we live in has become so saturated with information and media. However, in the case of digital media, the connection may go deeper than this, as the fundamental structures of language, symbols, grammars and meanings are also the fundamental building blocks of digital media. If this is so, then how does this relationship work? What is its significance, if any?

A digital media poetics needs to be applicable to a wide range of different technologies and applications and able to capture its essential forms and structure. Most of all, it needs to describe the unique properties that differentiate digital media from other types of media such as film, television and print.

4.4 A digital media poetics

A digital media poetics will be applicable to a range of genres, styles, contexts and formats, but will also be able to identify and articulate endemic properties and unique characteristics of digital media—what are these and what form do they take? One form is the virtual world in all its variations, ranging from cyberspace-inspired virtual realities to participatory community networks, from fictional universes to alternate reality games (ARGs). The world as primary construct is a pervasive theme at all levels in digital media and provides a suitable structure to accommodate interaction, representation, structure and algorithm. Likewise, models of language resonate with digital media on many levels. Interface design invents languages for interaction; it draws upon a multitude of media languages via an eclectic collection of different modes of representation. It is reflected in the lingual architecture of structure, and the expression of logic through the language of code in algorithm. Process is central to all of these through the conversation of interaction, the expression of representations, the building of structures, and the systems generated via algorithms. Many of these aspects are mediated by artificial entities—whether personified through the design of a character or given autonomous behaviour and agency within a digital media world.

An alternate model is needed to accurately identify and analyse the forms of expression and modes of communication of this particular vision of digital media. Each of these will now be explored thematically.

4.4.1 New iconography

Icons simultaneously resemble and signify their meaning, which in some cases may consist of complex layers of associations and ideas. They predate modern alphabet-based languages for communication; many early civilisations had sophisticated symbolic language systems. Of particular note are the Egyptian system of hieroglyphs and Mayan glyphs, both of which have a wide range of possible expressions. More recently, the Isotype system (Neurath 1936) and Blissymbolics (Bliss 1985) have introduced constructed iconographic languages to contemporary communication. Modern ideographic language systems such as Chinese are also rich in iconography. On an informal level, there are other new symbolic languages being developed in email and chatrooms, such as emoticons and desktop icons. They are typically used to represent a key concept or idea in a compact form. They may take their form from a stylised drawing of this concept, or they may be more abstract using the graphic language of line, form and scale to create a shape that feels right for the concept. This aspect of their nature—being able to represent a large body of information in a simple form—makes them ideal elements in electronic space or interactive system. Icons may become active agents, represent the mood of an avatar, or act as signs in a virtual world. They may serve to personify a concept, represent a sound, or assist in the construction of an electronic identity for a place or person. Their flexibility and universal nature make them ideal communicators in electronic worlds.

A digital media poetics embeds iconography within digital media and augments its symbolic power through additional aspects such as interaction, dimensionality, code, animation, sound, and mutability.

4.4.2 Language of computers

In considering a unique audio-visual language for digital media, we need to consider the fact that it offers almost any form of possible representation. However, there are basic elements that are endemic to all media from which representations are constructed. These forms of representation are dependent on the technical capabilities of the computer and so are always changing. It is therefore not possible to define an absolute audio-visual language of electronic space. Instead, an evolving library of form consists of vectors and pixels, icons and geometric primitives, codes and glyphs, links and networks, constructs and spaces, topologies of information and autonomous entities. Other elements include iconography, synthetic materials, skins, and emulated media. This 'language of computers' is constructed from the natural data of electronic space itself: the elements, forms, icons and spaces that constitute artificial worlds.

Although changes in digital media technology mean that there is no universal computer language, a digital media poetics can serve to define instances of this language that are related to specific technologies but share a common structure.

4.4.3 Nonverbal language

Nonverbal communication is characterised by immediacy, intimacy, impact, and depth of meaning expressed through action, gesture and symbol. Within digital media this communication occurs via a hybrid language that blends film, graphic design, visual arts, theatre and architecture. Over the previous century visual languages have come to dominate communication; in many ways, digital media draws upon these earlier forms in its sophisticated visual language. By way of example, the ubiquitous computer icon has evolved from the static form typical of the visual communication strategies of graphic design to a dynamic, animated form within digital representation. Virtual worlds may be explored in terms of their use of nonverbal language. It seems natural that the digital representation of these worlds exploits the expressive potential of digital media. One important aspect of this representation is player-to-player communication, which may be seen as equally important as the systems (game mechanics, administrative, technical) used to govern and maintain the persistent world. Four typical levels of nonverbal communication may be identified within these environments: chat using graphic symbols and abbreviations; players' actions and gestures in world; players' creations or modifications in the world; and meaning implied in the players history or past actions.

Through the model we can describe the ways in which nonverbal communication takes place within digital media and the relationships between different levels of this exchange.

4.4.4 Construction of meaning

In the construction of meaning in digital media, both the elements that constitute the representation and the underlying system that connects them are equally important. By way of example, virtual worlds may be built from collections of objects, characters, and icons. The mapping and exploration of these spaces involves a process that identifies, decodes, and transmutes these elements into a system. Subsequently, meaning emerges at the intersection of the language, interface and underlying system of relationships embodied in each world. The player in this environment inhabits a posthuman body of signs (Hayles

1999) and effectively lives a parallel existence or second life in the game world. There is a sense of being somewhere other than an empty simulation of textured light and form. The virtual world is somehow… real. If it is a multiplayer world then many other people are experiencing the simulation online with the player, and this is shaped by the game system—a highly organised set of rules for creating and maintaining an active world. These are likely to include rules for social interaction, progression through the game, an economy, and constraints on navigation through the environment—all of which create meaningful play in different ways.

Using aspects of digital media poetics, the various structures, interactions and mechanisms of meaning construction may be identified and understood—both those constructed deliberately by the designer and those that emerge through play.

4.4.5 Process and play

Interaction that engages the player with a computational simulation can embed them directly within its process. The player is an integral part of this system and is an integral component of the world—not an external entity that is mediated through the one-way interaction common in new media. In a traditional point-and-click interface for example the system does not store any information about the user from one click to the next and interaction is limited to the selection of items in a predetermined, hierarchical structure, through the single action of selection. This system could be an abstract game such as Tetris, engagement with an interactive installation, or free play with an improvisational music system. Furthermore, some game worlds engage the user in an ongoing simulation that typically stores and manipulates data about them. In many games this may be quite basic information such as score, energy, life and player's location in game world, but in MMORPGs an entire player history is both saved with their character and also distributed across the player-to-player interactions that occur in the game world.

Using our model we can identify what is communicated to the player through process and play rather than through the representational content of a game.

4.4.6 World as medium

Building virtual worlds and digital games can be seen as an extension of the practice of 'world-making'. Artists and designers may take on the role of world builder—creating coherent alternative worlds from patterns of information. Holtzman (1994) describes the way in which an artist develops 'a system of symbols to represent a view of reality' and through this system 'shares his consciousness of aspects of that reality.' The representations of these worlds are made of meshes, geometric primitives, textures, materials, sound, music, text, graphics, animation and other media elements. However, they are also defined in terms of the relationships between these elements—their behaviour, spatial location, connection to parameters in the world, the meaning each representation is intended to signify, and so on. A virtual world may be far more than simply a space. It may have its own physics, indigenous life and ways of being, as well as history, society, and politics. The player is factored into this system through their agency and effect on the virtual world.

Through a digital media poetics, we can explore the complex multi-level relationships and structures that emerge in these worlds.

4.4.7 New media ecologies

In the field of alife, real world structures such as ecologies, economies and other complex systems can be represented as a set of rules. Given time and a space in which to evolve, these rules can be expressed via an adaptive, dynamic simulation that plays host to a population of artificial lifeforms. The outcome of this system is unpredictable and not entirely under the control of its creator – it has a life of its own. This leads us to question of where life and intelligence reside, and what role they may play in electronic space. These rules and systems can represent a denatured logic expressive of a machine-driven AI or they may capture familiar, everyday forms of life and place them into a new context. If life can be abstracted to a process expressed via digital media then it is likely it will evolve lifeforms that are particular to that space. A new media ecology may be quite different than the form we are used to. This offers the opportunity to explore alife as a kind of alien intelligence, whose difference is reflective of the nature of the digital medium.

The model may be used to decode and translate communication between the alien intelligence of artificial worlds and our own embodied human experience.

4.4.8 Generative meaning systems

New processes for the generation of meaning can be seen at the point of intersection between alife and generative systems, computational semiotics, and digital games. The life processes encoded into alife software are connected to systems and codes of signification in digital media to develop models for the evolution of digital media languages. The forms evolved by the system are represented in realtime 3D simulation—through form, structure, colour, sound, motion, surface and behaviour. The game environment makes the system tangible and provides a medium for feedback. This model may be described as a 'generative meaning system'. It suggests that meaning may emerge via interaction between life processes and mutable forms of communication, rather than being intentionally constructed or designed. This intersection allows digital media languages to be bred as living systems that may adapt to different semiotic landscapes or evolve through their interpretation and usage.

Articulation of generative meaning systems is grounded in the framework established for a poetics of digital media and can be further defined by expanding and exploring this model.

4.4.9 Identity and perception

Via digital media we can explore the dynamic between the iconic ideal and the personal specific, the real and the simulated, and the way in which our identity is shaped by our language and communication. By way of example, it is typical for people to construct an online identity (or identities) to access a MMOG in which thousands of players share a 'consensual hallucination' much like Gibson's cyberspace or Stephenson's 'metaverse' (Stephenson 2000). Somewhat like the concept of the 'third place' (Steinkuehler & Williams 2006) these alternate social spaces provide a hybrid mode of being for many players – in between reality and fiction, the virtual and the real. In terms of perception, digital game experiences such as this can be seen as being real, symbolic or in between. They may be seen as real, in that they are represented using all perceptual cues of real experience such as perspectival viewpoint, spatialised sound, immediate feedback, light and other phenomena. However, they are constructed from code—symbols and relationships between symbols—that is represented by this realistic simulation. In this way, they could be described as the symbolic made real: the world model/abstraction that forms the underlying system is experienced in a mode of perception usually activated by the real world. In this way, the idea of experiences and worlds that were only possible in theory, dreams, and the human imagination (and that of AIs) are actualised in the abstract space of the computer.

This combination of elements results in a kind of hybrid way of being that can be expressed in terms of digital media poetics – in the game space, aware that is a simulation, but at the same time immersed and engaged as if it is a real experience.

4.4.10 Crossmedia and the post-digital

One of the most significant aspects of digital media over the past decade has in fact been its apparent disappearance. This has occurred as it has become naturalised, more familiar, widely adopted and accepted. As a result, we may say that there has been a shift to a post-digital era characterised by ubiquitous media that embed the digital in anything and everything. Digital media is no longer primarily a single-user, single-screen experience. Wireless networking, GPS[10], RFID[11] and related technologies enable the integration of media into the everyday environment, effectively blending the virtual into the real. There is no longer the need to access virtual worlds through the window of the screen, as digital

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10 GPS: Global Positioning System

11 RFID: Radio-Frequency IDentification

media and coded entities are located within the space of actual, lived experience. The language of interactivity is extended to include the actions of the player's body in the real world as well as the virtual. This can be seen in the emergence of pervasive gaming in which games are played across networks of media (mostly digital, but not all) embedded into any number of different spaces—so much so that they can be difficult to discern from reality.

Via a model for digital media poetics we can understand these emerging post-digital forms as an evolution of the electronic spaces of virtual worlds and digital games.

4.5 A model for a digital media poetics

So, within the framework established in section 4.2 we can articulate a model for a digital media poetics to explore and articulate these themes. *Interaction* emerges as a common element across almost all themes—whether it is player input or the internal operation of a complex system. New forms of *representation* that capture the unique expressive potential of digital media also feature heavily. As noted earlier, while the model is not purely structural there is the need to articulate and describe *structure* in order to understand communication between worlds. Many of the languages and thematic concerns address the computational nature of digital media directly, and so the study of *algorithm* becomes an important component. Therefore, four major elements will be explored: interaction, representation, structure, and algorithm.

As each element and theme is explored, existing definitions in the language of digital media will be discussed. Each language device will be described in terms of its place in the overall model established. This model argues that these four elements are the key areas for a digital media poetics.

Following the elements, four common aspects of digital media will be introduced and used to examine the elements. Each of the four elements will be explored in terms of these four aspects. This approach provides a structured way to examine a wide range of different manifestations of digital media language. This structure is developed further via definition of relationships, such as those between player and entity that occur in digital media. A list of sixteen properties and characteristics for a poetics of digital media will be generated from this investigation.

4.5.1 Model: elements

Each of the four elements (Fig. 1) is summarised in this introduction to the model. A chapter on each of the four elements will explore each of them in detail. These elements can be seen as the building blocks of digital media language—common to all of its manifestations.

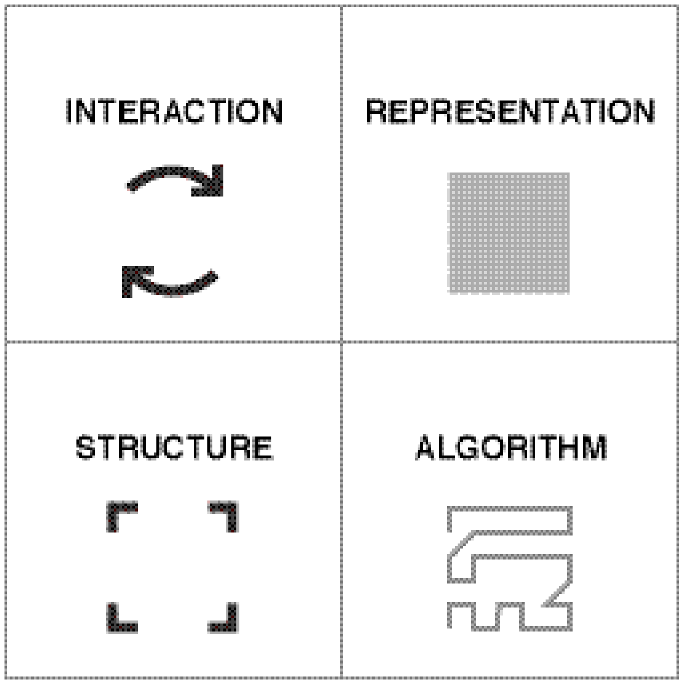


Figure 1. Primary elements of digital media

4.5.1.1 Element 1: Interaction

Interaction could be described as the events that take place in an exchange between a user and a particular piece of digital media. This description can be extended to include information about the nature of those events, measuring things such the intensity of engagement, frequency of interaction, degree to which interaction affects the work, and how that interaction is translated. Interaction describes the events or 'actions' of the language, and recognises that these actions occur between multiple entities in digital media: users, agents, representations, data, spaces, and so on.

At the most basic level, digital media involves a body of information, a user, and an interface that mediates between the information and the user. Interaction will be examined as a communicative medium in itself, independent of its digital media representation.

Examining interaction in itself allows the analysis of interactivity as communication. Many different modes of interaction may be identified, each communicating in a different way. Properties of these modes will identify aspects of interactivity as communication outlined above, and offer methods for analysing and understanding its use and effect.

4.5.1.2 Element 2: Representation

Representation of digital media is closely linked to how it is perceived by the user. Different combinations of media and types of representation result in a wide range of modes of perception in the user. Representation may be mapped over other dimensions (such as time and space); be composed of many different media (resulting in a hybrid); be synthesised or generated from data; or different modes of representation may be translated or morphed from one form to another. Representations are the forms or 'alphabet' of the language, recognising that, of course, each type of representation also has its own language or set of conventions and norms.

Each event and interaction in a digital media system needs to be made perceptible to the audience. Many different types of media can be used to represent the same digital media event, although the meaning of the event is changed through its mediation.

Objects, streams, and collections of media will be analysed separately in order to identify their relationship to the possibilities of representation outlined above, and this will enable analysis of their role in digital media.

4.5.1.3 Element 3: Structure

Structure is derived from the relationships between different parts of information in a given system. Which bits of information are linked, and the way in which they are linked, has a significant effect on the understanding of that information. Although context affects meaning in all media, in digital media that context can shift and be changed by a number of different factors. These include how digital media structures are navigated; nonlinear structures, such as a database; the user's agency within a structure; and multidimensional or layered structures. The structure or 'digital media relations' could be described as the grammar of the language.

Possibilities of linkages with interaction and representation will be examined, including the accommodation of the metaphor concept in interface design. The importance of structure, links and context in creating meaning will be explored, demonstrating that they are equally important as the meanings embodied within the representational forms of digital media.

Electronic space and databases are explored from this particular viewpoint on structures, and analysed in terms of they way they enable connections, relationships and context to form in digital media.

4.5.1.4 Element 4: Algorithm

The underlying computer program in digital media determines the logic of connections between interaction and representation. It defines the rules of operation and controls flow through its structure. This operation is cyclic in nature, may evolve and adapt to new circumstances such as changes in user behaviour, explains ideas such as ‘gameplay’, and enables data to shift and transform. Algorithm or ‘digital media code’ plays the role of logic in the language, determining which actions and connections make sense and therefore what meanings are associated with them.

While the algorithm is a fixed structure, it may change its parameters in reaction to interaction, map its output to various forms of representation, or be directly linked to the structure. Opportunities within simulation, generative systems, alife and databases will be explored. These will be analysed in terms of how the underlying logic of digital media generates different experiences for the end user.

Algorithm is directly linked to the computational nature of digital media, and its capacity to generate and manipulate abstract systems of logic. The significance of this element of the nature of digital media will be explored through these themes.

4.5.2 Model: aspects

In order to open up exploration the use of these elements in digital media, four common aspects (Fig. 2) will be used to expand the definition of digital media poetics. Based on the observation of a wide range of applications and works, these four aspects show potential as important characteristics of the medium. These aspects are related to the characteristics and behaviours of the four major structural elements. Each will be analysed within the context of each element. The intersection of the four elements and the four aspects will provide the model for a digital media language. These aspects are time, multiplicity, adaptation and transmutation.

Figure 2. Symbols for digital media aspects

4.5.2.1 Aspect 1: Time

Primarily, digital media are time-based media: the experience of each work occurs over time. In order for an interface to function, interactivity needs to be tracked over time. An understanding of how time works in digital media will be explored. Different states of perception result in different kinds of temporal experience. Time can be non-linear, move forward or backward, slow or fast, or could be a parameter in a generative process. Multiple time frames may coexist in a single digital media experience.

Forms of representation such as sound, video and animation may function within their own timeframes simultaneously alongside one another. The perception of time is linked to the flow of digital media, a narrative unfolds over time, and the timing of interaction may change its meaning.

Iterative processes occur over time, data is tracked over time, and time limits are placed on electronic games. A website may be born, change and grow, and die. Digital media may be archived or published in fixed forms such as CD-ROM or DVD, but they may then be adapted or changed and reformed at a later date.

The temporal nature of digital media is therefore complex and multifaceted. The intersection of interaction, representation, structure and algorithm will with time each demonstrate a different part of this complexity. Time is linked to the pacing and flow of digital media.

4.5.2.2 Aspect 2: Multiplicity

In digital media, the concept of the source or original copy is something that is created artificially. Once something becomes data it has the potential to be copied, sampled, manipulated, transformed, cloned, mutated and reconfigured in any number of ways.

The same data or concept may be viewed from a number of perspectives. Information may be filtered in various ways, a different path may be taken through a 3D space, or a different algorithm used to generate a digital media element. A generative system may be able to create an infinite number of possible configurations of a single system—each belonging to the same family, but different.

Multiple readings or pathways may exist through a single digital media structure; or the relationships embodied within that structure may be flexible and adaptive, perhaps linked to cumulative patterns in user input that create meaning through their use.

This flexibility of digital media is an opportunity to create active, live bodies of information. These opportunities will be explored within multiplicity as it applies to interaction, representation, structure, and algorithm. This multiplicity relates to the range of expressions within a digital media language.

4.5.2.3 Aspect 3: Adaptation

Digital media respond with a multitude of different forms of feedback: changes to data, direct manipulation, changes in the behaviour of agents or of the environment, loading new media, and so on. It is a reactive medium. The frequency and type of these reactions change the player experience. This is typically a feedback loop in which the action of each party constantly affects the other, something like a conversation.

Digital media has the capacity to become personalised or adapt to a particular user's needs and behaviour. In this instance, the feedback is not immediate, but more like a cumulative effect which could be described as a kind of 'machine learning'. Alife also functions in this way, where typically multiple generations of lifeforms evolve and adapt to meet a particular set of performance criteria.

Adaptation is the result of interface. A particular interface to digital media can be seen as a structure navigated through interaction, with the reactions of the interface occurring on a number of different levels. These manifest in terms of changes to the representational forms embodying the interface, the user's location within its structure, the responses to their interaction, and the logic that determines these responses.

Although the implications of adaptation are most obvious through interaction, interesting possibilities also emerge from its application to representation, structure, and algorithm. Adaptation can be described in terms of the capacity and flexibility of digital media to change in response to feedback.

4.5.2.4 Aspect 4: Transmutation

Given the fluid nature of digital media, it is natural for transmutation to figure as an important aspect. Although mutation and change can occur metaphorically in other media, when the media is digital this transmutation is literal. One body of data can literally be reconfigured as another.

Neurological synaesthesia is described as 'an involuntary joining in which real information [received by] one sense is accompanied by a perception in another sense' (Cytowic 2002). This phenomenon has inspired the concept of digital synaesthesia, where one form of representation is translated into another via a computational process. This type of digital cross-modal transfer, in which sound becomes image or vice versa, is central to the idea of transmutation.

Transmutation can take a number of forms: media shifting from one media type to another, one form of representation to another, or perhaps one element to another. The shifting of elements could involve a shift from interaction to representation, for example. Many possibilities exist in the shifts between different types of media for, example, the representation of sound as image, or vice versa.

These shifts may be instantaneous, or there may be a fluid transition from one state to the next resulting in a kind of media morphing. Capturing a morph midway can result in new configurations of meaning in between one state and another, a hybrid that could not be created by design.

There are multiple levels to transmutation within digital media. It will be examined in terms of its manifestation in interaction, representation, structure and algorithm. Transmutation can be seen as the shifts and translations of meaning in a digital media language.

4.5.3 Model: relations

It is not only important to identify and articulate the elements and themes that constitute a digital media poetics, but who or what is the subject of interaction, representation and so on. This may be explored at both the macro and micro levels in terms of worlds and the individuals that populate those worlds. It is within this framework that the study is situated: the 'language' describes the ways in which communication occurs at these various levels. Each will be defined in turn.

	player	entity	virtual world	actual world
player	X	X	X	X
entity		X	X	X
virtual world			X	X
actual world				X

Figure 3. Levels of communication in digital media

Relationships occur across any part of a matrix (Fig. 3). Common examples include the interaction between player and virtual world, the internal system of events between the virtual world and itself, the crossmedia interaction of real and virtual worlds, local connections between players and entities, and the mediated experience of player-to-player communication.

4.5.3.1 The player

A player engages with the system. They communicate with other players and entities in the system via various levels of interface that define the ways in which they may act and interact. The player experience changes significantly depending on who or what they are engaging with—another player, an artificial entity, the real world (mediated via digital media) or directly with a virtual world. While player relationships exist at all levels in the system, the element of interaction is largely concerned with the player experience.

4.5.3.2 The entity

Although an entity can in some contexts refer to many classes of object in a virtual world, in this case it is defined as an agent or other discrete representation with its own internal structure and autonomous system of interaction. Most typically, this would be a bot or Non-player character (NPC) but this may include simple, dynamic objects with limited functionality. Again, entity relationships exist at all levels of the system; however, the element of algorithm is strongly connected to entities as it drives their behaviour.

4.5.3.3 The actual world

The actual world includes other types of media that may be related or connected in various ways. It is there by default as even the most minimal virtual world needs a physical medium in which to exist (a computer), but may take on a larger role—particularly in crossmedia and pervasive gaming projects. In this context it is used as a general way to refer to media or events that exist outside a simulated or virtual world. The element of representation is strongly related to this concept of the actual world; it determines how media is presented concretely as installation, animation or audio-visual form to the player. However, these relationships also exist at other levels of the system.

4.5.3.4 The virtual world

The artificial or virtual world is the place in which a simulation may be situated. In some cases it may run autonomously without player interaction, but typically it involves at least one player and in most cases multiple players simultaneously or asynchronously. Although relationships connected to the virtual world exist at all levels in the system, the element of structure largely governs the nature of these worlds.

4.6 Methodology: exploring the language

Four themes for the investigation of the elements of digital media language have been identified: time, multiplicity, reactivity, and transmutation. The symbols used in the figure below are introduced here, but used more extensively later in diagrammatic representations of relationships in digital media.

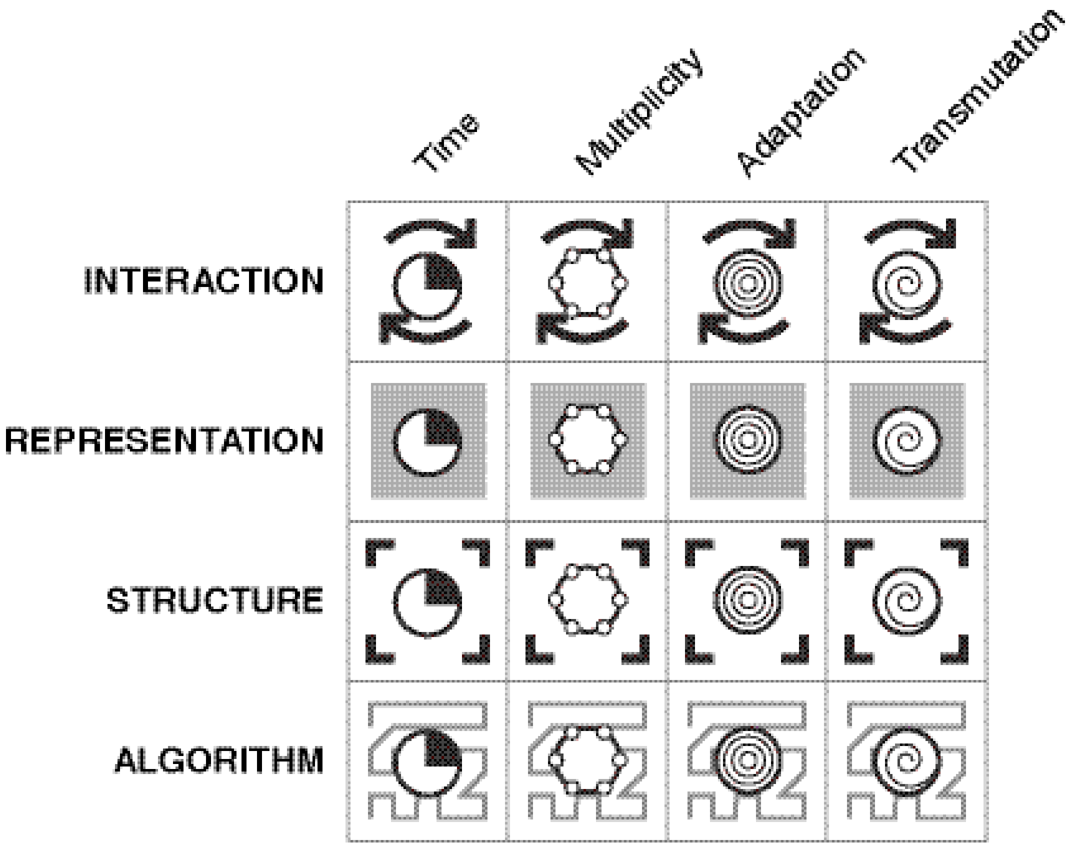


Figure 4. Properties and characteristics of digital media

The elements and themes identified provide the basis of a methodology for exploring the potential forms of digital media language. This model of four elements, each explored in terms of the four themes, gives us sixteen areas of investigation (Fig. 4). Representation can be investigated in terms of time, multiplicity, adaptation and transmutation. Alternately, transmutation can be examined from the point of view of its manifestation in interaction, representation, structure and algorithm. This investigation will use this system as an index or map to navigate the properties and characteristics of digital media.

Using this system, each node on the map will be explored in turn in order to identify and articulate the nature of these properties. Taking this approach enables this digital media language to be searched systematically and for its possibilities to emerge from the results of this search. Although it is limited by the parameters set by this model (the four elements and themes) no other constraints are placed on the exploration of the language. That is, each node on the map is given the same emphasis and approached from the same point of view. In later analysis, it is likely that some areas will appear to be more important than others, but initially no assumptions will be made and each will be given equal consideration.

Navigating this map of digital media language will be achieved through a process of identification, articulation, demonstration, and expression of the properties and characteristics. Using this four-stage process on each node on the map enables the systematic approach to be applied at this next level in the investigation. Again, the intention is to allow as much as possible for the exploration of new potential and to limit assumptions or preconceptions.

Identification of each property begins by simply locating the place it occupies on the map. Time and interaction, transmutation and algorithm, reactivity and structure are all nodes on this map, and are starting points for identifying properties of digital media. Once located, the intersection between the element and the theme can be described using more specific terminology. This terminology serves to give the property an identity, a ‘name’, which reflects its nature.

The articulation of the property presents a concept describing its nature in more detail. Particular types of interaction, for example, may lead to multiplicity; while others relate more to transmutation. Articulating these differences and how they work will lead to an understanding of their nature and how they capture the new potential of digital media. This stage of the process asks the questions: what is each property made of and how does it communicate?

While for practical reasons each element and its various aspects are explored in isolation, in some cases they are highly interlinked and difficult to differentiate. The close relationships between interaction and player, expression and actual world, structure and virtual world, and algorithm and entity indicate the emphasis of study in each of the elements. When dealing with the investigation of individual properties generated by the system, areas of overlap and crossover may be identified. Key points of crossover will be explored in the concluding notes on each of the four main elements.

Examples from a wide range of sources are introduced to demonstrate the concepts introduced in the stages of identification and articulation. These include recent and older works, experimental and more mainstream examples, and a number of different genres and applications. In most cases a common thread demonstrating the given property across examples that are different to one another is explored, to test its validity. These works also serve to demonstrate each property in action.

Finally, each property is explored as a form of expression within the digital media language. Building on the analysis of its individual capacity to communicate in isolation, the properties are examined in relation to a number of works, in case studies that define the role of each property in the wider context of the entire model. This exploration is framed within a model that articulates the potential of interaction as 'the actions'; representation as 'the forms'; structure as 'the grammar'; and algorithm as 'the logic', concepts introduced earlier in this chapter. This model will be systematically explored in the following chapters on each element.

4.7 Scope of study

This digital media poetics is intended as a general tool that may be applied to a range of applications and genres within the broad definition of the area outlined earlier. However, it has a dual purpose – like all models it has a particular bias or focus that it seeks to make clear to the reader. In this case this is the modes of communication and expression that emerge from the play and experience of virtual worlds and digital games. However, it has a dual purpose – while it seeks to demonstrate what is novel and exciting about these experiences, it may also be used to provide a fresh perspective on other forms of digital media, by applying the world metaphor to a word processor, web page or interactive television, for example. It may assist in the identification and understanding of as yet unknown, emerging forms of digital media. The scope of this study will focus mainly on digital games and electronic media art, as these areas have provided the most telling examples during the period of research and has included development of digital media art; bibliographic research; conversations and discussion groups; several conferences; playing of many games; being in virtual worlds; experiencing digital art and design exhibitions; teaching a multimedia and digital arts studio; and immersion in a wide range of digital media experiences.

4.8 Summary

This thesis explores digital media as a new form of expression, consisting largely of nonverbal language and communication through process and play situated across the virtual and real worlds. Existing models for understanding digital media were analysed in the previous chapter and an opportunity for another model—inspired by a digital media poetics—was identified. To provide a starting point for a new model, a framework was established combining aspects of game studies, semiotics, ontology and alife. Major themes such as new iconography, a language of computers, nonverbal language, construction of meaning, process and play, world as medium, new media ecologies, generative meaning systems, and identity and perception serve to expand the initial statement of my vision of digital media. A model for a digital media poetics is proposed consisting of interaction, representation, structure, and algorithm across time, multiplicity, adaptation and transmutation. A methodology for exploring this model, largely through examples from the domains of digital games and electronic media art, is articulated for expansion in the chapters that follow.

5 Interaction.

I can recall when I first observed a TV game system as a child. Upon visiting a family friend who had older children, they turned their television on and started playing with it. Not simply switching channels or tuning into patterns of 'snow', but moving a block of pixels up and down the screen with a small handheld controller. I cannot recollect the precise date, although the television was an old black and white model and the resolution of the graphics was very coarse, so it may have been the late 70s. This moment stands out in my mind. I remember feeling an odd excitement, but unsure as to the reason. I had been used to television as something that played a cycle of predetermined programs over four different channels through the course of each day. In reflection, I had seen three new things that day: one, that you could play, control and interact with the television screen; two, that you could reprogram that screen (the TV game had a couple of different games and difficulty settings); and three, that the functionality of technology could be modified (the TV game system changed the possibilities of the television screen). That is to say: TV game + television = interaction.

5.1 Introduction

Interaction is a defining characteristic of digital media. Almost all of the works in this investigation include some form of interaction. It can be argued that all media are interactive in some way. Books and films can be interpreted in different ways and an audience may influence the development of a medium such as television. However, digital media involve more literal and direct forms of interaction that have a direct impact and provide immediate feedback. In our model, interaction relates to the *actions* possible within a digital media poetics.

Interaction is usually centred in the interface, which facilitates the relationship between audience and content. Interface design is central to the study of Human-Computer Interaction or HCI. A key problem addressed by HCI is the different nature of computers and humans. People think, behave and communicate differently from the ways that these processes are represented in the logic and memory of the computer. Something is needed to bridge the gap and act as translator – the interface. In HCI, the interface is typically described in terms of the GUI (Graphical User Interface) that introduces the idea of 'the user' – the individual using the system. These systems are often formalised in design documents, for example, Apple Computer have published the 'Apple Human Interface Guidelines' to assist developers in designing applications for their operating system Mac OS X. The interface designer uses the principles of HCI to construct a space where the user can engage with information through interaction.

However, it is important that the interface does not distract the user from their sense of engagement. Laurel (1993, p. 116) recognises the importance of the interface as an experiential activity so that 'a person can experience a mimetic world directly, without mediation or distraction'. In order to achieve this, the focus of the interface should be 'what the *person* is doing with the computer – the action' (ibid.). So, the nature of this interaction has a significant effect on both the experience of digital media and how effectively it communicates.

Both the human mind and the computer have vast potential in terms of analysis, modelling, communication and storage of information, albeit in vastly different ways. Finding the ideal way to interface the two is not an easy task. As a result, many different types of interaction have evolved. The user may be allowed to browse and search with non-linear access to information through the selection of different paths in an interface, or use search engines to find data about key words or concepts. Interaction may be centred upon the navigation of a fixed or changing structure, often using a spatial metaphor. Electronic games, VR, and other forms of simulation introduce further dimensions to interaction, such as gameplay and immersion. Multimodal interaction is typical of a computer user as they shift between applications for word processing, 3D modelling, web browsing, and so on. In each case, the user's experience is shaped by the nature of the interface.

Interaction describes the actions of the digital media language. This includes everything that the user or player may do and how the system may respond. It may also include interaction that takes place within the system itself to generate further actions. Digital media can invite a high degree of participation or display a high degree of autonomous agency. In some cases, it may do both. Interaction may occur via several different channels such as a point-and-click user interface, a specialised peripheral, interactive environment or animated characters. Our model needs to address the particular nature of actions within digital media and be able to articulate this wide range of possible activities.

The interface is the conduit through which the information inside the computer (by its nature, highly abstract) is made perceptible to the end user, and through which interaction is facilitated. In the way that it makes information perceptible, it may be seen as *a form of representation*. Manovich describes this process in relation to the filtering of culture through interface, and how 'the computer interface acts as a code that carries out cultural messages in a variety of media'. This is related to the experience of browsing the web and the mediation that occurs through both the web browser and the OS. This process itself has an effect in that 'a code is rarely simply a neutral transport mechanism; usually it affects the messages transmitted with its help' (Manovich 2001, p. 64).

In the way that the interface allows interaction with information, it is *a feedback system*. It may be viewed in terms of the underlying feedback loops that generate the human-computer interaction. Viewing interactivity as a feedback system introduces a set of broad principles on the nature of interactivity, and its effects on the perception of the user. The importance of the control system and how different systems generate different types of interactivity becomes apparent. Originally, the idea of interface was defined in more technical terms to describe the hardware and software of a given system. This idea developed to 'include the cognitive and emotional aspects of the user's experience as well' (Laurel 1990, p. xi).

The elements of an interface work together to create *an experience* for the user. An interface typically involves a number of different media and modes of perception, generates realtime feedback, and allows direct manipulation. This results in a highly experiential activity. Analysing interactivity from this point of view highlights the emotive and intuitive aspects of the interface.

Different types of human-computer interaction introduce a wide range of issues and opportunities. Current thinking includes a diverse range of concepts such as narrative, cultural theory, and gameplay.

The notion of agency and narrative can be seen in the application of concepts of theatrical performance and narrative by Laurel (1993) in *Computers as Theatre*. In her model, interactivity is viewed in terms of an ongoing narrative in which both the computer and the user play a part. Rather than separate the computer and the user by placing the interface between them, she places both within the interface. Models used for analysing narrative in a theatrical context are applied to the interface to demonstrate the role that both the computer and the user play a part in the ongoing performance and exchange that generates interactivity.

We may also look at the idea of interface as cultural artefact. In *Interface Culture* (1997), Johnson outlines the idea of interface design as a medium. He argues that the interface itself is a form of communication and expression. In fact, even the most transparent interface adds a layer of mediation to the content. He argues that interfaces have a cultural dimension and that the kinds of interface we use reflect the preferences and ideas of the culture from which they are created. So it is not only the types of images and sounds used in an interface that are culturally influenced, but also the selection of different types of media and modes of interaction. This suggests that particular types of interactivity will become popular and others disappear as the culture in which they are situated changes.

A different way of looking at interface may be found in the idea of *gameplay*, a term from the world of digital games. Salen and Zimmerman provide an analysis of electronic games and articulate the nature of gameplay and other concepts that are identified with games in *Rules of Play* (Salen & Zimmerman 2003). They describe the ways in which people interact with electronic games from cultural, psychological, and functional points of view. The way that electronic games offer models of reality that involve stylisation and compromise, and the nature of the relationship between the user and the game are analysed. In this view of interactivity, the notion of gameplay is articulated in terms of more general concepts of play and the nature of simulation.

5.2 Interaction in practice

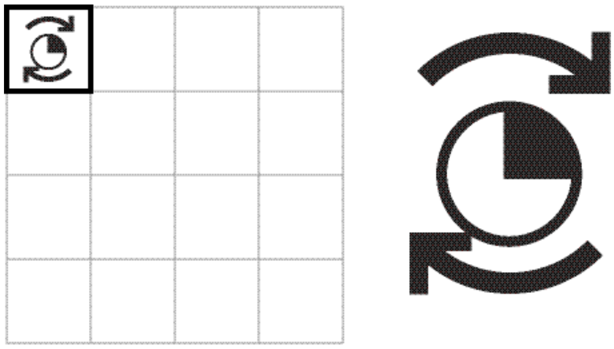
In my own practice, interaction—the possibility to give players agency within the digital space in order to facilitate a direct experience of computational process—is essential. I aim to create experiences where meaning embodied in the logic and structure of the world emerges through play and interaction.

In the development of my interactive sound design works the process of interaction design is somewhat like creating an instrument. Often these works begin with an idea about sound design such as the sequencing of samples or the movement of sound sources through space. How the player interacts with the system defines their role and what they expect to be able to do. Often they will learn or test the possibilities through play, and so how they are integrated within the interface is important. For example they may be embedded within the world, or may exist outside of it, using a set of controls to manipulate it externally.

The player often has a central role in an artificial world and this must be considered early in its design. Although the world does not need the player in order to exist and function, it typically requires (and is constructed for) their input. In *lifeSigns*, the players are able to interact on a number of levels: navigating the space, triggering image and sound, providing energy for entities in the world, and assigning labels to them. While the simulation continues to run without player input, the player has an important role in changing the balance of energy in the world, by favouring some entities over others. Through this action they take on the role of feeding and nurturing entities that are interesting to them, leaving others to fend for themselves.

Important aspects to consider in interaction design for artificial worlds have emerged through this practice. Firstly, it needs to be explored in terms of an exchange between player and system. For example, is the player embedded in a flow of events that they must respond to or is the system passive awaiting their input? Secondly, we need to consider the range of actions made possible and how these define the role of the player. How does the player learn these actions? How does their role relate to the overall world design? Thirdly, every action may require a reaction, or in many cases multiple possible reactions, dependent on a range of parameters. Are these predetermined, generated or selected from a range of possibilities? Do they change over time? Finally, actions may be interpreted in different ways by the system or may change meaning in different contexts. How will different players interpret their role in the world? What if the player's actions shift across media – do they have the same meaning?

5.3 Time and interaction



Interaction can be viewed as an exchange, or perhaps conversation, between player and world. This exchange shapes the player's experience of the world. The flow of this conversation may be slow or fast, or may vary dependent on the activity. *Experience flow* relates to how actions are performed within the interface.

A player's engagement with digital media is heavily influenced by their mode of interaction. Different types of digital media use varying modes of interaction. A video game may use a highly reactive immersive experience whereas an on-line database may use a combination of modes of engagement, such as searching, reading, and querying. An exchange with a point-and-click interface may be different again, working much like a formal conversation between player and media. Thinking in terms of HCI, these varying forms of exchange could be called a human-computer conversation.

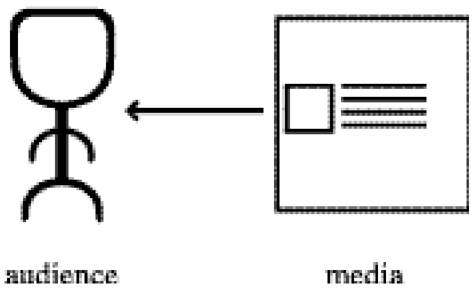


Figure 5. Traditional relationship to media

Consider the flow of this exchange or conversation. In a traditional media relationship, such as that experienced in television, this flow moves in one direction. Fig. 5 shows this movement from media to the audience, whose role is to receive and process information. Of course, television is somewhat interactive. Its form and content may be shaped by the viewing habits and tastes of the audience for example. Viewing a television program may be an interactive process in that it can trigger a range of different responses in the viewer.

However, typical broadcast television (digital television is another matter) is not directly interactive in that the program does not change immediately in response to the choices of the viewer.

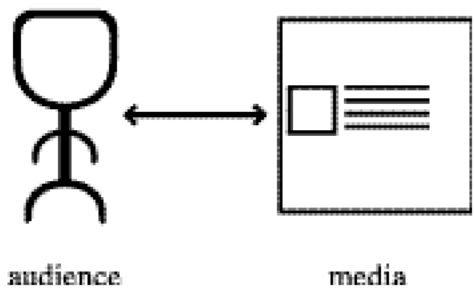


Figure 6. Traditional human-computer interface

Fig. 6 shows a typical interface in which this relationship is expanded to a two-way engagement between media and audience. The audience is no longer passive, but able to respond to the information presented to them by making choices, manipulating elements of the interface, and so on. The information is flowing in two directions.

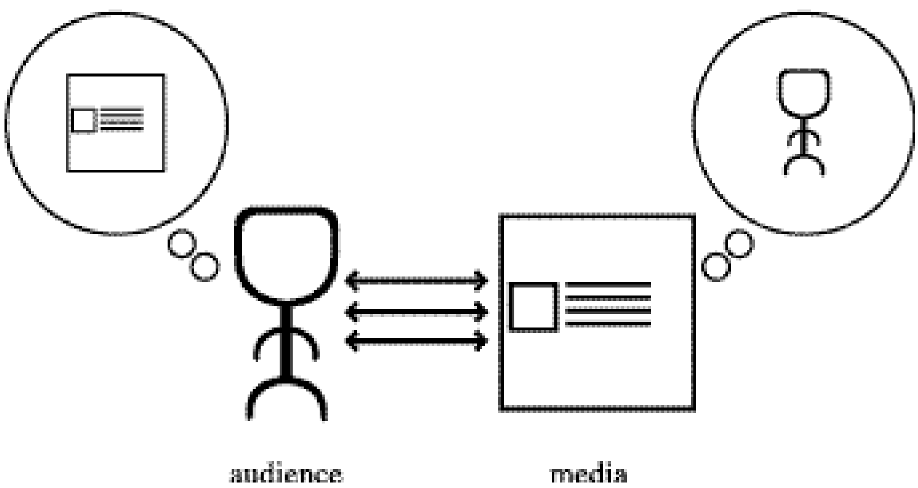


Figure 7. Expanded human-computer interface

However, digital media can function on another level altogether. The relationship illustrated in Fig. 7 involves multiple levels of engagement. Both media and audience develop 'understandings' of each other through the engagement. That is, the audience change their behaviour according to what they learn from the interface, and the interface adapts its form and content in response to the cumulative data collected from the interaction of the audience with the computer. This is more like a conversation where the context changes the flow of information exchange (Pask 1975).

Various modes of interaction result in different kinds of flow that reflect the player's experience and perception of time. The way the user interacts with the media relates to how the message is perceived. Poole discusses the sense of being immersed in the process of playing a video game, via the work of Csikszentmihalyi on flow. He found that 'people engaged in very complex tasks reported an experience of ecstasy or bliss, losing track of time and losing the sense of self' (Poole 2000, p. 180).

Applying this idea to all digital media is to establish one method for measuring and analysing interaction. Various types of *experience flow* may be identified, ranging from the intense engagement of digital games through to more subtle, but equally absorbing, activities such as web browsing. This concept of can be used to describe how the human-computer conversation defined earlier unfolds. If we revisit the diagram introduced earlier then we can identify variables in a formula for analysing *experience flow.*

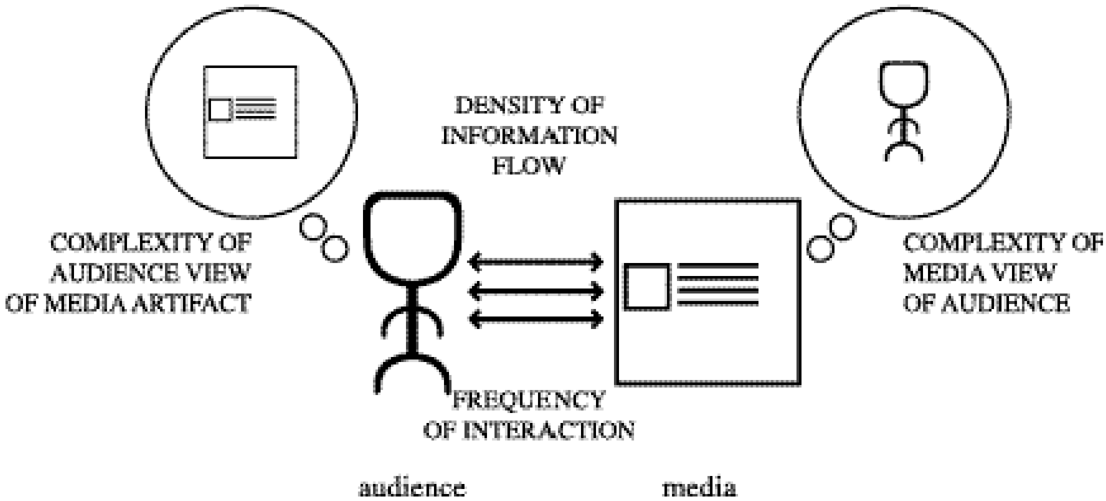


Figure 8. *Experience flow* diagram, with variable factors labelled

The pace of the *experience flow* can be considered when analysing an interactive experience. Another key factor is the frequency of interaction: how often the player may act upon or influence the world. This may range from the realtime, immediate interaction in an electronic game to the slower pace of searching the Internet. The density or amount of information in the flow also has an effect on the user experience—too much may result in an overload of information or overflow. All of these factors together contribute to the view that each party has of the other: frequent and meaningful interaction received from the player will assist in the computer providing appropriate actions and responses in return. Likewise, having the opportunity to interact and respond to the computer assists the player in forming an understanding of the computer.

If we apply this concept to interactive cinema, we can see that the *experience flow* is problematic in this situation because of the clash between the passive experience of video and the active experience of making choices. When a sequence of video finishes, the pace of the experience changes abruptly and if not handled delicately can be disruptive to the flow of the experience. In contrast, a good video game exploits changes in the pace of interaction to create *experience flow* that could be compared to a good drama. Video games are typically broken up into levels and stages, with difficulty and interactivity varying from fast action levels to playful bonus stages.

When compared with the typical ‘point-and-click’ interface, the importance of a continuous flow of interaction becomes clear. Here the computer only has the chance to respond to the user at discrete moments, usually with no knowledge of the time elapsed between each moment. This model has been adopted from the world of hypertext that is dependent on discrete links between bodies of text. The pace is defined by the speed at which the player clicks a button and moves from one section to the other. Pointing and clicking can be disruptive and distracting, as the player is alternating between watching linear sequences of media, and interacting with static menu screens. In contrast, in a digital game, time is part of the interface. This results in a continuous, uninterrupted experience in the game world, leading to a more immediate connection for the player.

Figure 9. ***Sonic the Hedgehog*** **(Sonic Team 1991)**

Sonic the Hedgehog (Yasuhara & Naka 1991)—the original version developed and published by Sega for the Megadrive—introduced a different kind of video game experience in 1991. In contrast to many other platform games with complex moves and rules, it has very simple gameplay that rewards skilful play with bonus points, but getting from one level to the next is relatively easy. The games designers create a sensation of speed and free exploration via open level design and a fast-moving scrolling display. During play, Sonic accelerates to speeds where the player loses direct control and lands in an entirely different place than anticipated. The player becomes highly engaged with the game and involved in the immediacy of its *experience flow.* Although Sonic may die, this does not happen that often (especially on the lower levels of the game) and so the player is free to explore the game environment and play with its physics. By way of comparison, another platform game *Super Mario World* (Miyamoto 1990) involves the need for accurate timing on jumps and defeating enemies, and as a result does not have this free play aspect. It involves the player in a different kind of *experience flow* via its expansive interconnected game world; this invites exploration and experimentation with its various entities, who respond to various types of interaction such as being jumped on, hit, fed, and so on.

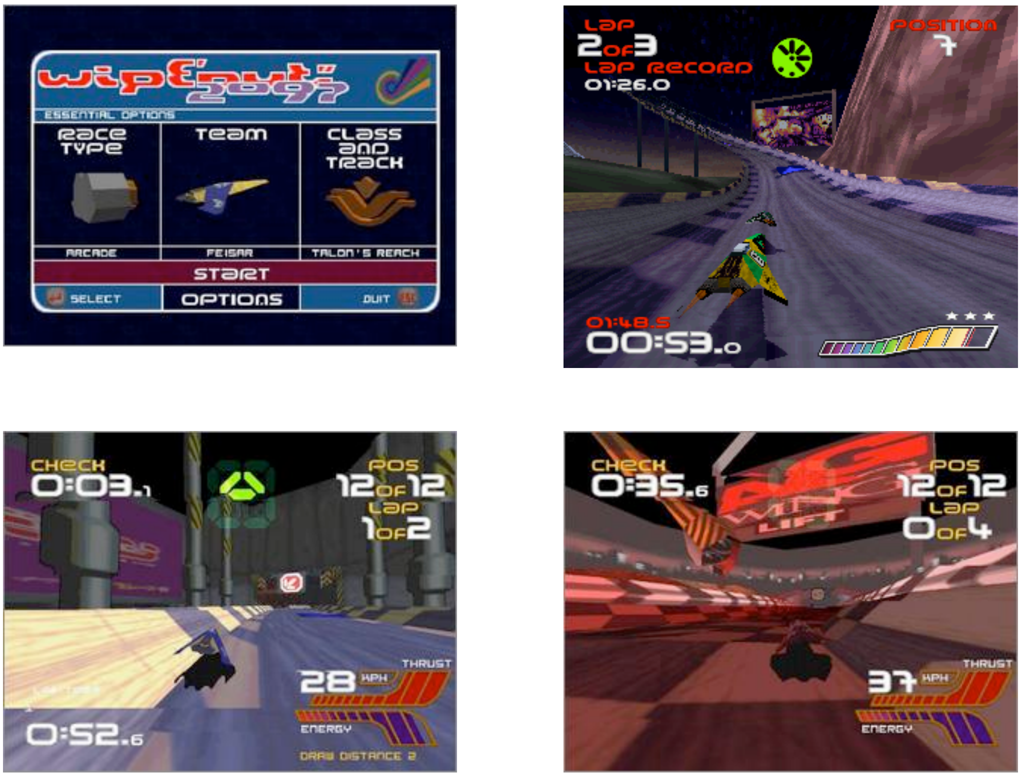


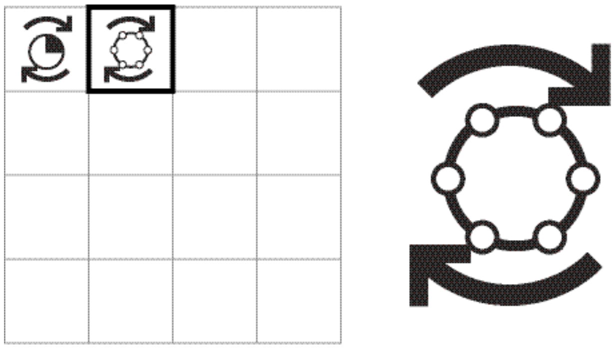
Figure 10. ***Wipeout 2097*** **(Psygnosis 1996)**

The *Wipeout 2097* (Burcombe 1996) series of games delivers an immersive experience that relies on a combination of high frequency feedback, illusionary space, engaging graphics and sound. The game controller gives access to a number of different methods of controlling a futuristic racing craft. This connection between player and craft establishes an immediate *experience flow* via a direct relationship between the player's actions and the game system. The player pushes the controller to the left and the craft immediately turns, applying acceleration quickly moves the craft forward, and so on. *Wipeout 2097* is situated in a 3D space depicted using an exaggerated perspective to reinforce the sensation of movement and high speeds, and to create the sensation of being in the game world. The player's perception of this world is heightened by the realistic graphics and energetic soundtrack, resulting in a highly engaging flow state. However, this is dependent on mastery of the game. Collisions, timeouts, attacks from rival pilots and other game hazards can quickly disrupt this flow. Shifting from digital games to generative art, *Imatraveller* (Driessens & Verstappen 1996) uses a continuous zoom into the space of a generative system, coupled with some simple interaction (moving the mouse about) to create a constant *experience flow*. There are no threats or hazards to distract the player from immersion in the generative loop of an abstract world—thereby creating a different kind of intensity.

However, interaction need not always be a continuous streaming process. A slow moving experience such as that found in navigating the world in the original game of *Myst* (Miller & Miller 1993) can result in a similar form of engagement. In this game an island is represented as a three-dimensional space that may be navigated via discrete steps through fixed locations in the environment. As the space of this world is consistent, the same kind of continuous stream of experience occurs—albeit at a slower rate, allowing a more meditative mode of engagement with the its space and the puzzles that must be solved in order to progress through the game.

Experience flow is also connected to other properties related to time. Although it focuses on the player experience, it is facilitated by *simulation time*: the speed and timeframe in which a simulation is situated, discussed in the next chapter. *Simulation lifespan*, its overall structure or timeline, is described in Chapter 7 and frames the experience; *system process,* explored in Chapter 8, relates to the computational processes that are generating the flow. In some cases, such as games, these connections are apparent in various levels of the simulated world. However, it can sometimes be difficult to make connections—such as digital media where the players decides the lifespan of the experience; when visiting a website; or in artworks in which the computational processes are obscured or concealed.

5.4 Multiplicity and interaction



Equally important as the flow of an interactive experience, is the range of actions that are made possible. Many different modes of interaction may be blended within an interface. *Hyper modality* describes this range of actions.

Many effective digital media works allow multiple points of view and various pathways through a body of information. Individual or customised experience unique to each player is characteristic of digital media. This may be very simple—involving a basic level of choices from a predetermined menu—or it could involve the tracking of behaviour and presenting a customised interface in reaction to the player's choices. A number of different modes of interaction may be linked to various levels of content. By measuring the range of possible interactions and their relationships we can observe their effect on the way digital media communicates.

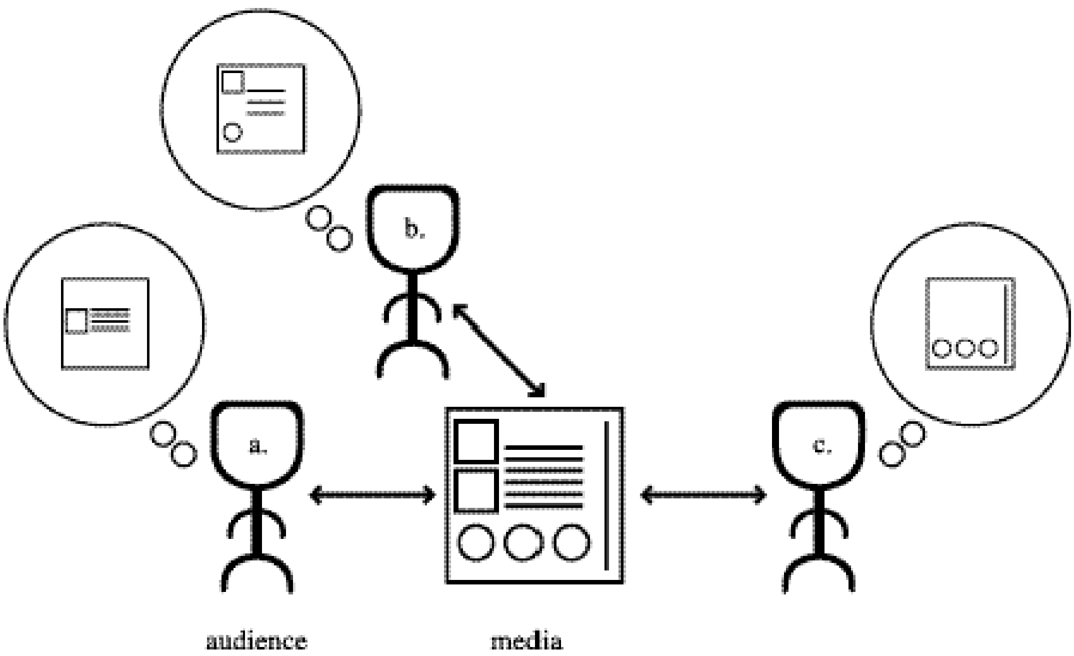


Figure 11. *Hyper modality* expressed via multiple perceptions of a single body of information

In Fig. 11 three individual users (a, b & c) access a single body of media. As they select different options and pathways through the interface they create their own experience, represented by the subsets of media shown in their thought bubbles. This is a simple illustration of how even interaction with a simple media construct can result in individual outcomes for the end users.

This idea is extended further via the dynamic nature of digital media and its relationship to interaction. The same content may be viewed in different ways depending on what inputs it receives from the player. A simple example of this is an online database where information is searched dependent on criteria entered. The content is assembled in response to these criteria and what the system may already know about this particular player. A further extension of this concept is the multi-modal interface where the content displayed is determined by on-screen toggles that turn filters on or off depending on the requirements of the player. An example of this type of interface is a 3D environment that allows different rendering algorithms and labelling systems to be selected by the user, each revealing a different level of information. So, *hyper modality* relates to the number of different modes of interaction and what action they perform in the system.

This moves the emphasis away from the presentation of a single theme or idea towards networks of connected ideas and content. A significant proportion of digital media is networked or accessed online, so this connectivity is theoretically limitless. It can be made up of many, many pieces or bits of information that are recombined to create different information spaces. These individual bits may change over time, transform in response to user interaction, or establish new relationships with another element. In some cases a work may consist of bits drawn from a diverse, eclectic mix of sources recombined to give them new meaning and context and presented as a single, cohesive experience. This is particularly the case in crossmedia works, such as *The Beast* (Stewart & Lee 2001), that trace a narrative across print and online media alongside game experiences, performances and site-specific installations. Similarly, works such as *polar* (Nicolai & Peljhan 2000) create interconnected installations of media and data that operate in multiple modes simultaneously, although these are contained within a similar space.

There are two aspects to consider in understanding how *hyper modality* works: firstly, there is the number of different modes of interaction; and secondly, the number of different actions to which these can be mapped. In some cases a limited number of possible interactions may be mapped to a large number of possible events, each determined by a specific context. This allows the player to learn a small set of possible actions and then apply them in different ways as circumstances change. Alternately, various levels of the system may be accessed as the player switches between different modes of interaction. Sometimes, multiple modes of interaction may be blended in a single interface allowing the player to develop their own style of play and influence on the system.

Figure 12. ***Aliens vs. Predator 2*** **(Monolith Productions 2001): alternate views of the game world through the eyes of three different characters**

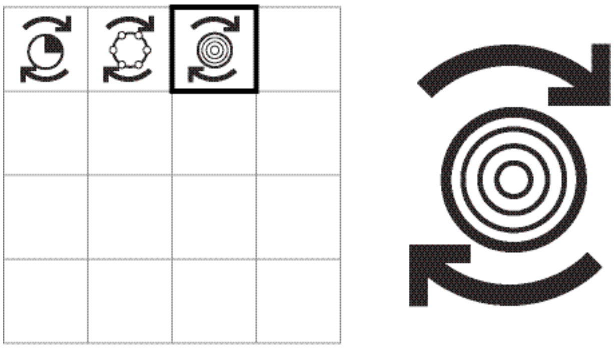
In the game *Aliens versus Predator 2* (Westwater 2001) the player may choose between three of the game characters: a marine, an alien or a predator. This choice determines both the appearance and interaction with the game world, creating a different feel to the gameplay for each character. The marine functions as a typical soldier, while the predator has different modes of vision, targeting systems and symbols from another language—to create the feel of another alien culture. Meanwhile, operating the alien feels like being an animal because of the way it moves, jumps and uses infrared vision. The alien has no typical game heads-up display, to reinforce this more direct view of the world. The same narrative is played through the eyes of each character, which allows comparison of their different points of view. Each of the three modes of interaction offers a different experience of the game world that is consistent with the related character.

Figure 13. ***Simcity 2000*** **(Maxis 1993): screenshots depict alternate views of the same simulation**

SimCity 2000 (Wright & Haslam 1993) shown in Fig.13 above simulates a real city, with the player building roads, buildings and other infrastructure to manage an expanding city. In this game, the player interacts with a process and the content is simply a representation of that process. Each interaction has a direct result the placement of a building, a tree, a section of road but also has a cumulative effect: the wrong strategy will end up creating a barren and lifeless city. The player has a god's eye view of the world and interaction is in some ways closer to the operation of computer graphics software than a typical game. As a result, it has a high degree of *hyper modality.* The viewpoint may be scrolled and zoomed. Buildings and other objects may be constructed and connected. Various data about the world may be displayed and manipulated, and the speed of the simulation may be sped up and slowed down. The player shifts between different modes of interaction in order to engage with the complex task of establishing, building and maintaining a city.

Other properties connected to multiplicity can be related to *hyper modality.* When the various modes are collapsed into a single, shifting form of representation the result can be described in terms of *semiotic morphism*, discussed in the next chapter. The range of different modes expressed by objects in a simulated world can be explored via the concept of *ontological complexity*, discussed in Chapter 7. A simple count of how many different modes are being calculated by the computer simultaneously can be described in terms of *multi-processing*, introduced in Chapter 8. Like other aspects multiplicity, can be identified in the various elements of digital media. The same multiplicity may be mapped in different ways: for example, multiple modes of interaction may be possible and these same modes may be mapped literally to the representation or interpreted in various ways.

5.5 Adaptation and interaction



Via interaction, a world or its entities express certain characteristics or personality. Typically, rule-based systems of interaction determine rewards, punishments or other results in response to player actions. *System behaviour* articulates this set of actions and reactions.

The central role that interaction plays in digital media creates a new opportunity for communication. The idea of interactivity as the primary means of communicating a message can be explored by focussing on the systems behaviour, instead the visual or audio content. In this scenario, interaction becomes the medium for the message being communicated.

In considering the ways in which the system may adapt its behaviour we may also look at how it interacts with itself—its own internal processes and responses. Interaction that can adapt to the player can be described as *system behaviour*, somewhat analogous to its personality or character. This relates not only to how the system may react to the player, but the ways in which a work governs itself and its own actions over time. Unlike many other media that have a fixed duration, digital media may be expressed as an ongoing experience: there is not always a beginning, middle and end. Via these internal processes of interaction digital media is constantly regenerating itself, formulating new responses, displaying new combinations of parameters, or creating novel behaviour. Even within fixed rule systems that are common in many digital games, the player senses that the system is changing its behaviour in reaction to their choices. In other systems, such as those that are common in alife projects or the AI of bots in games (Funge 2004), the system is literally adapting its behaviour in response to that of the player.

Of course, this must somehow include a player in the loop, who may be engaged in the process of 'passive interaction'. This term refers to the ways in which players interact with the system simply by supplying data to be processed or taking on the role of observer. That is, they are not deliberately interacting with the process other than simply being there. Further to this point, the role of the player may simply be to influence the system rather than directly controlling what is going on. In the case of multiplayer works, many players may shape the world via the cumulative forces of their actions.

The potential of this idea is best demonstrated by looking at a specific type of digital media experience: the simulation. Its goal is to simulate some aspects of reality in a virtual environment. Some typical examples include flight simulators, god games, and scientific visualisation. Essential elements to a simulation are the behaviour and rules that make the system work.

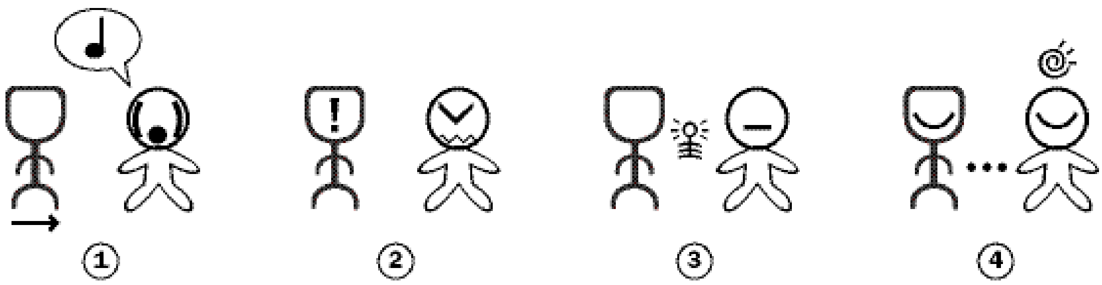


Figure 14. *System behaviour* expressed via an exchange between a player and a digital entity

The options for interaction may change in response to conditions in a virtual world, actions of the player or other factors that govern a simulation. How the computer adapts to these changes can be described as *system behaviour.* The simple example in Fig. 14 shows an interaction between a player and an entity. The player moves towards the entity, triggering a response. The entity then becomes hostile towards the player, who is surprised but then recovers by offering a gift to the entity. This makes it happy and, as a result, the player happy (perhaps this action was rewarded with some points or another reward). This short sequence demonstrates a simple set of interactions between player and entity, governed by the possibilities allowed within the simulation in which they take place. *System behaviour* can also be explored across an entire virtual world (the overall system), within networks of entities, entities and players, players and players and so on. In each case the behaviour is governed by rules that define what interaction is allowed, what is rewarded, reactions to certain actions and so on.

Some of this behaviour can be very subtle. The original version of Pong used extremely low-resolution graphics and sound. However, the way the player interacted with the system captured the essence of the game. New graphics and sound only spoil the effect. The important elements are how the ball (actually a single giant pixel) bounced in reaction to the bat and the simple rules of the game.

Interface design is often discussed using terms such as ‘look and feel’, which refers to the design and appearance of the GUI (Laurel 1990), and ‘usability’, which describes the more functional aspects (Nielsen 1993). It is often based around a central metaphor or idea that drives the design of the interface. The way that this colours the representation of the content can be seen as a kind of mediation, like the design of a book or the cinematography of a film. A well-known example is the desktop metaphor central to the graphic user interface of modern operating systems. Heated arguments take place between users of the MacOS and Windows on which system is the most effective. The functionality of these two systems is relatively similar: the key difference is the way the system ‘feels’. This is directly linked to how it behaves and interacts with the user.

This idea of *system behaviour* suggests that the way the digital media behaves is perceived and understood by the audience. It can form a significant part of the message being communicated. One way to explore this idea is to look at the interaction between players and game entities such as digital characters.

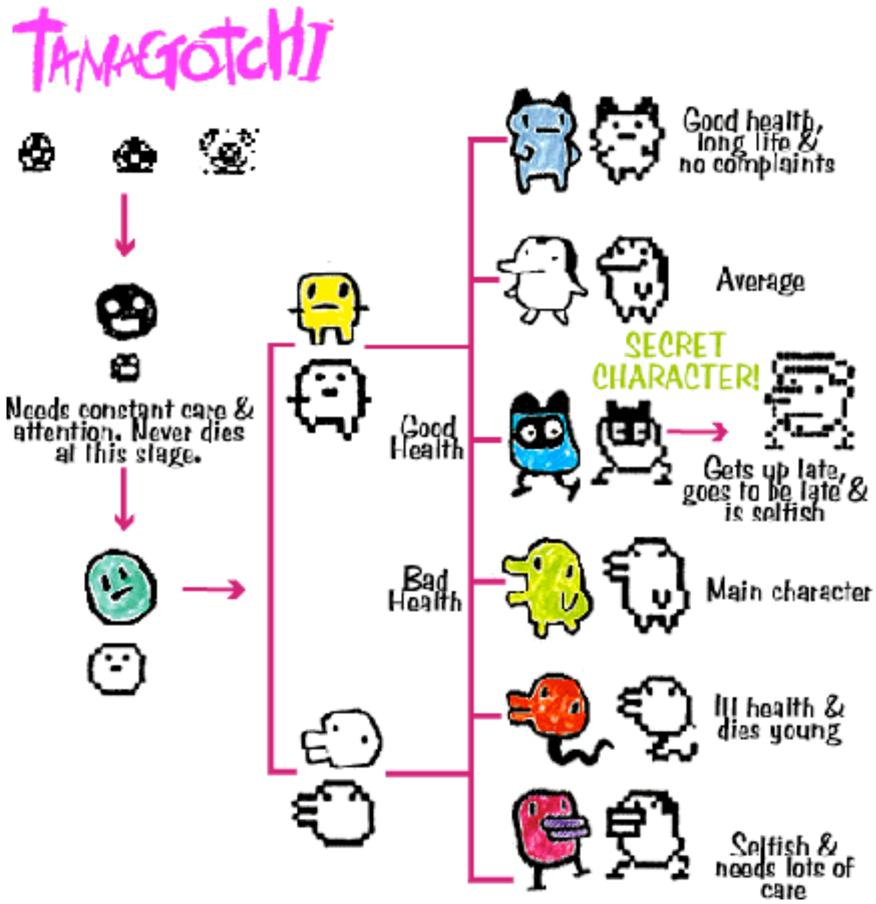


Figure 15. Tamagotchi growth chart

Tamagotchi (Maita 1996) is a handheld digital pet designed for and popular with children. It involves a game based around raising and caring for a digital creature over the course of its lifespan that may last several days. Tasks for its owner involve feeding, cleaning up, playing games, medication, discipline and so on. If abandoned, it dies. Depending on how it is taken care of it will evolve into different types, each with their own personality and behaviour. This interaction is based around strict 'cause and effect' style rules that are predictable and have consistent outcomes. So, while the *system behaviour* is complex and it may take many games to play through all of the possible outcomes, it is also fixed—new responses cannot be generated by the system.

Such interaction is largely based around a single player and an entity. However, the current generation of these games allows players to connect their Tamagotchi so that they may visit each another, give gifts and so on. Their pet may also visit *TamaTown* (Bandai 2006) via a website set up for this activity and return with points and objects for further play. Through this combination of individual, multiplayer and online play a wider range of behaviour emerges as the player develops their relationship with their digital pet.

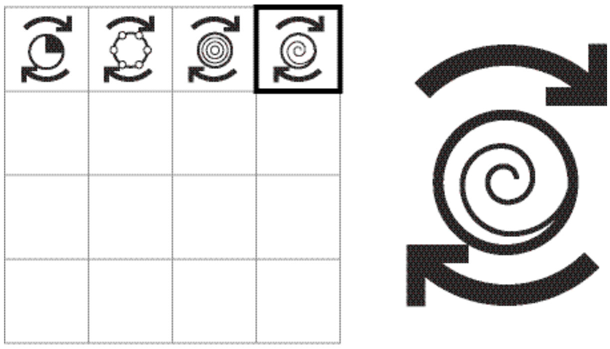
Figure 16. *Spore* (Maxis 2008)

A forthcoming game by Will Wright, entitled *Spore* (Wright 2008), aims to include interaction and behaviour that is mutable and adaptive in a simulation of evolutionary processes. In the game world, players can create and edit digital characters from a library of appendages, organs and other body parts. The construction of this entity is directly connected to its behaviour in the game world in terms of attack, defence, movement, interaction with objects and so on. The game moves along different stages of complexity from a single-celled lifeform stage, through to a single animal, a society of intelligent creatures, a civilisation and finally a network of planets and space colonies.

Through its flexible *system behaviour* the game adapts to the player on a number of levels. Firstly, it is reactive in that it responds to the actions of the player using patterns of behaviour and responses; secondly, the game space changes as the player introduces their customised creations; and thirdly, each of these creations has their own personality that emerges from interaction between the first and second points. Fourthly, the overall simulation of the world includes dynamic behaviours that come from predator-prey relationships; resource generation and collection; formation and distribution of populations of creatures; and building and destruction that occur in the simulated environment.

Other properties of adaptation may be related to *system behaviour*. To a large extent *play mechanics*, discussed in Chapter 8, generate the dynamics of this behaviour. The flexibility with which digital media may be experienced and expressed is governed by the structure of its *meta design*, described in Chapter 7. This experience occurs through varying degrees of *adaptive expression*: forms of representation that adapt to change, explored in the next chapter. Essentially, adaptation takes a different form in each element and these forms may sometimes blend and blur into one another.

5.6 Transmutation and interaction



The actions of the player may be interpreted by the world in any number of different ways. As interaction becomes data it may be given new meaning within a world by shifting context or translating across media. *Transmedia mapping* defines the interpretation of actions in an interface.

Interaction also relates to the translation or amplification of human input. Interaction is read by the computer as data and so may be translated into another form, such as the transmission of control signals in telepresence. Remote human activity may be used to remotely control a robot, where the motion of the operator’s arm is translated to the motion of the robotic arm. More typically, however, the computer is used as a tool for processing interaction and translating it into meaningful feedback for the player. This could be a navigation system for a virtual world, an audio-visual instrument that generates musical-visual form, movements and gestures in an interactive installation, or a set of coded actions in a crossmedia environment.

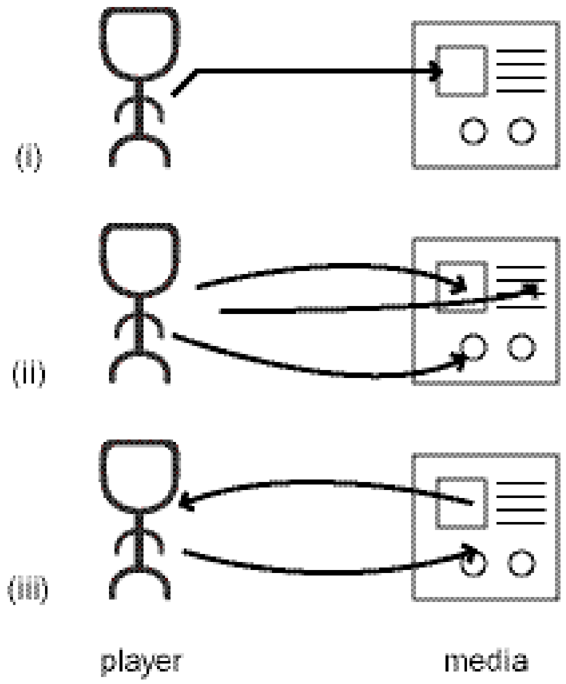


Figure 17. Examples of *transmedia mapping* in different modes of interaction

Three simple connections between the user and a digital media work are illustrated in Fig. 17. In example (i) mouse movement is mapped directly to onscreen media; example (ii) shows multiple streams of interaction such as motion tracking mapped to multiple media; and (iii) depicts the feedback loop involved with controlling an onscreen character. In each example the interaction data is an active parameter in the simulation resulting in immediate changes to the image on screen.

Apart from being a convenient way to navigate and select options within hierarchies of content, interaction can involve human performance and the way in which the computer processes that performance. The player sees their actions mirrored back to them, filtered by the interface. Gestural actions become part of the language of interactivity, where certain movements with a mouse or with a pen on a touch-sensitive pad may carry specific meaning. The speed of movement, sequence of triggering certain thresholds, type of motion, and consistency of motion become possible parameters that may be connected to the interface.

This form of interaction may also be seen in visualisations of data in VR. The proximity and position of the player in the virtual space may trigger thresholds, manifest new objects in the space, or switch modes of representation. Parameters may be directly linked to the player's position or rotation, resulting in realtime changes in the world as the user moves about, such as in *Menagerie* (Fischer 1993), a virtual world populated by animals. As the player moves about, bold motions frighten the animals away, while gently approaching the animals will tame them. Their actions are translated to the outcome of the world, establishing an interdependent relationship between player and virtual animals. Another work, *Haze Express* (Sommerer & Mignonneau 1999) generates abstract artificial lifeforms that are constantly moving within a screen. The screen is situated in an installation as if it were the window of a train, and the player places their hand on this screen to attract forms toward them. Simple hand gestures on the screen establish tactile interaction with the artificial lifeforms. This direct interaction creates the perception that they are more real than if the interaction occurred via a point-and-click style interface.

In both cases, there is a meaningful interpretation of the performance of the player to influence a virtual world or entities within that world. *Transmedia mapping* describes the interpretation of interaction.

Interaction may also traverse media where a sequence of actions may begin in one place, then shift to another. Players may start a game online, which then leads them to continue the experience in an urban context using a mobile phone. This in turn may lead them to follow the line of interaction into a gallery space in which an interactive installation is situated. The original context provided a particular space with its own rules and conventions of interaction that were in part translated to the new context of the mobile device with certain additional elements, changes and some aspects removed. Within the gallery space, this same process is repeated. Each new mapping of the original system also reinterprets it, with each context resulting in a different experience for the player: the online world plays like a game, the mobile device situates the player in a real urban environment, and the gallery installation has a physical presence that gives the interaction another meaning altogether.

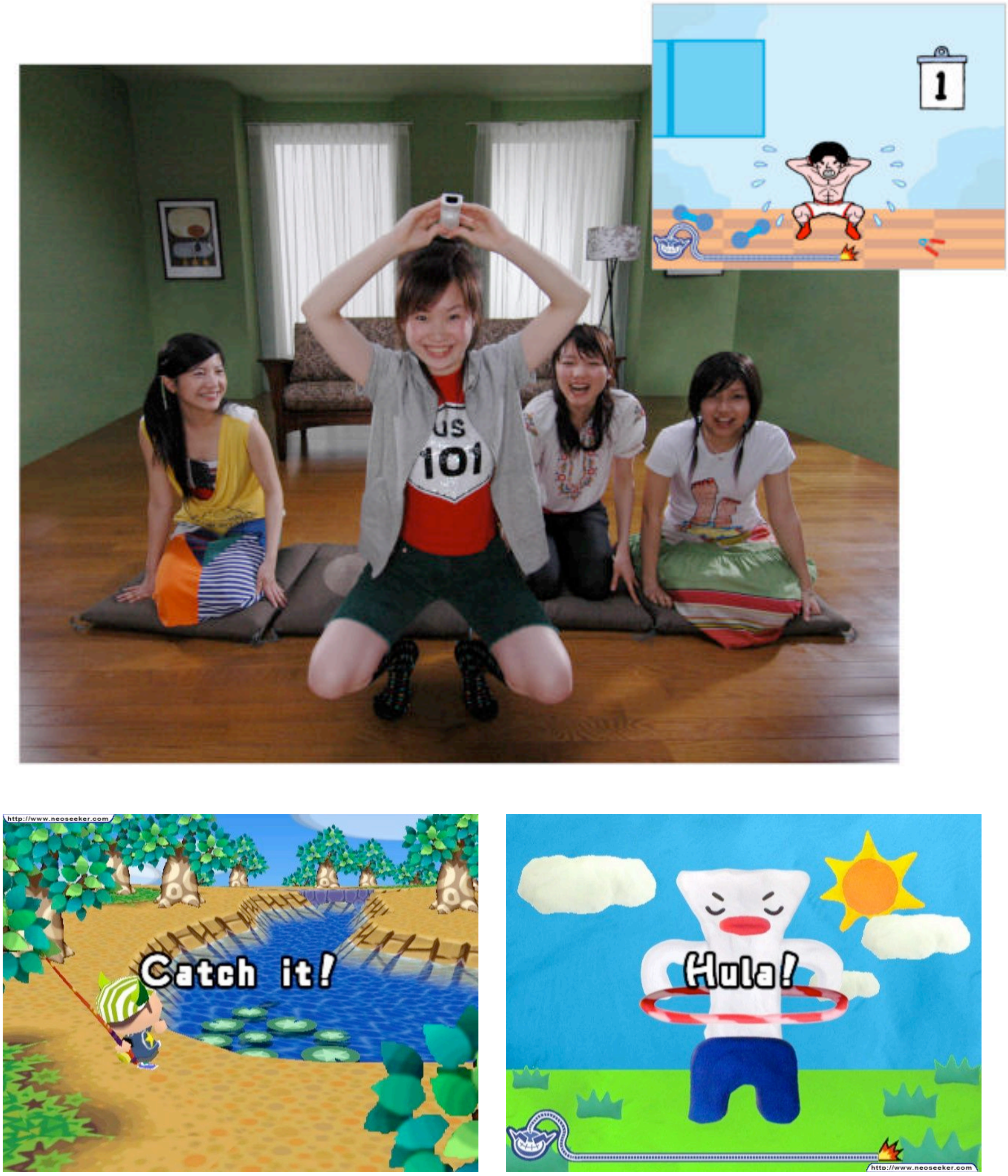


Figure 18. *Wario Ware: Smooth Moves* (Intelligent Systems 2006)

The Nintedo Wii introduces an alternative model for interaction design in console gaming systems. Rather than the traditional gamepad style controller that reads the player's thumb movements and button presses, the Wii remote allows the player to use body movements and gestures to play. Apart from making play more accessible this introduces a broader range of meaningful interactions that the player makes, external to the virtual world of the game and that are transmuted into actions in the game. *Wario Ware: Smooth Moves* (Abe 2006) on the Wii involves the completion of many mini-games to move through the various stages on its map. Each game calls upon a particular pose or gesture that relate to familiar actions from everyday life such as using a remote control, balancing an object and so on. Although they are familiar, these gestures take on new meaning to the player when they are recognised by the game system and formally become embedded in the process of interaction.

Figure 19. Carsten Nicolai & Marko Peljhan, *polar* (2000)

polar (Nicolai & Peljhan 2000) is an interactive artwork that aims to 'make(s) it possible to experience the data flow in global and local networks both sensuously and cognitively'. This data is transmuted through a multitude of systems – much of the interaction takes place within the installation system itself. This is a space constructed to create an exchange between player and system on a multitude of levels. Defined as a matrix of information, the player is physically and cognitively immersed in a space made of data that is sensitive to their position and movement via a high-resolution 3D tracking system. This data consists of overlapping flows of information, mapped to changes in light, sound and image that alter the physical space in which these are experienced. So, both incidental and deliberate player interaction alter the flow of data and thereby alter the installation space, which in turn alters the player interaction—and so on in a recursive feedback loop.

Transmedia mapping is connected to the other properties related to transmutation. It may be facilitated by systems of *evolutionary code*—computer software that evolves—discussed in Chapter 8. Alternately, transmedia mapping may facilitate processes of *emergent meaning*, explored in the next chapter. It may be generated by certain types of *recombinant space*, particularly those related to the traversal of different media, explored in Chapter 7. It may also be related to certain types of multiplicity, such as *semiotic morphism* and *hyper modality*. Transmutation is a key aspect of digital media and so it is not unusual that it finds expression in many of its properties—sometimes overtly, for example in a synaesthetic artwork; in other cases its presence is more subtle, say in the levels of GUI in an MMO.

5.7 Four interactive sound design projects

Interaction is a key theme of a cluster of works produced by myself between 1996 and 2002 that examine the potential of interactive systems in the manipulation or recomposition of sound. *We are Sound* (Shaolin Wooden Men 1995) employs an arcade game style interface in the realtime composition and play of four tracks of electronic music. In *Soundform* (Innocent 1997c), icons representing evolving sequences of sound can be mixed in and out of a continuous stream of sound. The *Transmutational Meta-Processor (TMMP)* (Innocent 2001b) is a system that enables flexible reconfiguration of relationships between a music sequencer and visual effects in realtime. A similar idea is explored in *au_vecta* (Innocent 2002), where the movement of virtual cameras through a field of sound sources animated in 3D space is controlled via a number of keyboard controls and toggles. All of these projects connect interaction and sound in an interactive environment.

Figure 20. Shaolin Wooden Men, *WE ARE SOUND* (1995)

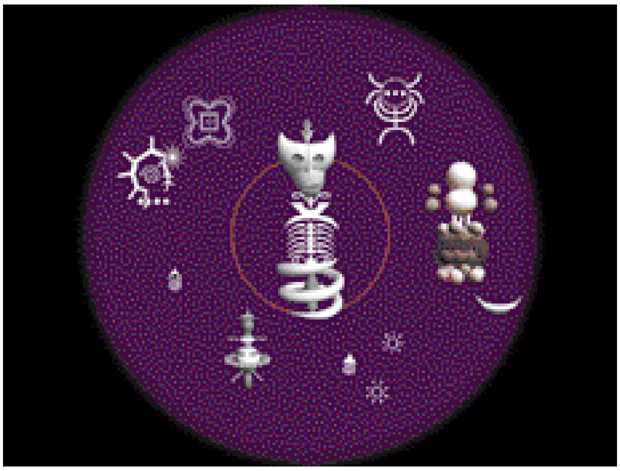


Figure 21. Troy Innocent, *SoundForm* (1997)

A common thread in these works is the exploration of realtime sound mixing as the basis of *interaction flow*. This involves the modification and play of an environment that dynamically reacts to input, creating a continuous stream of small tweaks and changes. This is in contrast to traditional models of interaction in which the user navigates an interconnected body of discrete media elements, such the sections within a CD-ROM or the pages of a website. The works enable interaction with a process and create an ongoing dialogue with that process as the user tests and experiments with its possibilities.

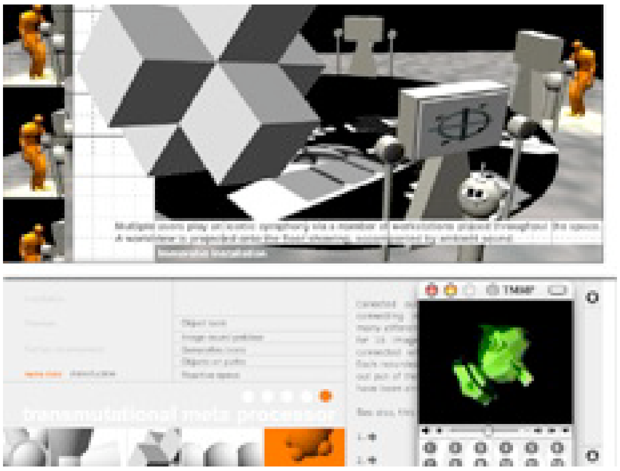


Figure 22. Troy Innocent, *TMMP* (2001)

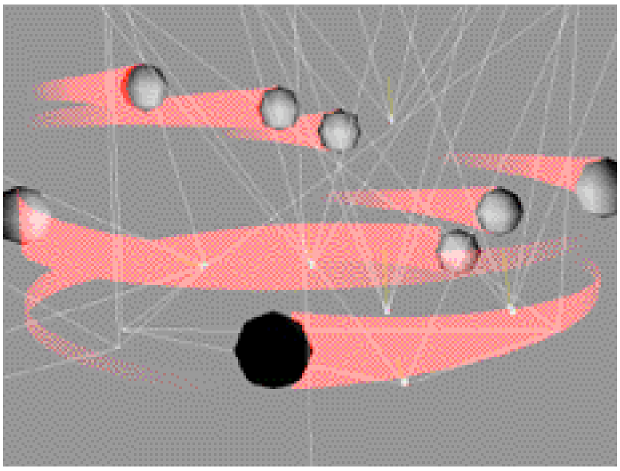


Figure 23. Troy Innocent, *au_vecta* (2002)

The *hyper modality* in these works is more varied than that found in a CD-ROM or static website. All works use an interactive environment that is modified and reconfigured, so there is more than the simple navigation of a static body of data – the user can change the work. In *We are Sound* this occurs through up to four players modifying the content of four tracks of sample data to create new mixes through the action of an onscreen avatar. *Soundform* employs the direct manipulation of icons that may be moved, played, muted or combined with other icons to produce further icons (inheriting characteristics of their 'parents'). *TMMP* is a system that is highly interactive in that it is designed as a production tool for the recording of improvisations in abstract electronic image and sound. Thirty keys on a standard computer keyboard are given new meaning in *au_vecta* through the assignment of functions in the remixing of a three-dimensional abstract space of geometry and sound, being used to mix parts of the environment in and out, change the point of view, and modify the behaviour of the space.

As these works represent interaction with a process, the environment itself acts as a visualisation of that process in terms of the idea of *system behaviour.* Although the nature of interaction and type of sound varies in these works, they all represent sounds as objects in a dynamic environment. The appearance and behaviour of these objects, typically represented as icons, indicates their function and potential in the system – through their reaction to the user, motion on the screen, and changes in their visual appearance to indicate state changes in the system. That this behaviour is reactive—it happens in terms of an ongoing process of interaction with the system—is significant, in that it involves the user in the play and experimentation with an environment that embodies the process being represented in each work.

Transmedia mapping in this body of work is centred in the idea of the translation of action into image-sound events that modify the underlying interactive sound system. *We are sound* uses an arcade game interface that allows avatars to jump, transform and play sounds into the soundtrack through simple button presses. Direct manipulation of icons in *Soundform* modifies allows the space to act as an experimental 'playspace' in which the actions of multiple users contribute to the evolution of short musical sequences. *TMMP* may be connected to external sensors or variable controllers that allow subtle modification of visual and sound parameters in realtime. The space of *au_vecta* also functions as a site of experimental play as the keyboard functions as a control panel for the reconfiguration of parameters of the environment.

5.8 lifeSigns: eco-system of signs & symbols

lifeSigns: eco-system of signs & symbols (Innocent 2004) explores interaction on a number of levels. The interactive installation combines two separate views of an artificial world populated by living signs or 'lifeSigns'. A projected map of this world, accompanied by a generative soundscape, is combined with four workstations that enable navigation and play. The space appears to be infinite as the player may continuously navigate and search in any direction—there is no up or down. Although it is a three-dimensional representation there is no horizon line or indication of linear perspective, but instead multiple layers of abstract form, colour and movement. When lifeSigns are played they perform animation and music, and their energy is increased—thus making them more likely to persist in the world. When multiple users are playing a number of lifeSigns simultaneously, the result is a symphony of artificial image and sound.

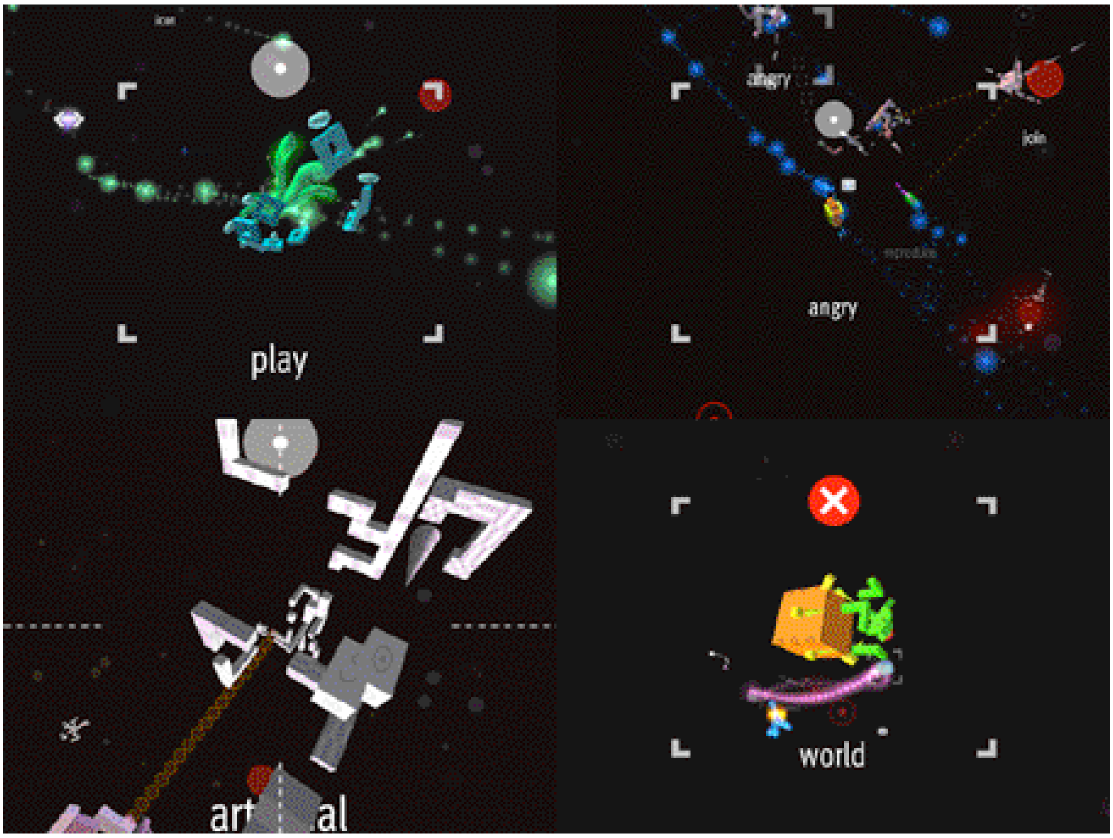


Figure 24. Troy Innocent, *lifeSigns: eco-system of signs & symbols* (2004)

lifeSigns is a digital game. The *experience flow* is generated by the continuous, realtime feedback loop of the game engine. Players have an ongoing exchange with the world: they engage and experience the space in the kind of moment-to-moment existence of everyday experience in the real world. This mode of engagement is typical of games; however, the gameplay of *lifeSigns* is open-ended, with no actual threats that will interrupt the experience. (The player does not die and is not forced to restart from the beginning of a level). This results in a mode of 'free play' with the system that allows exploration and experimentation with the possibilities of the artificial world. Overall, the work attempts to establish a natural flow to the interaction through the use of the realtime feedback and experience of the simulation with the free exploration of the space.

The *hyper modality* varies from low levels of engagement in simply being in the space, to higher levels of engagement where players are engaged in the processes of the world itself. Overall, this can be described in terms of three levels of experience. The first level is the 'ambient' experience of the installation space through listening to the multi-layered soundtrack, observing activity in map view, and watching the lifeSigns on screen as they act autonomously. Secondly, players may use the interface to navigate the world, observe a range of lifeSigns behaviour and form, and moving through multiple layers of the space.

Finally, the highest degree of interaction occurs through the play of lifeSigns, causing them to animate and generate music in response to the performance of the player. This mode of interaction draws upon conventions of the live performance of electronic music, through its use of touch-sensitive pads that respond to varying pressure and styles of play.

lifeSigns respond to play in many different ways. Some distort their form or become animated, others change colour or begin to glow all while playing rhythms, melodies or ambient soundtracks. Each lifeSign combines expressive properties of abstract electronic form and sound in a unique combination—resulting in a wide, free-ranging exploration of the *system behaviour.* The work becomes a tool for the generation of novel representations of interaction as each lifeSign reacts differently to being played. In addition to their response to play, the alife system that drives their autonomous behaviour drives their interaction with one another, and these processes are represented through animated actions and sound on screen.

The *transmedia mapping* in this work occurs through two quite different processes. There is an immediate translation through the play interface to the audio-visual parameters of individual lifeSigns. Press the buttons firmly or softly and the animation and sound varies in response. Holding the buttons down enables variations in the image and sound through the continuous control of their parameters. Each action also results in 'signals' being transmitted from the lifeSign being played onto others, causing chains of interaction to occur that may result in feedback loops or cascading echoes of interaction persisting after the player ceases to play. On another level, this play also changes parameters that relate to the alife model that generates the behaviour of the work. Playing lifeSigns gives them energy, thereby increasing their probability of persisting in the world—as those that have low energy are either killed by others who are stronger or removed from the world. Each player also has the opportunity to interpret the meaning of a selected lifeSign by selecting from a list of sixty-four words. These meanings are accumulated over time, allowing multiple players to input data into the system.

Experience flow relates to the overall pace and intensity of engagement with digital media. The degree of interaction measures the range of effect of interaction, and interactivity as communication is expressed as the *system behaviour*. Finally, the *transmedia mapping* into media and other forms is described as the mode of interaction. For example, using fluid interactive flow with a high degree of interaction is characteristic of video and computer games; whereas a very abstract mode of interaction combined with a high degree of interaction is characteristic of a computer operating system.

5.9 Summary

Interaction is defined by drawing upon various approaches to interaction and interface design. It is introduced as the actions possible within a digital media poetics. Four key concepts are explored:

- *experience flow*, properties relating to the conversation between player and computational system and how it develops over time
- *hyper modality*, the range of different types of interaction possible within a world, including those interactions that may cross over multiple worlds
- *system behaviour*, the overall pattern of responses and adaptations made in response to the player or internally within the system itself and how these express a personality or set of behaviours
- *transmedia mapping*, interaction made meaningful via the ways in which it is mapped and connected to player, entity or world(s).

Two examples of works that experiment with these concepts have been analysed above—a body of works dealing with interactive musical-visual form, and a game artwork that feeds player interaction into an ecosystem model.

6 Representation

In 1983, our household acquired a Sharp MZ-700 PC, the same year that it was released. Initially it was used for playing games and writing essays (it came with a small plotter). After turning the machine on you would wait up to half an hour for software to load from an audiocassette. Incidentally, playing these back on a regular cassette player resulted in some fantastic sounds. By loading BASIC into the machine I was able to then write my own software and games on the system. The MZ-700 was able to display a screen of 40 characters by 25 lines in eight colours. There was no graphical drawing function apart from this display of graphical characters on the 40x25 grid. At first it appeared that game graphics had to be displayed using letters and numbers, much like ASCII art. However, the back of the user manual documented two alternate character sets that included many different creatures and game icons. These could then be drawn into the grid and animated to represent the game world. For a number of months every spare moment was spent conceiving, designing and programming MZ-700 games.

Although I did not realize it at the time, several things were happening as a part of this play with the MZ-700 system. First, I was able to create my own content for the medium, which was not possible with television, for example. Secondly, the earlier experiences of playing games (the black and white TV game, a friend's Atari 2600) could now be translated into making them. This also required learning basic programming and provided an early introduction into the language and logic of the computer. Finally, the quirky display system of the MZ-700 provided first-hand experience of the idea of mapping data to a representation—a key property of digital media. What could one moment be a garbled screen of letters and numbers could with the selection of the appropriate graphics set become a game world. The invisible data encoded into the computer program *was* the game world and its representation on screen was simply a stand-in for the code that lay underneath this graphical surface. This language of representation consisted entirely of graphics and sound coupled with interaction. Through this programming experience the relationship between computer code and its representation became second nature to me.

This experience also engendered an appreciation of a digital aesthetic. At this early stage the graphics and sound of systems such as the MZ-700 (we later acquired an Apple //c that had its own unique characteristics) were full of artefacts generated by the limitations of the system itself. Limited colour, lo-resolution characters, synthetic sound and other limitations had their own charm. A number of years later I was introduced to the Roland TB-303 Bassline by a friend. This instrument was designed to synthesise the sound of a bass guitar and to play its role in song composition and rehearsal. However, due to the limits of analog synthesiser technology at the time, it has its own sound. This came to be the signature sound of the electronic music genre known as acid. By tweaking the controls on the little silver box a seemingly infinite number of variations of this unique electronic sound could be generated, most of which sounded nothing like a bass guitar. A couple of entranced hours went by during my first encounter with this process. I was listening to a representation of sound synthesis and manipulating it at the same time. The representation of this process was both fluid and mutable and I was deeply embedded in it.

Although at the time I was simply a curious teenager with nothing better to do than play with technology, these early experiences shaped my understanding and expectations of media.

6.1 Introduction

Representation describes the alphabet of the digital media language: the basic units of meaning that may be used to construct communication and build expressions within the language. These include a diverse range of elements from other media such as image, text, sound, and video that take on new forms in their digital media context. Hybrid or alternate forms are also included in this alphabet as they are blended or translated across media. Representation in digital media is open to many possibilities as it can emulate almost any previous aesthetic, style or mode of representation. However, this also means it can be difficult to identify or articulate modes of representation that are specific to digital media.

First of all, we may consider what is included in this metaphorical alphabet. The capacity for digital media for emulation enables it to incorporate a wide range of existing media, each with their own characteristics and properties. These include:

- text and typography—very descriptive, can be used to convey accurate information
- graphics—illustrations, diagrams, charts, maps via layout, screen design, and graphic style
- photography—emotive, historical, illustrative etc., may also be manipulated or composited
- animation—two-dimensional, three-dimensional, computer generated, hand-drawn;
- sound—music, sound effects, voice, atmosphere
- video—broad range of content and applications including documentary, drama, educational
- architecture—spatial metaphors and navigation, and ‘immersive’ experience.

Visual media dominates this list, including languages of film and video, graphic design, visual arts and architecture. Text plays many roles in this language—such as the labelling of icons, titling and annotation of content—but words are just as likely to be spoken as depicted on screen. However, communication primarily occurs via interaction with moving images—

visual, time-based media. For example, the content of hypertext is given meaning largely through its navigation—the process of interaction—rather than the text in itself. Although the representation of digital media unfolds over time, the nature of this time is subject to change as part of the process, both from the audience and the system itself.

It is a fundamental aspect of the computing machine that makes this fluidity of expression possible. At the most basic level the same string of bits can be mapped to any symbol within the system of representation used to display data. The ASCII code for the letter 'A' is 65, but this arbitrary number could just as easily mean '@' or 'seed' or 'entity37'. At a more complex level, data structures defined and managed by a computer program can be expressed in any number of ways. They may be printed to screen as text, displayed as a computer graphic diagram, mapped out into a game world or synthesised into a simulation. Data exists separately to its representation and is mediated by processes that generate its expression, typically in realtime. Therefore, theoretically the same data may be represented using any number of schemes. As a result, digital media is characterised by a separation between the codification of data and its expression through the artifice of representation. This kind of thinking led Goguen to develop theories of *semiotic morphism* (Goguen 1996), describing computational processes that are able to construct different representations of the same data. Although this is still an experimental approach (as it requires data to be encoded using a system of algebraic semiotics) it demonstrates the potential of this idea. From a systemic point of view, a 'system generates representations from a player's interaction with the game, out of the experience and logic of play' (Salen & Zimmerman 2003, p. 422). and within this system 'each category – production, signification, consumption, bodily experience, and representation – is in constant feedback and feedforward loops with the others' (Hayles 1999, p. 28).

Digital media, therefore, is predominantely the time-based, audio-visual expression of data. A significant innovation in the representation of digital media is the use of visual symbols and icons to represent information. The ubiquitous computer icon has evolved from its static form in the visual communication strategies of graphic design to a dynamic, animated form within digital representation. New iconography, that originates from the conventions of Graphical User Interface (GUI) design, but extends this paradigm much further, can be seen in forms of representation such as digital games and online communities. Meaning is constructed in many cases almost entirely from audio-visual code, with words and texts serving to punctuate or augment the visual narrative.

Therefore, we may explore digital media in terms of its audio-visual syntax. This is not to say that text-based communication is not a part of digital media, but simply that it is dominated by other audio-visual forms. The effective use of these can be observed on many levels.

Firstly, such forms may be viewed from an aesthetic point of view; secondly, in terms of functionality; thirdly, in relation to their connection with the aspects of interaction discussed earlier, and finally, in terms of their use of the range of media possible within the schema of digital media representation itself.

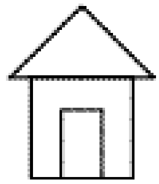


Figure 25. An icon

To further explore representation in terms of digital media, an understanding of its new iconography will be constructed throughout the chapter. As each property or characteristic in relation to representation is defined, further aspects of this iconography will also be developed in parallel. Icons, signs and symbols have a long history, predating written languages as one of the earliest forms of recorded communication. They are designed to achieve compact, efficient communication and to capture the essence of key concepts in an easily recognisable form. This is the main role they play in GUIs. Prior to their use in interface design symbolic systems were typically used in the graphic design of books, maps, street signage, and personal insignia. Socially and culturally, these visual languages reflect important aspects of ourselves in that ‘they reflect the way in which we think, our knowledge of the world, and the way we create visual interpretations of the world’s relations rather than the things and relationships themselves’ (Liungman 1991, p. 7).

The term icon has come to have a different, more general meaning in digital media than its original meaning: a symbol whose form resembled what it represented. For example, an icon for a cow would look like a stylised cow; an icon for a church would look like a church. In digital media all visual symbols used in a GUI are typically called icons, even if they bear no resemblance to what they represent. They are a symbol whose form is *directly linked* to what is represented. Double-click a folder named ‘Office Files’ and you get to exactly that. An interface may include icons for key areas of content, each of which takes you directly to that content. Icons have not been able to do this before.

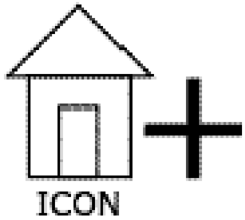


Figure 26. A hybrid icon

Digital media offers the possibility of hybrid icons. These are images often combined with text and related action, such as the typical 'roll-over' state followed by an activated state. This allows the icon to go through three distinct levels of meaning: first of all as icon, then as icon and label, and finally as a signal that a particular state has been achieved in its activated state. In digital media, an icon may adopt any graphic style or appearance such as photographic images, objects placed within a scene, or other non-typical media. Anything can be an icon.

6.2 Representation in practice

Within the contemporary mediasphere, language extends beyond words, images and sounds to include icons, spaces, processes and systems interconnected to form new, digital languages. My work focusses on the endemic forms and structures of electronic space expressive of the unique properties and characteristics of digital media, that blends a multitude of 'natural' data forms—such as codes, glyphs, geometric primitives, links, networks and topologies of information. Inspired by the sonic landscapes of electronic music, the aesthetics of rendering artefacts, and the plastic reality of simulation, this language investigates a 'new iconography' that draws on the history of the icon in pre-linguistic cultures, and its function in digital media communication strategies.

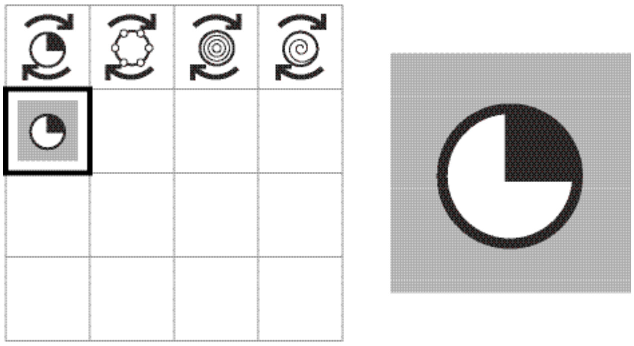
A visual language for electronic music is embodied in the various electronic spaces that are explored in *PsyVision* (Innocent 1996b). In this animation, one collection of media—rhythms, sounds, melodies, basslines, and other sonic elements—are mapped to and illustrated by another collection of media consisting of animation, characters, textures, environments, objects and icons. Each musical composition is rendered into its own space and is expressed by its visual language. Associations are made between the two by synchronising sound and image elements so that they become a single expression, fused together into an audio-visual syntax that emerges as the work plays out. These spaces demonstrate and illustrate the 'new iconography' that is driven by digital media aesthetics.

Digital media can consist of any number of possible modes of representation, each with their own particular characteristics and methods of communication. In *Semiomorph* (Innocent

2001a), the same game world is rendered in four different modes in order to compare four different player perceptions of that world. These modes are blended with one another so that the same map is presented simultaneously using different schemas of representation. Developing the system of representation for *Semiomorph* involved building a database of media that could be mapped to the data structures of the game. Icons, textures, objects, characters, animation, music and sound all form part of this database, with many items in the database having multiple forms of representation: as text, diagram, icon, and simulation.

In developing schemas of representation for artificial worlds, several key opportunities present themselves. First of all, consideration of its temporal nature must be taken into consideration. How are events sequenced or synchronised? What is the tempo or pace of the world? Second, the separation of data and its representation allows for some interesting possibilities. How is the world mapped to its representation? What forms are used in this representation? Third, the schema for representation does not necessarily have to be static – it may be dependent on various parameters of the world, player, entities and so on. What variations, if any, are possible within the schema or is literally a fixed mapping without any translation? Finally, the representation may travel across different media either through a synaesthetic relationship, or perhaps via crossmedia traversal. Do these shifts change the meaning of the data and what impact does this have on the player? Does accessing a broader range of this audio-visual syntax create a richer experience?

6.3 Time and representation



Each world is able to define its own timeframe or timeframes in terms of how it manages and sequences both input and events. Although this is typically analogous to the realtime experience of the real world, in a simulated world time is fluid and malleable. *Simulation time* describes this particular aspect of time in digital media.

Conventions for the representation of events over time have developed through media such as film and television. Techniques such as montage, pans and dollies, dissolves and cuts are some examples of conventions of cinematic language. In these media, movement through time typically follows a single fixed path. In contrast, digital media allow time to become another parameter for interaction or computation. Time may be stopped, sped up or slowed down in a simulation—thereby changing the representation to the player. In the case of digital games there may be time limits or goals that make up part of the gameplay, such as rewards for achievement within a certain time, or the requirement to finish a set of objectives before time runs out. These aspects of *simulation time* create the sense that digital media has its own definition of time. This can be highly fluid and variable in ways that are quite different from our familiar experience of time as a constant tick, that is emulated by many existing media such as traditional cinema narrative. Within digital media, the dimension of time becomes something that can be played with as part of the representation.

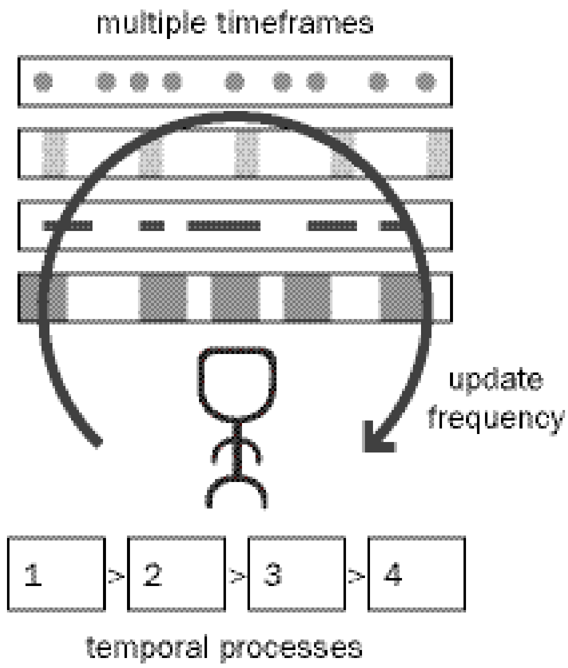


Figure 27. Aspects of *simulation time*

Three aspects of *simulation time* are introduced in Fig. 27: firstly, the frequency of updates in relation to the player; secondly, the possibility of multiple timeframes coexisting within a single digital media experience; and thirdly, the overall temporal processes embodied in the representation itself, such as the simulation of growth or decay. Each will be explored in turn.

The simplest manipulation of time in digital media is that of the speed at which the representation is updated for, or in response to, the player. The latter may methodically move through different parts of a work at a consistent pace, or rapidly search through as many options as possible. Consequently, the rate at which the information is consumed may vary with each individual. This rate of consumption may be altered by delaying key parts of the content, but it is still typically subject to variation by the player. Overall, a number of variables need to be considered: how often interaction occurs, what feedback is provided, the internal clock within the simulation, and the timeframe for representation.

Multiple timeframes may coexist in digital media either through the user activating a number of tasks simultaneously, or via navigation in and out of multiple streams of information. In some software, the rate of simulation can be sped up or slowed down, restarted from a key point, played backwards in order to look at the events from another viewpoint. This is the case in simulation games that involve the design and maintenance of a system such as a city or social network, or in the action replay of a player's performance after they have completed a game. Alife simulations such as *Avida* (Adami, Ofria & Brown 1993) allow the playback of data generated by the software for analysis and observation of the evolution and behaviour of agents in the system.

In some digital media, the user may edit the content and recreate it with each interaction, such as ‘edit your own movie clip’ applications in which pre-existing segments of digital video or animation may be recombined. *Let Us Play!* (Coldcut 1997) included a CD-ROM that allowed video clips to be triggered via the keyboard in a style similar to the VJ sets played by Coldcut in their live shows. Software such as *Arkaos* (Resibois 2008) also allows this time of free play with digital video material. More recently, games such as *The Movies* (Moore 2005) feature the production of machinima as central to their gameplay. Alternately, elements of the interface may be recombined, allowing the player to manipulate the representation itself to suit their personal taste.

Websites capture time in another way, as they are constantly being updated and changed, often in response to the input of the audience via surveys, email responses, and software that tracks the movement of the user through an interface. So a website that is always being modified never has a single fixed form, but many iterations within its lifetime. This means the experience of the site may be different from day to day, and that it has no fixed, definitive representation. While this aspect is most commonly attributed to websites, other digital media may also be modified in this way. Software and video games may be updated with new versions, or new content published for them. CD-ROM works may have a hybrid element, where part of their content is updated via a link to media on a website. In each case there is the opportunity for the project to evolve with new content, reworked interface, and so on.

Time can show age, growth and evolution in digital media, particularly in networked environments that persist over extended periods. In some environments the construction of the work is made visible over time. This may be seen in websites, wikis and blogs that include archives, posts and comments with timestamps, and the chronological representation of content. Within virtual worlds lighting and particle effects may represent the time of day or current season. Worlds that allow modification and content generated by players have timelines much like cities, farms or forests in the real world, as growth, decay and other dynamic forces come into play. Other worlds that allow for the development of a player’s character over time through the acquisition of skills and levelling represent the timeline of the player’s experience via their character.

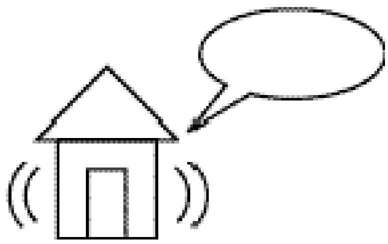


Figure 28. A digital media icon

Returning to the theme of iconography in digital media, its relationship to *simulation time* may be explored. A digital media icon is created through the integration of sound, motion and other dynamic properties to a graphic image. This makes the icon more adaptive to user interaction, as each icon's performance becomes a micro event in itself. More recently, animated interface design has become common, with GUIs constantly moving and icons having behaviours that react to the user in simple ways. Web designers such as Yugo Nakamura (Nakamura 1999) and Joshua Davis (Davis 2002) regularly publish experimental works online that demonstrate new ideas in dynamic interface design. The *praystation* (Davis 2001) project made available source code for creating dynamic, animated web design. These dynamic properties—when used sensibly—allow for the icon to communicate via means other than its graphic form, in the ongoing flow of *simulation time.*

Sound becomes particularly important in extending the icon's meaning. The sound may be a short melody, a sound effect, a fragment of ambience, or a voiceover that becomes associated with the icon and reinforces its meaning. In some cases, its sound may be reused elsewhere in the interface when its graphic form is not visible, or it may only exist as sound. These sonic icons are like motifs and spot effects used in the underscore of cinema, announcing some new potential or change of state in the interface—similarly to earcons and auditory icons in sonification and auditory display. Used consistently, they come to form another layer of the communication system.

Early attempts at interactive cinema, such as *Burn:Cycle* (Arussi 1994) or *The Dame Was Loaded* (Giles 1995) used a database of video clips that are played in response to the player taking different paths within a hierarchy of pre-recorded storylines. Although the emotional engagement of the player with the narrative is heightened by the cinematic sequences, when they are forced to switch back to choose the next path in the story there is a distinct break in the flow of the experience. In comparison, the *Tomb Raider* (Gard et al. 1996) series of games uses cinematic techniques both in the non-interactive storytelling sequences and the play of the game itself. The placement of the cinematic sequences occurs at points where the players need a break from the game, such as after a particularly difficult task or achieving a major goal. Generally, this results in a better blend of narrative and play, combining both an involvement with the story and an engagement with the process of playing the game. For the most part the player is embedded within *simulation time* and therefore within the world of the game.

Figure 29. *Tomb Raider Gold* (Core Design Ltd. 1996)

Game engines may also be used to create films in game, described as 'machinima'[12]. The system takes another twist as multiple players perform within customised versions of 3D games such as *Quake II* (Carmack & Willits 1997), and record their actions from the point of view of multiple virtual cameras. These 'recordings' are then edited to form a narrative, and viewed as short films. This process can be seen as a form of hybrid image production or a participatory interactive cinema production model. The realtime output of the game is adapted into an edited animation which shifts it into another timeframe altogether.

12 <www.machinima.com>: Web site documenting films made with digital games (accessed 31st January 2003)

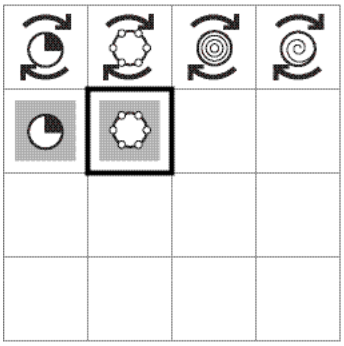
Figure 30. ***Second Life*** **(Linden Lab 2005)**

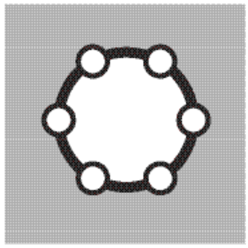
While games like *Tomb Raider* follow a fixed sequence of events within a pre-determined game world, some virtual worlds allow the player to develop their own timeline, manipulate events and generate content. The player is not only embedded in *simulation time*, but they become an active force in the generation of its representation. This is one of the more interesting aspects of *Second Life* (Linden Lab 2005), a virtual world that emulates social and economic models from real life. Within this online environment, players are not limited to chat, playing games and exploring the virtual world. They may also create and sell objects that they make in world, and own land for the purpose of building homes, shops and other structures. They may create animation and computer programs to change the behaviour of the world, and stream audio and video into the world for performance and broadcast. The appearance and layout of *Second Life* is largely determined by its residents—who may spend more time immersed in the simulation than they do in their first, real life. This leads to the construction of elaborate fantasy worlds and surreal environments that are far removed from reality. In these spaces experimental forms of expression have emerged that explore the artificiality of the virtual world and the aesthetics of online avatar performance. Via these varied activities each resident of the world experiences a multitude of different forms of *simulation time,* as they trace their own individual timeline through the simulated world.

While *Second Life* operates in realtime, the frequency of updates the player experiences relates to how often and for how long they log onto the world. Multiple timeframes coexist in the world; each of these is connected to an individual avatar. These avatars may be instantaneously transported to any location in the world; this allows them to shift across multiple threads of activity quickly or to engage in multiple activities at once—such as exploring a place, or chatting with players located somewhere else and altering the appearance of their avatar. The world itself has its own timeline as players build, modify, destroy and populate different zones and spaces. With each return visit to the world something may have changed while the player has been logged off.

Other properties connected to time are related to *simulation time.* The relationship of this to the moment-to-moment time of *experience flow* has been discussed in the previous chapter. While *simulation time* relates to the micro level of time in digital media, *simulation lifespan* relates to its macro level. *System process* typically drives the simulation, generating *simulation time*. As discussed earlier, various modes of time may be generated in digital media. Some of these, such as the realtime experience of gametime, may be easily scaled across various properties related to time. In other more fragmented or asynchronous expressions of time such as web browsing, the links may be less coherent.

6.4 Multiplicity and representation





How a world is seen and heard can be expressed through any possible media, either through emulation or digitisation. Furthermore, the underlying data is separate from the representation and therefore can be mapped in any number of different ways. *Semiotic morphism* describes this process.

A recurring theme in the study of digital media is the universal nature of the computing machine. The computer can take on many different forms and be applied to a range of tasks. This shape shifting can be quite fluid and direct, with the computer 'morphing effortlessly from calculator to spreadsheet to word processor to video-editing console and back again' (Johnson 1997, p. 147).

This separation of data and its expression opens up the possibilities of representation of digital media. The same data may be represented in any number of ways to different players or within various contexts. Data from many sources may be combined or filtered via processes embedded in the system. As a result there is not one definitive representation, but many. While other media may be fluid during their production, they become fixed upon publication. Digital media may remain fluid as it is experienced and this multiplicity that is possible in its representation becomes part of its language.

The new, digital iconography is constructed from the blend of many, many different media. The range of forms that is typical of this iconography needs to be approached in a way that takes into account the forms' heterogeneity. The field of semiotics has been used to analyse the production of meaning in a wide range of media, including the interdisciplinary field of computational semiotics. In relation to this, a cross-disciplinary approach that proposes a formal structure for the analysis and deconstruction of interface and metaphor is Goguen's *algebraic semiotics* (Goguen 1999). The key representation of this approach is *semiotic morphism* (Goguen 1996): the 'systematic translation between sign systems'. In terms of semiotic theory, *semiotic morphism* allows the signified message to be mapped to various signifiers, resulting in a system that generates different instances of semiosis. This strategy reflects the nature of the computer both as a manipulator of language and a computational machine. Three levels of this concept need to be defined and understood: the data structure, the expression of this data, and the processes that operates between data and representation.

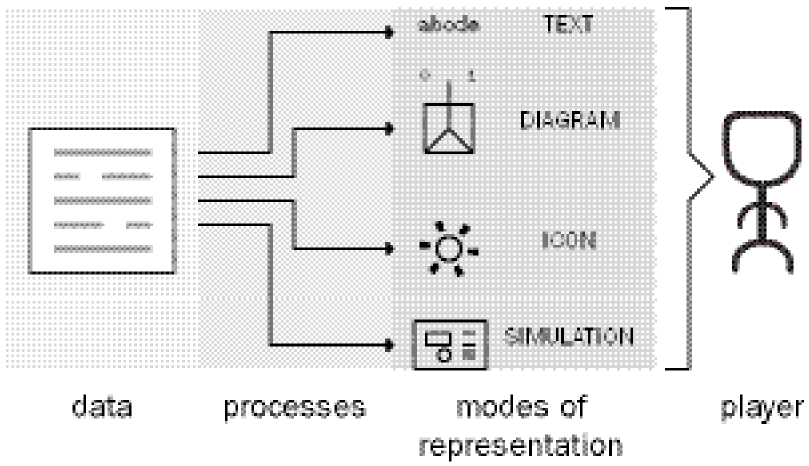


Figure 31. Schematic of the *semiotic morphism* process

In terms of representation within digital media, there are two main ideas to be explored: firstly, systems that allow representation to fluidly shift between different media types or to be blended across media types simultaneously, such as image and sound. These relationships are established either by mapping parameters of one representation to another or via processes that interpret digital data and then translate it into another expression. Mapping may involve specific images that are associated with particular sound files; while interpretation may involve processing the data of an image to create a sound file. Secondly, there is the separation of data and its expression. The underlying system of a game world is defined in code that has both its own internal representation to itself (the data) and its expression (images, sound and animation) to the player. This expression may be modified so as to use a different sign system than the original, without modifying the underlying data. Fig. 31 outlines this process, in which a single body of data is expressed via four different processes into different modes of representation that are each experienced by a player. In terms of the system, nothing appears to have changed—however to the player the meaning of the game world has altered. *Semiotic morphism* demonstrates the variability and mutability of representation in digital media.

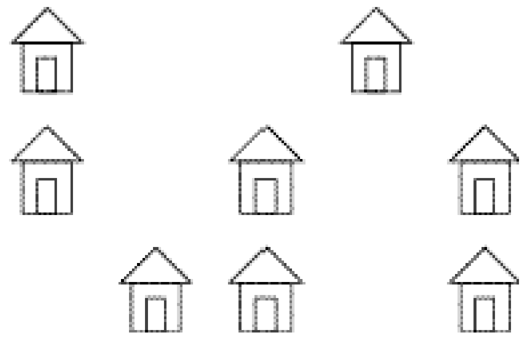


Figure 32. Dynamic icons

Exploring this idea within the context of the iconography of digital media leads to a consideration of how *semiotic morphism* enables multiple meanings to be expressed via a single icon. Dynamic icons with multiple states or agency further extend the idea of the icon being the representation. For example, options on a CD-ROM menu may change depending on context, or to signal that a particular section has been completed. (In this case, the icon itself has a set of states that are triggered by what is going on in around it in other parts of the interface.) This concept is extended further again in the fields of icons seen in video and computer games, where the user navigates a moving set of symbols that represent a game world. In these games the user becomes an icon in the interface (an avatar), and triggers changes in the other icons representing the game system.

Poole analyses *PacMan* in terms of an immersion in signs. This dynamic engagement requires that the representation 'project the active (rather than just the spectating) consciousness into the semiotic realm' (Poole 2000, p. 197). Being absorbed in a digital game means becoming part of the system so that 'for the duration of the game, [the player] lives among signs' (ibid.). By becoming part of the representation of dynamic icons, the player is 'having a conversation with the system on its own terms' (ibid.).

Another classic game, *Galaga* (Namco 1981), offers a similar experience. The player's avatar is a small ship equipped with a laser to destroy an oncoming alien invasion. Colour, form and movement of the alien invaders indicate the place of the player in the game system, and affect their choice of strategy in winning the game. These alien icons assemble in rows at the top of the screen and then fly and spin about, dropping bombs on the player. The player's success depends on both their ability to coordinate their ship using the joystick, and their ability to read the symbolic action of the game system.

Figure 33. Toshio Iwai, *Music Insects,* 1992 and *SimTunes* (Maxis 1996)

Toshio Iwai is a Japanese media artist whose work takes a playful exploratory approach to digital media. *Music Insects* (Iwai 1992) was originally developed as an interactive experience for the San Francisco Exploratorium[13]. The work begins with a blank screen, onto which players may draw or paint coloured pixels. Constantly moving in straight lines about the screen are four ‘music insects’. If one of these walks over a coloured pixel, it plays a musical note. The pitch is determined by the colour and the timbre by the insect itself. The image drawn on screen becomes the music that is played as the music insects walk across the image. Special pixels may be drawn to screen that change the direction of an insect. This allows more complex composition, loops and so on. As the entire system works in realtime the composition may be modified during play. *Music Insects* was subsequently redeveloped as an interactive music game under the name *SimTunes* (Iwai 1996). In this version, a larger screen size is possible as well as a wider range of possible instruments. This work demonstrates the possibilities of synaesthetic media using mapping. In this case the individual pixels of a digital image and their colour values become notes in a musical composition. The end result is musical notation by 8bit bitmap.

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13 My first experience of the work was at the Art Gallery of NSW in Sydney in 1994 as part of the *Nintendo Killed the Video Star* exhibition.

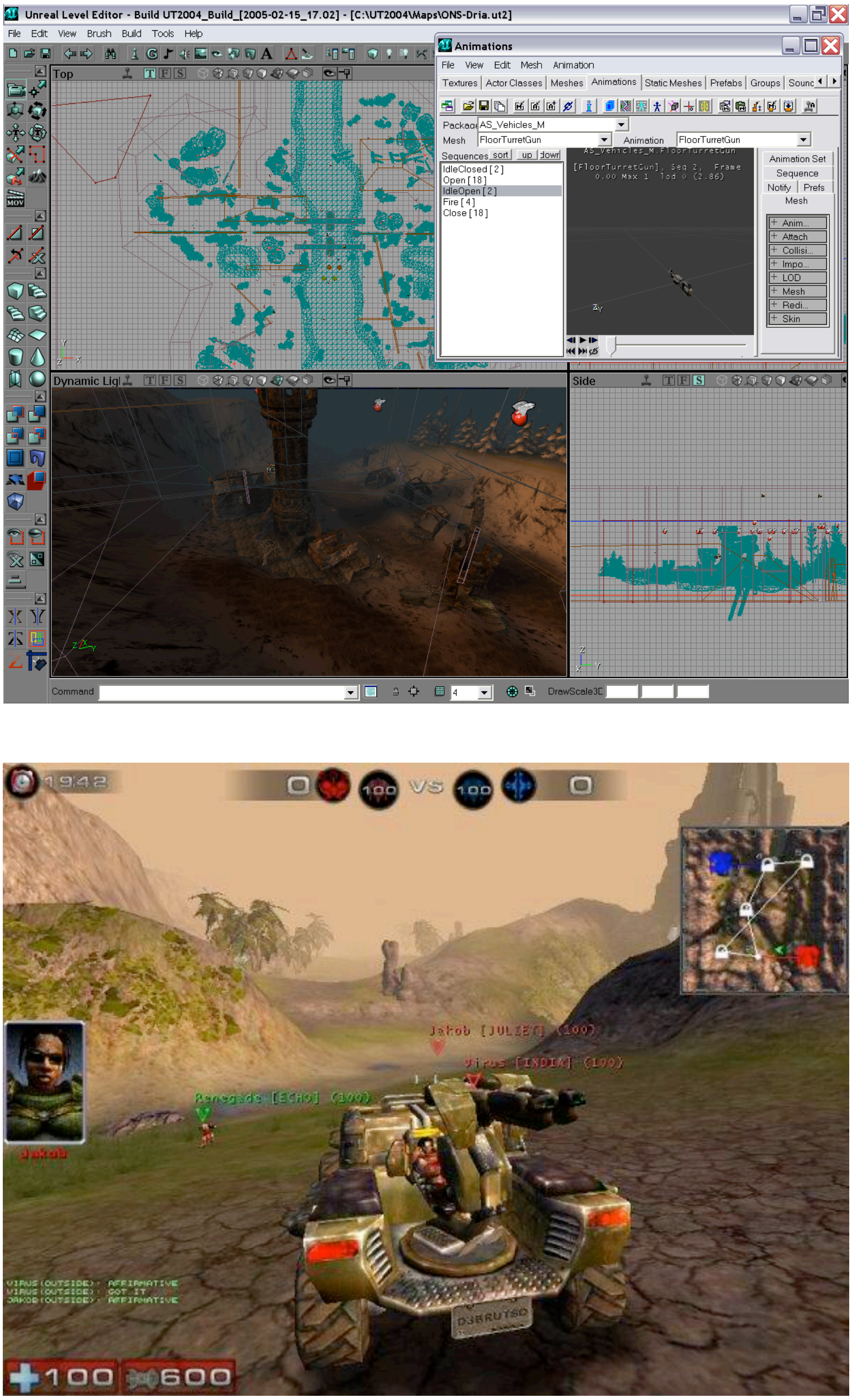
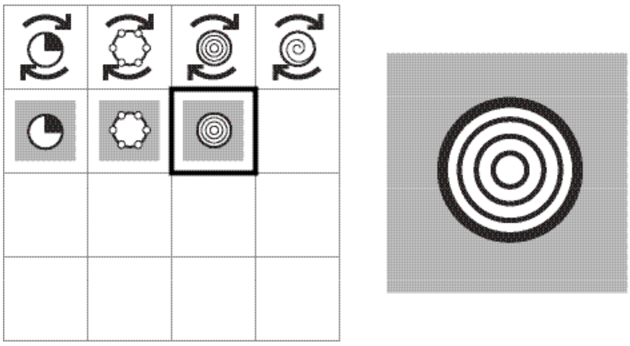


Figure 34. ***Unreal Tournament 2004*** **(Epic Games and Digital Extremes 2004): Images of game editor and in-game action**

The First-Person Shooter (FPS) *Unreal Tournament 2004* (UT2K4) (Epic Games and Digital Extremes 2004) extended earlier versions of the game through the addition of multiplayer vehicular combat situated in beautifully rendered CG environments. It is distributed with software for editing game maps and modifying content. A special edition of the game included video tutorials detailing how to modify players, maps, code and other aspects of the game world. Players have created their own wiki reverse-engineering other elements of the game engine. Through access to the same editing tools used for creating the original game content, they are able to craft their own expressions of the underlying data of UT2K4. This has resulted in many different interpretations of the game world, some of which no longer represent a game at all. It has been used as an architectural visualisation tool (and there is a version of UT2K4 designed specifically for this purpose); for VJ performance (custom maps with particular actions bound to the computer keyboard so that modified content and different rendering schemes can be activated in time to music); for the creation of game art, with for example modifications to the game that use it to tell a personal narrative; and for digital filmmaking or machinima, typically created by fans to expand the fiction of the UT2K4 universe performing stories situated in the established narratives of the game world. The player's relationship to the game world is changed—as they are no longer only playing the game, but also reinterpreting its data by mapping it to different sign systems, and also adding data to the game world by making new structures.

Semiotic morphism is also connected to other properties related to multiplicity. Its connection to *hyper modality* has been covered previously in terms of player experience. In its dependence on solid rules for mapping data, *semiotic morphism* is closely related to *ontological complexity*: the complexity of an ontology and its possible relationships, discussed in the next chapter. To a lesser extent, it is connected to *multi-processing*, introduced in Chapter 8, as this is a measure of how much computation is occurring in a simulation. These relationships depend on where the process of *semiotic morphism* is located – in the user interface, in the production process, or behind the scenes in the code or structure of a world.

6.5 Adaptation and representation



From the broad range of possible expressions possible in digital media, the world or its entities may adapt or reconfigure its representation in response to the player or to any other source of data. Each expression may be parameterised, constructed or generated in realtime. *Adaptive expression* articulates this aspect of representation.

Each instance of a digital media representation is constructed in relation to its environment whereby it communicates on multiple levels simultaneously. A player's avatar, for example, may be read as a highly complex iconographic representation. This is largely because the various elements that go into constructing each representation may interact with one another as well as with the user. The discussion of *semiotic morphism* illustrates that digital iconography is highly variable as it is built from many different media components. This means that representation may be constructed in response to interaction, player profile, context, filters or other settings. Furthermore these may be modified in realtime. Thus the representation becomes something that is negotiated and generated rather than simply presented to the player.

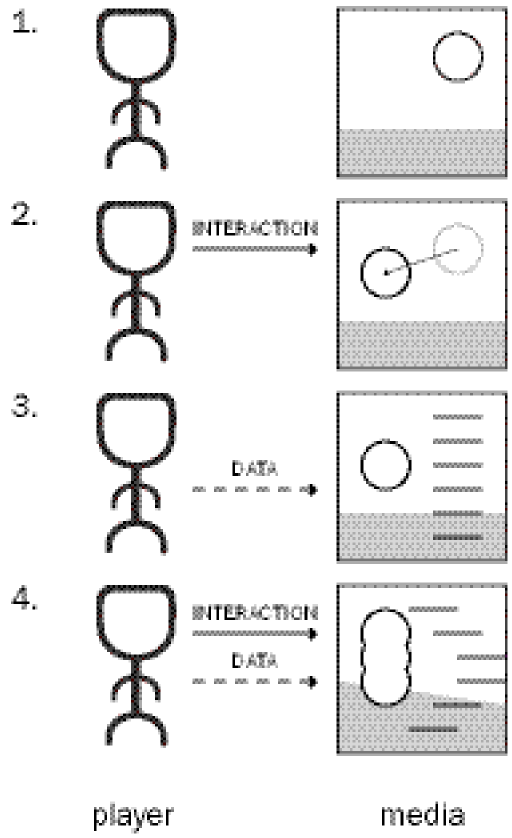


Figure 35. Four-stage sequence depicting the process of *adaptive expression*

The process of *adaptive expression* is illustrated in Fig. 35. A player engages with a world at first via interaction with objects in the world, then by contributing data, and finally via simultaneous processes of interaction and data collection. As a result the world is changed as it adapts its representation to the two streams of input received. *Adaptive expression* has a strong connection with aspects of interaction, particularly *system behaviour* and *transmedia mapping*, in that it is representation generated in response to input. This may be internal input within the system itself or, more typically, the input of players. A GUI, an online avatar or data-driven website all have the potential for *adaptive expression*. In some cases representation may be presented as the system for play—or it may consist of a language, complete with rules of engagement and for its expression. In either case the representation—in this case a simulation or a language—adapts and changes in response to its use.

Online interactive environments are typified by topology that is ‘very complex, often fast-changing, and socially produced’ (Dodge & Kitchin 2001). These worlds take their cue from the mapping and construction of the real world—but are actually built from networks of information. Free from physical or material constraints, a range of inventive representations of space become possible. The artificial nature of this space means that it 'consists of many different media, all of which are constructions; that is, they are not natural but solely the production of their designers' (ibid.). The way these spaces are constructed changes our understanding of the information represented, as 'all maps are designed to either change or reaffirm the way we think about, and comprehend, the data presented' (ibid.).

This suggests that many forms of *adaptive expression* tend to evolve, such as those present in an online community. In these spaces a persistent media artefact is generated over time via the interaction between players, developers, and the constraints and opportunities of the online host. This process mimics the evolution of natural languages that also move through stages and cycles of development (de Landa 1997). Initially, a world is launched with a particular vocabulary. As players become familiar with it, they develop new expressions in that vocabulary. In turn the developers make note of these and include them in an updated version; or they are simply adopted by the online community itself. The adoption of the raid target icons or 'lucky charms' in *World of Warcraft* demonstrate this process. This system consists of eight icons that players may place on targets in game to coordinate strategies in battles involving large groups of players. Originally developed as a mod or add-on by players, they were later included in the official 1.11 patch release for the game by the development team.

Adaptive expression allows the computer to act as more interesting conversational partner (using its own language of course) in exchanges with the user or player. That is, it is constantly constructing new representations in response to the user—in some cases these may be unique and customised to the individual and/or current data. Shifting, adaptive meaning construction is typical of digital media, contrasting with the fixed, didactic modes of other media. By way of example, Lunenfeld (2000) describes image in film as determinative, versus the dubitative image of digital media. As the player enters into dialogue with the system, one or more instances of *adaptive expression* occur via the various systems of representation in digital media.

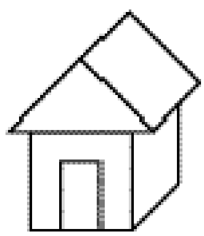


Figure 36. A spatial icon

Icons in an artificial world have a capacity for *adaptive expression.* When extruded into three-dimensional space the icon becomes an object or spatial entity. Spatial icons have further opportunity for mutation and change as other considerations such as multiple viewpoints and relationship to a given space are introduced. In terms of the user's perception the icon can be seen to become more tangible or real through its physicality, and colour and shape have to be considered from another approach. Digital game design often includes systems of three-dimensional icons that take into account the advantages and disadvantages of the space. A three-dimensional model of a given space may serve as map, interface and 3D model simultaneously as the user rotates and activates rooms on the map to zoom into that particular section. Three-dimensional action games often feature highly stylised rotating objects such as power-ups and energy tokens in highly realistic game environments as icons within the game map. The interface is no longer seen as separate to the content, but instead forms part of the content itself.

Tomb Raider (Gard et al. 1996) is set in three-dimensional game worlds that utilise a formal system of three-dimensional icons. The game employs a third person perspective that allows the player's avatar, Lara Croft, to function as an icon. When she gets attacked, she flinches, and when she takes out her guns, her arm moves to lock onto the closest available target. Specific objects in the game world act both as convincing representations of objects in the space, and as icons that indicate a particular function of the system. Her health may be restored by picking up medipacks found lying on the ground, and additional ammunition appears as a pair of clips ready to fit into a pistol or shotgun. However, they are identical each and every time—making them less realistic, but more easily recognised as symbols of the game system. She also interacts with other 3D icons in the space, for example opening doors, pushing blocks out of the way, switching switches and so on. The meaning of these spatial icons comes from their appearance, behaviour, and context in the world.

In contrast, it may be the forms of representation that are adaptive rather than their context in an artificial world. Generative systems are an example of this kind of *adaptive expression* in action. In these systems, software agents or entities defined simply by a string of data are expressed via a process that maps this data into a representation. In this case the process literally takes on a life of its own as it produces content within the defined system. These processes mimic real life, often using metaphors of natural reproduction and mutation. Typically a set of base level primitives will be defined and then endlessly recombined using combinations of simple rules. This idea is extended within the field of genetic programming (Koza 1992) in which these methods are used to write the software itself. It may be possible for new types of logic to emerge, through the process of entities writing software to create another generation of entities, and so on.

A generative system thus consists of rules, processes, building blocks and other elements that are used to create its output. These systems may be used for the generation of images, sounds, structures, spaces, video, animation, the behaviour of entities in a system and so on. Theoretically, any possible configuration of media may be generated within the limits of the elements designed into a particular system. Given the potential to model life processes in digital media, Kelly speculates that, in theory, ‘the Library contains all the forms of life past and life future and even, perhaps, the shape of life present on other planets’ (Kelly 1994, p. 273).

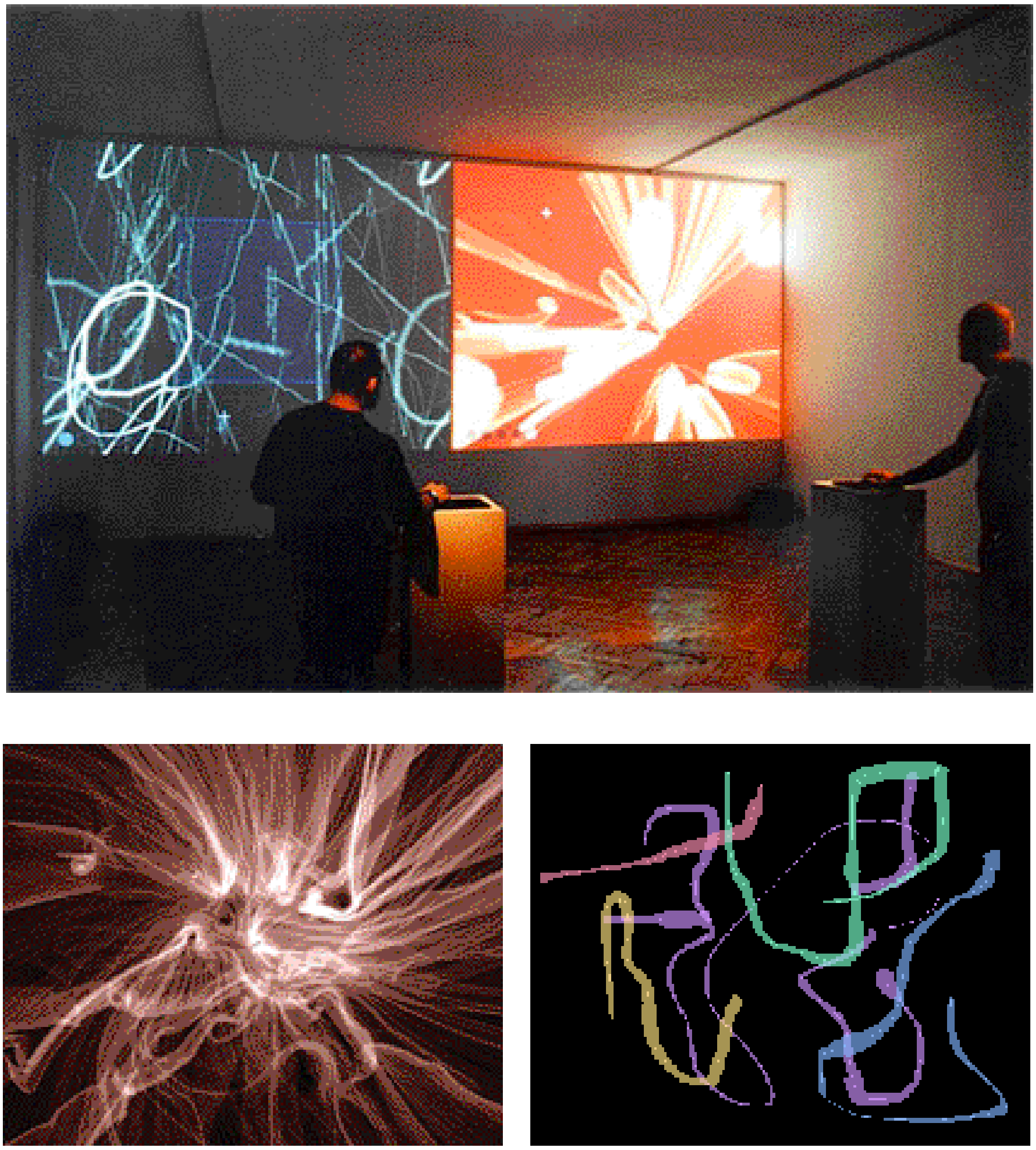
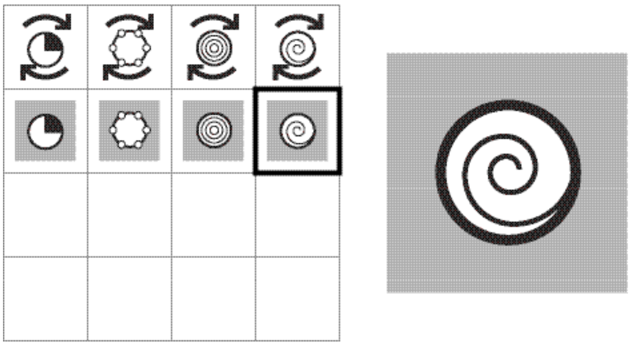


Figure 37. Golan Levin, *AudioVisual Environment Suite* (2000)

Adaptive expression may be highly abstract or very specific. In *AudioVisual Environment Suite* (Levin 2000) gestures performed with a computer mouse are recorded as patterns on the screen, accompanied by a musical score generated from the pattern. The patterns are visually filtered and modified by the computer, resulting in further changes in sound, and the overlapping of a range of gestures. In this work the representation of gestures performed by the player translate to an audio-visual instrument that is flexible and adaptive to many different styles of play. It does not rely on a library of predetermined responses but each composition of animation and sound is uniquely generated from the player's activity. In order to make this work consistently, constraints are placed on this input; aspects such mouse speed, and X and Y position are mapped to parameters such as the appearance of marks on screen and the pitch of the notes played.

Various other properties connected to multiplicity are related to *adaptive expression*. Its connection to *system behaviour* was explored in the previous chapter. There is a direct relationship between the range of possibilities of *adaptive expression* being generated via the flexibility of structure within *meta design*, covered in the next chapter. Some connections exist with *play mechanics*, outlined in Chapter 8, such as the way that entities may alter their behaviour or the rules of a generative system creating image and/or sound, in response to interaction. Once again, these connections may be explicit—in systems that seek to explore mutation, and dynamic forms of digital expression—or, in the case of more conservative forms of digital media or those distributed across a range of media, harder to find.

6.6 Transmutation and representation



Amongst the range of expressions and multitude of media types, there exists a broad range of possible interpretations of the meaning of digital expressions in the world. These expressions are further expanded by the many different contexts that each expression may be experienced within—created by previous events, location in the world or other factors. *Emergent meaning* describes these phenomena.

Within the realm of digital media, the possibilities of fluid transcoding allow for both deliberate and accidental shifts in meaning to occur. Virtual worlds, software art, and VJ systems are examples of these processes in action. Elements such as textures, spaces, icons, movements, colours, animation, and geometry can be mapped to properties of sound such as pitch, tempo, timbre, rhythm, and frequency. This allows the figures and forms to become 'visual instruments' whose actions and movements are played in sequence like music. These sequences consequently create visual constructions that represent the sound and evoke mood and atmosphere.

This points to a key characteristic of digital iconography—its synaesthetic qualities. Rather than viewing the representation as being composed of different media connected by relationships within the process of *adaptive expression* or by instances of *semiotic morphism*, we can see a fusion of media into blended forms. Text-images, image-sounds, sound-spaces, space-texts and so on. The kind of synaesthetic data that is generated by the crossmedia processes inherent in these representations comes to take on another meaning as it gains its own identity. Once identified, these hybrid forms of representation then become part of the digital media alphabet.

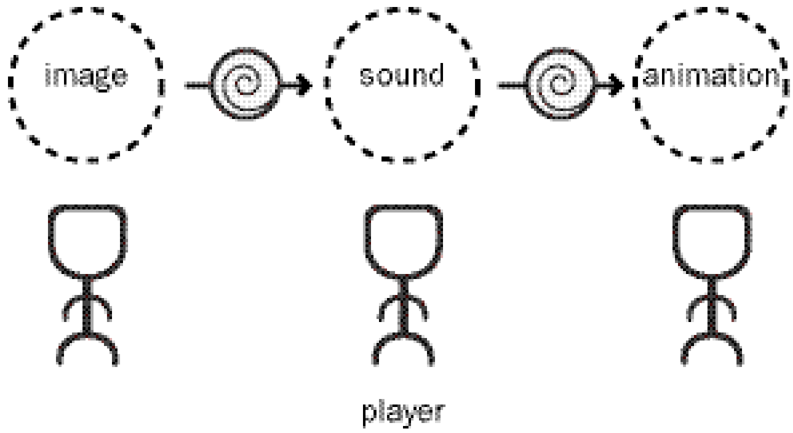


Figure 38. Media transmuted from one form to another, leading to *emergent meaning*

A linear process of media transmutation is depicted in Fig. 38. Image becomes sound which in turn becomes animation, with the player embedded in the process interpreting each new representation as it is generated. These processes of media translation and their interpretation by players can be described as *emergent meaning.* There are two main mechanisms for this that can be explored: firstly, those that facilitate this process largely through internal, systematic processes; and secondly, those that work through a network of distributed connections with other environments, such as the real world.

In the first set of systems, often mechanisms of *adaptive expression* allow the representation to change its appearance, soundtrack and behaviour in response to cumulative feedback from the player. A simple example is a data-driven website that tracks profiles and presents information it has determined to be most relevant to the player, based on their previous visits. A more sophisticated example is a generative artwork that builds a picture of a player's aesthetic preferences in relation to the artwork's output over a period of interaction, thereby subtly performing a process of aesthetic selection. These systems may include evolutionary or generative aspects such as the use of iterative processes and genetic algorithms. These may be combined with a method or function for the interpretation of meaning of the entities evolved by the system—within a representation that encapsulates these characteristics in a coherent, persistent world and enables the interaction of an audience. This process of *emergent meaning* is essentially the construction of digital media expressions (interactions, graphics, sounds) from a base set of units of meaning (the database of media within the work) to adapt to patterns of use by the users or players (the formation of a language within a community).

The second example is largely demonstrated by crossmedia systems that translate play across a range of different media experiences, linking them with a story or other device.

Here, the shifts in meaning occur via these translations and in the juxtapositions that occur at random during the process. By association with the real world, the representation becomes richer in meaning as it draws upon a variety of contexts, other media and so on. Characters and stories that exist across media are commonplace, typically appearing as animated characters, in games, as toys, merchandising and so on. The fictional universe appears to persist across these media within the real world. Some of the ways in which this happens are trivial (updating your blog from your mobile phone may be fun but not life-changing); others carry more significance and potential impact. Virtual worlds have become increasingly embedded within and connected with the real world, via crossmedia communication and pervasive gaming. By way of example, a more meaningful engagement with real life is expressed via Alternate Reality Games in which the game is not only staged across media, but is intended to be indistinguishable from real life itself. Crossmedia links involve characters and stories in which the traversal from one medium is often an integral part of the meaning.

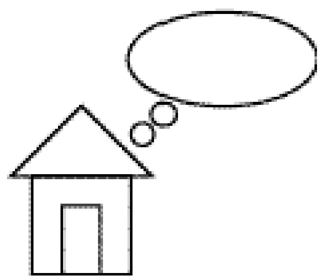


Figure 39. A thinking icon

I now turn to *emergent meaning* within the context of digital media iconography. In more complex digital media systems, thinking icons become possible, with embedded metadata and rule systems that allow them to alter their behaviour to particular interface contexts or states triggered by the user. This can be seen in the development of customised and personalised interfaces that react and adapt to a particular user's profile. Their potential may be extended further by developing grammars for the combination of individual icons to make more complex combinations of meaning. Here the communication system embedded in the GUI becomes much more like a language in the traditional sense of the word. These higher order icon systems are an example of *emergent meaning* in action.

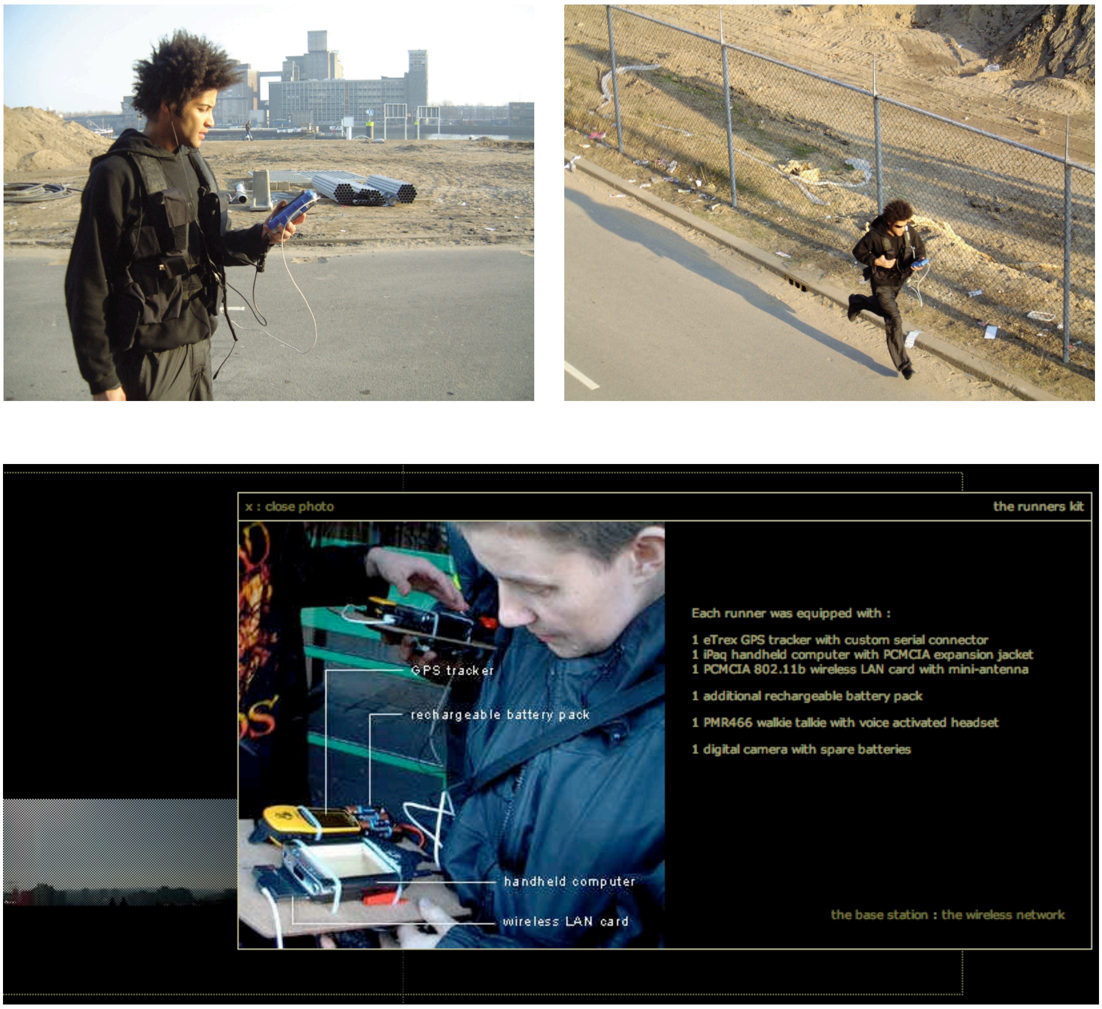


Figure 40. Blast Theory, *Can you see me now?* (2001)

Can you see me now? (Blast Theory 2001) is a location-based game developed by performance group Blast Theory in collaboration with the Mixed Reality Lab. The game connects two different spaces: the real streets of Manchester (or other urban city) and an online simulation of those same spaces. Performers play the role of street players who roam the streets with a PDA equipped with GPS, radio communications, digital cameras and wireless networking. Online players see the street players as if they were bots in a game world and must avoid them as they give chase. The position of the street players is synchronised with the virtual world via GPS – if they intercept an online player then that player is out of the game. Incidentally, a photograph of the location in which they were tagged makes a real connection between the two worlds. In this case, meaning emerges via the system that makes this connection. The game world is given new meaning as it is a representation of a real space with real people running about, and the streetscape is transformed as it literally becomes a game world that is being tracked and monitored using similar processes found in digital game worlds. There is no real intelligence embodied in the system: this emerges through the process of human participation in the game.

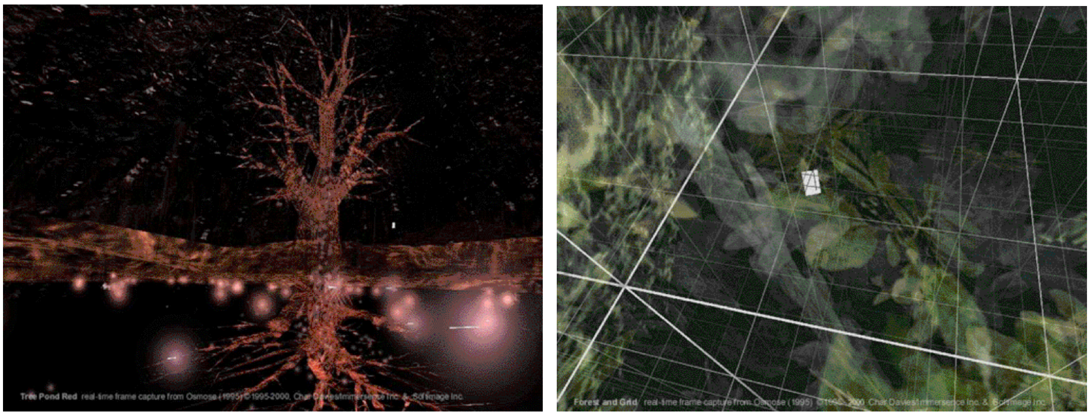


Figure 41. Char Davies, *Osmose*, 1995.

Osmose (Davies 1995) is an artwork that uses VR technology. It was first exhibited in 1995. In the work, the user is immersed in a number of different spaces that poetically express metaphorical themes of nature. These spaces are experienced through a head mounted display depicting a 360-degree stereoscopic view of the space. Multi-dimensional sound is also used by the work, which shifts and changes in response to patterns in user interaction. Interaction with the work occurs via a customised interface that tracks whole body movement and the user's breathing. Breathing in, for example, causes the user to rise upward in the space, while breathing out causes them to fall.

The main focus is the exploration and discovery of the many layers and spaces to the world presented—such as code, text, and natural spaces. Unlike in a game, there is no goal to be achieved or task to be performed; the focus is on the player's experience of being in the virtual world. The world uses soft, translucent forms and multi-layered graphics in the representation of its various spaces. Interaction between the sophisticated body interface and the virtual world result in a degree of gameplay: once the user learns the way the interface works they can use it to move between one space and the next. Through engagement with this system, the player has an experience in which meaning emerges through their exploration. In the player-system relationship the feedback loop can be seen in the way in which their body is connected to the environment, the illusion of the stereoscopic display and spatial soundscape, and the growing familiarity that they have with the artificial world.

Other properties connected to transmutation may be related to *emergent meaning.* Its connection to *transmedia mapping* is explored in the previous chapter. As it relates to shifts in meaning it is closely connected to *recombinant space* (introduced in the next chapter) as meaning is generated both by the different contexts offered by various media and the ways in which these are traversed and constructed. *Evolutionary code* is most closely connected to emergent meaning. By way of example, generative meaning systems may be modelled in software after processes of meaning construction that involve equal input from players and entities. It is in the following types of systems that the links between different modes of transmutation are most apparent, although they may be identified in a wide range of digital media. In a website, for example, meaning may be generated in terms of user tracking or profiling, but this is generally concealed from the player themselves.

6.7 PsyVision

PsyVision (Innocent 1996b), a fifty-minute computer animation, is an experiment with synaesthesia and visual language for eleven tracks of electronic music from the Psy-Harmonics music label. An electronic space is constructed for each track, populated by synthetic forms and animated characters to provide a place or home for the music. Textures, spaces, icons, motion and colour are used to create 'a fusion of iconic figuration and synthetic abstraction towards a language for the visual expression of electronic music' (Innocent 1996b).

Figure 42. Troy Innocent, *PsyVision* (1996)

A range of techniques are combined in *PsyVision*: predominantly animation, visual effects and electronic music. It draws on the language of music video, experiments in abstract film, digital game environments and computer animation. Different viewpoints of an animated electronic space are 'shot' and spliced together so that the virtual space is treated in a similar way to that of a multi-camera shoot on an actual physical set. The animation and sequencing of images become part of the expressive language of the work – equally important to their style and appearance. As a result, a cohesive digital media language of graphic elements such as form, colour and texture is combined with dynamic elements such as camera movement, animation and effects.

While there is no systematic process of *semiotic morphism* in the animation, it does combine many different modes of representation. Various graphic styles and aesthetics are blended into a single experience, as they are easily and readily combined in the digital environment—a space where virtually any type of representation may be blended or transmutated.

The visual language of *PsyVision* develops new iconography that draws upon the natural forms, structure and language of digital media. It explores the nature of electronic space through a deliberately synthetic aesthetic that highlights the plastic surfaces, stark geometries, media morphing, shifts in meaning, and blended realities of this space. In many instances a formal visual language is established comprising abstract symbols, synthetic characters, movements, textures and colours that are given meaning within the constructed space of the animation. In this sense, the space itself becomes a language in that it is constructed specifically to express the sound though a formal system of representation. The intention is not to create a mirror of reality (a common goal of computer animation), but to create imaginative new spaces—that provide a 'natural' place for this music to reside.

PsyVision deliberately explores *emergent meaning* through synaesthetic data, as the figures and forms become 'visual instruments' whose action and motion are played in sequence in a formal relationship to the music. These sequences create visual constructions that represent the sound and evoke mood and atmosphere. The formal language described above relates also to the sound, as features of the music are consistently connected to visual events so that they become a single, coherent audio-visual expression. These relationships range from simple editing techniques and camera motion through to icons representing individual sounds and spaces that express the overall atmosphere of a piece of music.

6.8 Semiomorph

Semiomorph (Innocent 2001a) is a digital game that is situated in a virtual world that morphs and shifts its representation to the player. In this world typical modes of representation—text, diagram, iconography, or simulation—coexist in the virtual space. The visual language of the space is embodied in game objects, avatars and environments that are represented using these various modes. The environment also employs the narrative structure of video and computer games, with rules and goals determining the gameplay:

> The goal of the game is to collect enough energy to create a significant shift in the graphical representation of the world. This is a semiomorph. During play you may shift your mode of representation, which will change the rules of play. You must avoid opposing entities and

blast icons. The relationships within the world can change suddenly through activation of power-ups and muticons (Innocent 2001a).

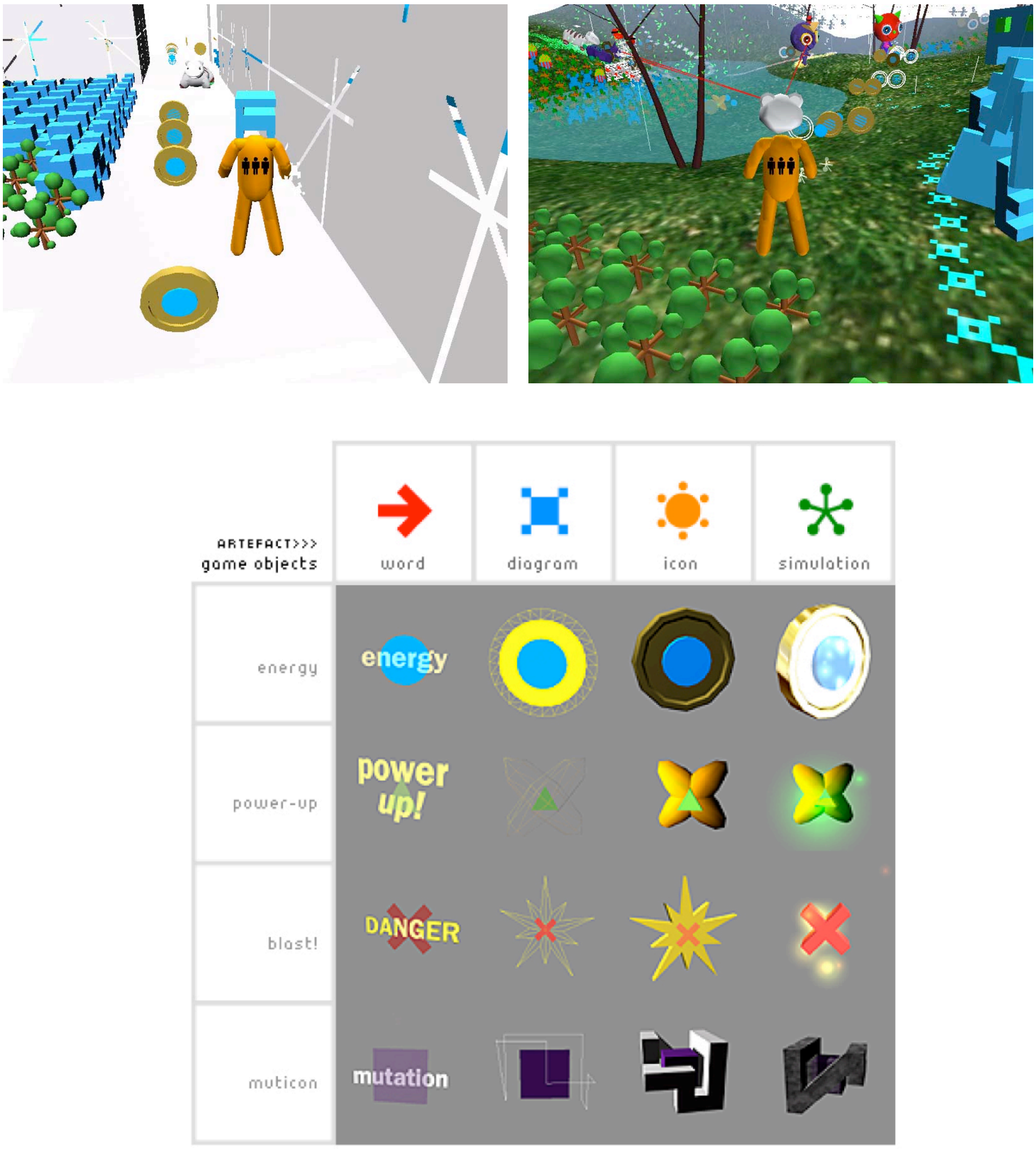


Figure 43. Troy Innocent, *Semiomorph* (2001)

Digital games present a hybrid space that is framed in *simulation time*. Music, sound, animation and cinematic conventions are all blended in games such as *Semiomorph*, in combination with interaction, gameplay and electronic space. Changes in the animation of avatars in the space may be triggered by the dynamics of the gameplay or by the actions of the player. Virtual cameras track and pan through the space as the narrative is generated through the play of the game. Sound effects move about with the avatars and objects they are associated with, providing a three-dimensional sound mix backed by the music and atmospheric soundtrack.

This work explores the expression of *semiotic morphism* through gameplay and the audio-visual language of a game world. A system for switching between the four modes of representation is integrated into the process of displaying each object in the game world. The player also switches between these different modes and as they move about the world they cause the space to shift and change in response to their presence. If the player is in diagram mode, for example, the space and objects around the player switch to a wireframe version. Overall, the game presents a space that is fluid and mutable, blending multiple forms of representation into a single coherent experience.

Semiomorph explores the language of digital games and the *adaptive expression* that this represents. The communication and expression does not come from single images or even sequences of animation and sound, but through the entire representational system of the world itself. The game objects, avatars, textures, sounds and spaces represent the underlying system of gameplay, AI logic, spatial relations and mapping of the game world; as such they embody a significant new form of representation. The behaviour of avatars and logic of the interaction become as important in the communication of the system as the audio-visual content, such as icons, textures, sound and music.

Through this blend of system and representation, another form of *emergent meaning* is expressed. The game system is represented as image and sound – both media are mapped to events in the game so that they occur simultaneously. This allows the game to communicate via the style and type of audio-visual language it uses. *Semiomorph* explores its four modes of representation in both vision and sound—as game objects shift in terms of their appearance, their sound also changes.

6.9 Summary

An overview of developments relating to representational systems within digital media has defined the area, by exploring digital adaptations of existing media and hybridised forms of time-based media. Novel aspects such as audio-visual syntax, data mapping, synaesthesia and digital iconography have been explored to expand the definition of representation. Four key concepts have been explored:

- *simulation time*, the speed and timeframe in which a simulation is situated
- *semiotic morphism*, type and number of mappings between data and its representation

- *adaptive expression*, forms of representation that are generated or that may adapt or change
- *emergent meaning*, meaning generated via shifts across levels of human-computer expression.

Works that experiment with these concepts have been analysed, including a synaesthetic computer animation, and a digital game that connects the representation of an interactive environment with a player via the rules of play.

7 Structure

During the 80s I spent a considerable amount of time wandering the world of Britannia in a series of epic quests. Despite the fact that this world was being represented by a matrix of small, low-resolution icons on the monochrome screen of our Apple //c machine with almost no sound, it still engaged me for long periods of play over many days and nights. A real sense of place was established in the virtual world as my avatar moved, navigated and explored its land and waters. A masterpiece of world design, it enabled the experience of a complex other world that had its own story and, more importantly, rules of existence and ways of being. Being in the *Ultima IV* (Garriott 1985) world involved certain limitations imposed by both game rules and early 80s PC technology, but it was a gripping, compelling experience for the 80s teenager (there were probably many adult players at the time as well). There was a high degree of immersion in the game world—not that I felt I was 'really there' (the holy grail of simulation)—but rather that I was mentally there in the game world. That is to say, the entire system of relationships between the representation of the game—character and monster icons, maps, descriptions of tasks and so on—and the relationships between these—geographical, thematic, visual, linguistic, gameplay-related, etc.—added up to not just a game, but a world.

Ultima IV blended a fantasy world, mapping, role-play, gameplay, visual language and more into a single, tangible form. Although it was a single player experience, the completion of most quests required collaboration with NPCs who would join your party. Items acquired value through their use in the game to access new dungeons or maps. Places became known by the journey required to visit them, the conversations with their inhabitants and their use in the game through items, knowledge and so on. Almost everything was a reference to something else in the game, and the story (and meaning) of the experience would unfold through the ongoing journey of the player. Although the journey is largely predetermined, it is not so much about what you do, but how you do it: the choices made, methods for solving puzzles, mapping the world and so on.

Around the same time, I acquired the expert edition of *Dungeons & Dragons* (Gygax & Arneson 1974) – the classic tabletop role-playing game. This was later upgraded to the *Advanced Dungeons & Dragons* (AD&D) rule-set that specified an entire set of rules and conventions for the construction and play of fantasy worlds. This was another kind of hybrid structure for making a believable alternate world. Thematically and structurally this play was similar to the *Ultima IV* experience, apart from some key differences—it was multi-player, required improvisation (through role-play), and game content could be created by the players. The DM (Dungeon Master) was chiefly responsible for this by devising scenarios and situations to challenge the players. There are some parallels with today's game-mod culture in that many players moved beyond using the sample maps and modules and constructed their own worlds within the defined system. This went as far as the construction of new classes, races, monsters, locations and so on. In fact, the digital game *Neverwinter Nights* (Oster 2002) is based on the same set of rules.

While AD&D had flexibility and played like a performance, *Ultima IV* was able to fit a representation of an entire world into an early-model personal computing machine. Both systems provided a structure for interaction with and representation of a coherent, alternative world. This second point is perhaps the most important. A book or film is able to create a fantasy world for a reader or viewer, but these two games allow you to be in that world or, better still, create it yourself.

7.1 Introduction

Essentially, structure describes the grammar of digital media poetics. It needs to take into account the temporal, interactive and computational nature of digital media, which as demonstrated in previous chapters, introduces both limitations and opportunities. Structure needs to make sense both within the computer (as required to generate, store, manage and represent the system) and to the human player, who will interact, play, manipulate, interpret and experience it. In this context, structure is concerned with identifying what entities exist in the world, their properties and relationships with one another.

A number of general aspects in relation to structure may be identified. These include the way that *non-linearity* allows meaning to be established by associative relationships, such as in hypertext, database and other structures that allow the dynamic, non-linear access to a body of information. The representation of digital media using *spatial metaphors* is typically situated within navigable three-dimensional space using a Cartesian coordinate system. Digital media structure may also be animated over *time*—objects within a space may move, structures may change shape, and pathways established, deleted or reconnected. *Context* is crucial, as the representation of information may change depending on a player's status, their level of access, where they had just come from, or metadata interpreted by the system. The structure itself may have *agency*—causing the structural relationships within digital media to change in relation to factors such as previous interaction, interconnected sources of data or rules for evolution.

Many different structures exist in digital media. Among these are hypertext, the non-linear navigation of linked fragments of text; windows, the dominant metaphor in operating system design; databases, a set of data structures and methods for querying those structures;

virtual worlds, three-dimensional representations of information; computer games, built from rules and systems; networks and virtual communities, information spaces generated through collective activity.

From this list, three major themes emerge: the formal definition of structure as digital data, the experience of that data as a space, and the player's interpretation of that experience over time.

Structure in digital media can be defined on a number of levels. Relationships between discrete elements such as pages and screens are documented using maps that show the possible pathways through a given body of information. These may be realised or constructed as a space. A measure that is typically used in mapping digital media structure is the link. The units being linked may be pages, screens, or rooms. Discrete elements in a given structure may be measured by their relationships. Hyperlinks are often used to link one element to the next, and so may often be used to demonstrate the end of one element and the start of another. As links are relatively easy to make in digital media, any element of a digital media work may be linked to any other element within itself, or in another work. This seemingly simple device has far-reaching implications. It is representative of digital media's non-linearity and random access to information. Put simply, as there are no pages to turn, no tape or film to shuttle back and forth, all elements in a digital media work are immediately accessible and may be recalled at any time. This shift does not only impact on the structure of digital media, but is connected to communication and meaning, as 'discontinuous media permeate our life, they are changing not only our way of thinking, but even our perception of reality' (Holtzman 1994, p. 172). This change is extending into other aspects of culture as we grow to expect the 'freedom to jump in a discontinuous fashion, from idea to idea, independent of the constraints of space and time' (ibid.).

Spatial models in digital media enable a unique combination of perception and cognition, as they enable the direct experience of data in a simulated space. This immersive experience can result in a high level of player engagement. It can also contradict our previous understandings of both reality and space. Heim describes this contradiction by saying 'there is a sense in which any simulation makes something seem real that in fact is not' (Heim 1993, pp. 108-9). This demonstrates the significance of VR as a means to make structure tangible and perceptible. We are familiar with the idea of navigating space through our own day-to-day experience of the world. Anders (1999) provides some useful insights into the way that we perceive space by measuring experience in terms of perception and cognition, reality and abstraction. Immersion in an artificial space creates a sense of place that is associated with the information or experience embodied within it. It implies our whole body, not only our hands and eyes, and often involves special interfaces that track gestures and movement. In understanding how to design and create artificial spaces, languages of architecture and environmental design may be considered as starting points for new strategies specific to electronic space, as much as multimedia design and animation.

Spatial metaphors apply to other forms of media, such as writing (staging of a narrative across a series of locations); sound (ambience and the creation of sound environments); cinema (the movement of a camera about a constructed space); and painting (in its use of perspective in the representation of space). As digital media includes all of these elements, the established conventions of spatial metaphors are often applied in the new context of digital media. Remediation (Bolter & Grusin 1999), the process of interpreting existing media spaces and structures into digital media, articulates the ways in which this changes existing relationships. New rules come into play that affect the elements of an interface on screen, conventions on the placement of objects in a virtual world, patterns in the reactions of a game, and the combination of sound and music. Manovich has suggested that the use of 'space as medium' (Manovich 1998b) or navigable space is unique to digital media. As the structure becomes interactive and navigable, this process becomes as important as the space itself.

Interconnectivity adds another layer of complexity. Connections can not only be made between elements within one particular digital media work, but these connections may extend outside the work and virtually connect to any other work. The common hyperlink is the site of 'something profound happening at the level of language' (Johnson 1997, pp. 110-1) that 'suggests a whole new grammar of possibilities, a new way of writing and telling stories' (ibid.). Each player's journey through a spatial construct of digital media structure generates a sequence of events that may be read as a narrative. In summary, data is mapped into a spatial representation and the player's navigation and interaction with that space generates their experience and understanding of the underlying data.

This brings us back to the ontological framework of entities, categories, and relationships introduced in Chapter 4. Essentially, 'a system is a set of things that affect one another within an environment to form a larger pattern that is different from any of the individual parts' (Salen & Zimmerman 2003, p. 50). All of these elements may be identified in the systems generating the underlying code. The virtual world provides the materiality in which ontology may be perceived and experienced. So, while structure is expressed as code, its expression as a world must also be considered, as this is how the player experiences it. An understanding of structure needs to take into account the human and machine point of view in equal parts, as well as the processes that generate structure.

It is important to note the dynamic and generative aspects of structure. Common patterns in the self-directed processes of matter and energy in geological, biological and linguistic systems are observed by de Landa. While each system operates in a different timeframe and has its own materiality, he identifies a number of ‘abstract machines’ and uses them to explore ‘the idea that different structure-generating processes that result in meshworks and hierarchies may also account for the systematicity that defines and distinguishes every language’ (de Landa 1997, p. 185). Furthermore, as each virtual world may have its own unique ontology to be experienced by players, it follows that each experience represents one possible world. This idea is explored in the theory of possible worlds: ‘a formal model developed by logicians for the purposes of defining the semantics of modal operators—primarily those of necessity and possibility’ (Ryan 1991, p. 3)—essentially a model for analysing ontologies in digital media. In these systems ‘the relations among worlds of the narrative system are not static, but change from state to state’ (ibid. p. 119). Juul notes that the ‘worlds that video games project are often ontologically unstable, but the rules of the video games are very stable’ (Juul 2005, p. 200). He highlights the perception of ontologies in games, in that while in code they are necessarily concrete and specific to the player, they appear to be mutable and fluid. The rules of the game world can change in ways the real world cannot: it is ‘half-real’.

7.2 Structure in practice

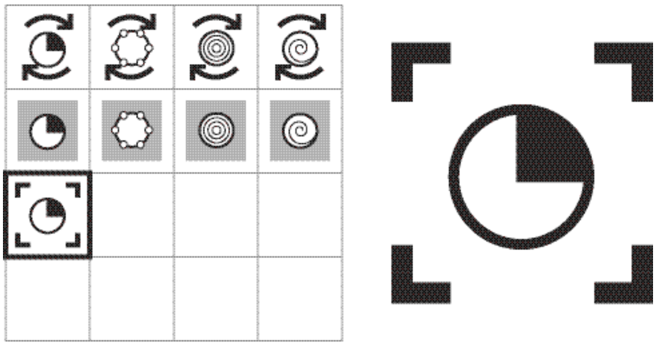
Each world functions as index, an interface and digital media ontology. The construction of an artificial world requires the definition of entities, categories and relationships in its data structures and code. By necessity, an ontology is constructed. Although these structures may be concealed, making them tangible and perceptible helps to define the world by making apparent its logic and structure. Ontological design then becomes part of the creative process, as many possible worlds may be constructed—each with their own individual meaning embodied within their structure.

Idea-ON>! (Innocent 1992) is an early CD-ROM work that explores part of this idea. It is a ‘database of experience’ made up of a collection of animated characters, minigames, and interactive experiments that are connected via a navigable space. This space is made up of five thematic worlds; the structure of each is designed to reflect their nature as chaotic, organic, hierarchical, totemic and so on. The organisation of the content into this space uses these worlds as categories, and within each one arranges them in relationship to one another. The space is the database, which the player moves through in order to access its content.

This approach to the construction of an ontology to define an artificial world is explored further in *Iconica* (Innocent 1998). The final work is preceded by two earlier iterations: *Memespace* (Innocent 1997a) and *Memetic Mutation (Innocent 1997b)*—each of which is ontologically different, representing stages in the design. Each of the three versions is a variation on the possible world that is defined by the alife model on which the world is based. Each iteration refines the model. Its final structure comprises elements, forms, entities, spaces and a world. An iconic language, including a grammar that defines relationships between each component, describes this structure. The ontology is embodied in the world, in the code that drives the alife model, and in the language itself.

Firstly, the overall timeframe of an artificial world needs consideration. Does it evolve or have a history? Does it persist over time or different play sessions, or disappear from memory when play is done? Secondly, the scope of the ontology may vary from simple models through to complex simulations. Is the world a simple construct or does it aim to offer a realistic simulation? How is the ontology used to communicate the nature of the world to the player? Thirdly, the ontology of the world may be used as a framework for players to make their own constructions. How flexible are the entities and relationships? Can players modify the world within these constraints? Finally, the design of the world may be expressed in a range of different media. How well does it map across these other expressions? How does its meaning shift in the process?

7.3 Time and structure



Although initially defined simply as a data structure, each world and its ontology must be expressed as a media artefact to be experienced by the player. These artefacts need to be defined as existing somewhere at sometime – they need to come into being, exist and, most likely, eventually disappear. *Simulation lifespan* describes the lifetime of a world.

As the grammar of a poetics of digital media, the structure of a *simulation lifespan* governs both the construction of its expressions and how their relationships over time unfold: when they should occur, who they address, and how they will be delivered. These expressions are located in space, either metaphorically as references to code in the system, or literally if they are situated within a virtual world. Either way, structure unfolds, grows, evolves and mutates over time in relation to internal system forces, player interaction, or a combination of both. We can call this the *simulation lifespan* of a digital media work.

There are three ways in which time is used to govern structure, relating to different dimensions of that structure: firstly, the timeline of a work itself that may be of fixed duration, open-ended, episodic and so on; secondly, the way that time provides a structure for those playing or using a work; thirdly, the lifetime of a work that includes its evolution and change through updates and editing.

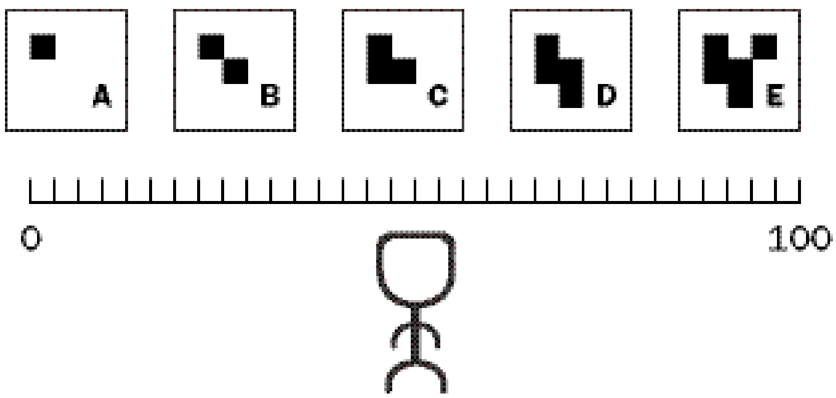


Figure 44. *Simulation lifespan*: timeline of a work

In Fig. 44, the timeline of a work is depicted as a series of changes in its structure over time. The timeline is the overall plan or map of a *simulation lifespan*. Different types of digital media will use this timeline in different ways. A persistent world has an ongoing timeline into which players drop in and out as the 'world time' unfolds. World events may have a beginning and an end, individual characters may stay the same, but the overall world will keep going for days, months – even years. This kind of *simulation lifespan* is different to that of the typical arcade or action game that may be played out over minutes or hours, although games played at home typically include 'save points' to allow the game to play out over a number of sessions. Still, the game experience has a definite beginning and end with various stages inbetween that are controlled by a game designer. Some players may take longer than others to complete a level, but the same structure is still played out through the participation of the player—unlike the virtual world, it does not have a life of its own. Experienced players demonstrate their knowledge of specific game levels by performing and recording a speedrun which involves the completion of the level in the shortest amount of time with the highest score, without taking any damage or other additional criteria. This tests the limits of temporality in a game structure. Another alternate *simulation lifespan* may be seen in virtual pets such as the Tamagotchi, in which short sessions of play are paced over an extended period of time that corresponds to the lifecycle of the artificial lifeform. Other projects, such as the typical website, have no internal timeframe at all and their *simulation lifespan* is entirely a function of the manner and speed at which a user browses their contents.

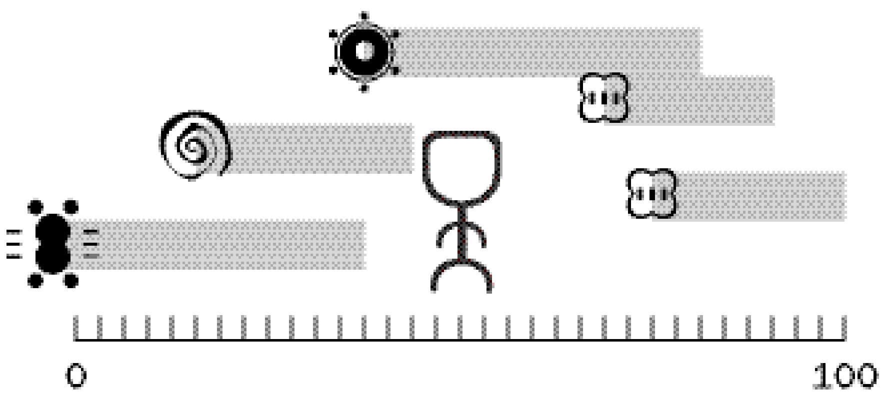


Figure 45. *Simulation lifespan*: time limits in a work

In Fig. 45 different objects (represented as abstract icons) appear and disappear in a work over time so that they exist for a specific duration or lifetime. This aspect of *simulation lifespan* relates to the way in which time is used to govern structure through time limits, the pacing of dynamic content, and the relationship of the passage of time to the structure itself.

Time limits are typically used in games to provide a challenge for players or as a way to test skill by measuring how quickly a level may be completed or the maximum score gained within a given period of time. Power-ups, such the power pill in *PacMan* that allows him to turn around and eat the ghosts, only apply for a limited time. In contrast, the momentary removal of interactivity so that an animation or movie clip may be viewed with its own internal *simulation lifespan* shifts the pace from that set by user interaction to that of the video or animation. In some cases, this can be disruptive to the player experience and so must be treated with sensitivity. However, an in-game video as reward after some particularly intense end-of-level action is effective, as the player is given a break from interaction to watch the progression of the game's narrative (if there is one). Alternately, a work may encourage the player to lose track of time – to get lost in the process. In this case, time limits and rules do not apply and the player is allowed to engage in a state of free play in a space that has an infinite timeline.

Pacing may also relate to the way in which content is accessed. The player may access a large-scale database (that is too big to view all at once) in tiny chunks suitable for consumption. A well-balanced hypertext document is structured in this way so that individual links become the device for pacing the *simulation lifespan,* as the user jumps from one chunk of information to the next. In some cases, there may be no time limits or apparent pacing of the content – staring at a screensaver, for example, may be an activity that has no apparent end. Finally, the *simulation lifespan* may have its own dynamic processes that relate to the passage of time. These may include the simulation of growth or aging, an internal sequence of events, or changes in an environment such as weather and other natural phenomena.

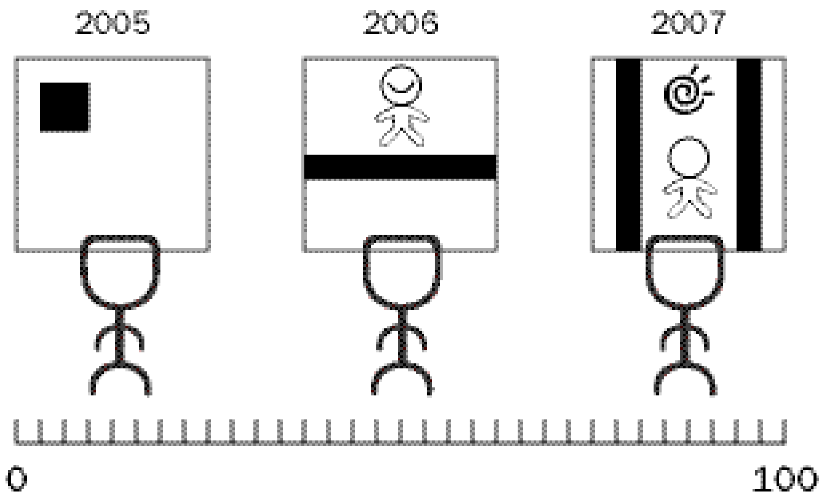


Figure 46. *Simulation lifespan*: evolution of a work

We can also think about *simulation lifespan* in terms of the lifetime of a work. Various iterations or versions of a work that appear over a three-year period are illustrated in Fig. 46. Some works are fixed – players may take different journeys through the content and pace that journey in different ways, but the structure is more or less always the same. Games published on disc for consoles typically feature this kind of lifetime. An online database is different. The method of accessing the database may be identical in most cases, but the content will change over time. It may start with few entries and expand to include thousands at a later date. At some point the database may fall into disuse, or cease to be maintained and subsequently die. A similar example is a blog that is dependent on the efforts of authors and readers to participate in its creation. Over time it will build an audience, grow in size, and usually it will eventually decline in activity and either cease to exist or remain frozen in time when the author and audience activity ceases. In all these cases, there is lifetime to the work that also helps shape its *simulation lifespan*.

So, there are three major aspects to consider in relation to *simulation lifespan*: the timeline of the experience; the way in which time is used to control or stage events in that timeline; and the lifetime of the work itself.

Figure 47. *World of Warcraft* (Blizzard Entertainment 2004)

Time plays a major role in the MMO *World of Warcraft* or *WoW* (Pardo, Kaplan & Chilton 2004). Multiple threads to *simulation time* can be observed in this virtual world—related to navigation, character development, upgrades and patches, and its online community. First of all, there is the size and scope of the game space. Getting from one place to the next takes time and there are few short cuts, and so it feels more like a 'real' space. The player is not able to experience this entire space at one time, or even perhaps over the duration of a week, as access to many areas is limited by the stage they are at in the game. This aspect of character development introduces another major element in relation to *simulation time*. Gaining enough game experience to reach the top level to the next takes a lot of time—weeks or months, perhaps years for some. The player's character persists throughout their time in the world and becomes the primary measure of progress and development.

While this remains the main focus for the player, the world around them continues to change. Sometimes, these changes are subtle patches to fix bugs in the code or glitches in the world. In addition, however, there are updates that change some aspect of the world or the game rules, or that introduce new content. Once these have been installed, the old version of the world is gone. Each update establishes a new iteration of the persistent world. This is in part driven by another timeline running externally to the world via the online community. An external commentary of the events in world takes place outside the game and feeds into its development and growth. These structures are also reflected in world via guilds and other social structures that perhaps have the most volatile timeline of all. They are not governed by many system rules but primarily on agreement between all players participating. As a persistent world it is structured around creating a suitable model of *simulation time* for the participation of thousands of players at a time on the many levels described. Although this world is believable, it is not realistic. As the game tasks or quests in the game need to be repeatable by every new player, very little changes in the game environment; while the player's character progresses by achieving a quest, the same task such as 'kill the local troll' will still need to be done the next day. However, the illusion of a persistent world is such that this does not concern most players.

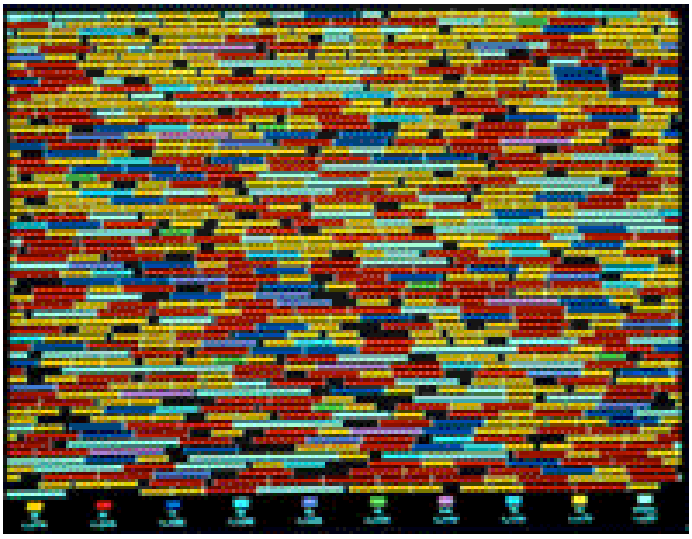
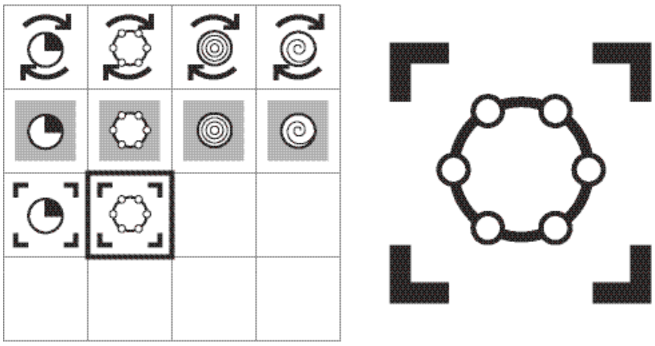


Figure 48. Tom Ray, *Tierra* (1992): programs represented as coloured strips

Tom Ray's software, *Tierra* (1992) demonstrates the potential of using data as the basis of alife in a simple world. Tierra visualises a collection of programs competing with one another for resources in their operating environment, hosted by a virtual computer. If one of the programs is unsuccessful it dies; if it succeeds it will go on to reproduce offspring, resulting in an ongoing cycle of activity. The programs begin as random sequences of code, but as the system evolves and successful programs emerge, the later programs become better adapted to the particular instance of the Tierra world. In terms of *simulation time* the work builds its own history, as each iteration of the world is a cumulative result of the previous events within the simulation. Patterns emerge over the course of the simulation as particular lifeforms begin to dominate and then die off, to be replaced by others. This process can continue indefinitely as there is no final endpoint to the process (unless there is a mass extinction). The simulation generates its own timeline from the dynamics of the interactions and relationships that emerge from its evolution.

Simulation lifespan is also related to other properties connected to time. *Experience flow* and *simulation time* have been discussed in previous chapters. *Simulation lifespan* is connected to *system process*—the loop, cycle or processes in a world—in that the lifespan of a simulation is the cumulation of many computational processes over time. They generate the simulation. As the *simulation lifespan* is the overarching structure of a digital media work it also relates to properties such as *meta design*—the flexibility of structure—and *evolutionary code*: the capacity for programs to evolve over time.

7.4 Multiplicity and structure



Each world needs to be made of something—usually data structures described via entities, categories and relationships. This ontology may describe a simple, stylised model world or may be vastly complex, expressing a complicated, realistic simulation. *Ontological complexity* relates to the scope of the world's ontology.

This origin of this multiplicity can be seen by viewing digital media as essentially a collection of diverse individual media elements that are arranged according to a coherent structural order. This is often referred to as a database, which is essentially a system for storing and categorising data, and perhaps most importantly establishing relationships within that data. Manovich writes at length on the database as a primary structure of digital media, referring to its common use in websites, CD ROMs and computer software that are built from a 'combination of original and stock material such as buttons, images, video and audio sequences, 3-D objects, behaviours' (Manovich 2001, p. 231). The process of constructing digital media involves manipulating the material within this database as a 'narrative is constructed by linking elements of this database in no particular order' (ibid.). In this way the process emphasises the construction of a knowledge system that is embodied in the structure of data itself rather than telling stories or articulating a single idea. This can lead to the generation of ideas and insights through the process of interaction itself: the player generates their own narrative. A system rich in *ontological complexity* has this potential.

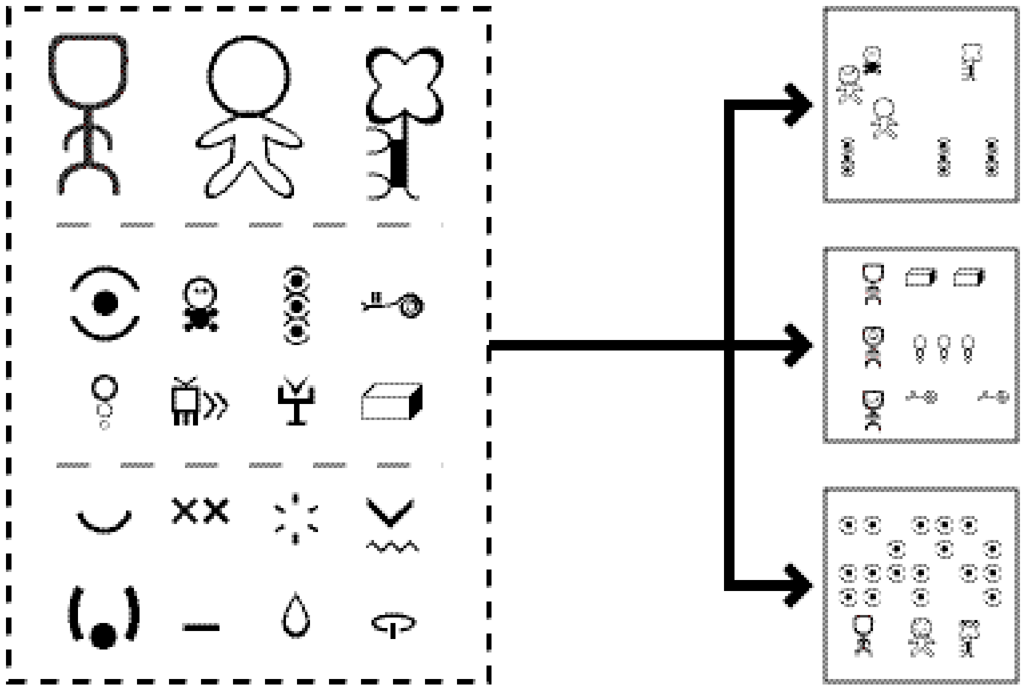


Figure 49. A database and various outputs in digital media exhibiting a high degree of *ontological complexity*

In Fig. 49 a collection of building blocks defines the possible structures within a virtual world. These can then be combined in many different ways to create a range of possible worlds, three of which are depicted on the right. This demonstrates that structure in digital media can display a high degree of multiplicity and complexity. The creation of labyrinthine complex structures creates a compelling experience for the player as they explore and decode the space of the work. Digital games situated in 3D space, such as *Half-Life* (Laidlaw 1998) and *Tomb Raider* (Gard et al. 1996) typically follow this model, as they involve the player in the process of decoding the rules or mapping the space. Even simple systems can generate complexity when operating in parallel or running autonomously over thousands iterations. Digital media left to its own devices will propagate itself like a virus rapidly filling an available mediaspace. The sprawl of the Web is an example of this. Although it may be experienced as complex, multi-layered data, it is typically regulated by familiar patterns and relationships. A useful analogy can be seen in the fractal image where familiar patterns appear at all levels of the image but in each instance the configuration of these patterns is different. This self-similarity in digital data is often generated by the repetition of modular structures and informational patterns, and understanding these structures is useful for organising and accessing information. As mentioned earlier, structure in digital media can defined in terms of entities, categories, and relationships. Through processes of replication and recombination these building blocks can create complex and highly variable fields of data.

If we add to replication the capacity for mutation then viral structures begin to appear. Via mutation, modules of data are able to replicate using alterations to their parameters or logic in order to adapt to changes in their environment, modifications by the user or player or by optimisation. This allows new concepts or ideas to form and then spread via a networked media structure which may occur on many different levels: long chains of ‘copy, paste, edit’ emerge within the domain of media production; via lines of digital distribution; tagging media with metadata; replication of entities in virtual worlds; player behaviour in networked worlds and so on. While it is true that within the digital realm the original source may be flawlessly replicated to infinity this is not necessarily the best approach. Creating systems that allow mutation to occur along the way is much more interesting. The counter to replication is deletion. This may occur via purging processes built into a system, deliberate deletion, or obsolescence. A system for *ontological complexity* will need to take this into account—some systems go as far as building self-deletion of modules into the rules of the world itself. Unlike *emergent meaning* which arises from the conversation between human and computer, *ontological complexity* relates to the internal structures and processes of construction within digital media itself.

Finally, this *ontological complexity* coupled with the twin forces of replication and mutation is capable of generating a high degree of variety—entire virtual worlds in fact. In order to understand their *ontological complexity*, we can look at their ontology and the mechanisms by which a world is built from these elements. This includes the ways in which units of meaning are defined within the structure, how they relate to one another, which of their aspects are able to mutate, the conditions for that mutation, and what triggers replication or deletion. All of these factors are reflected in the kind of world or space that is generated.

Ontological complexity is thus related to the building blocks available for construction and the ways in which the resulting structure is experienced.

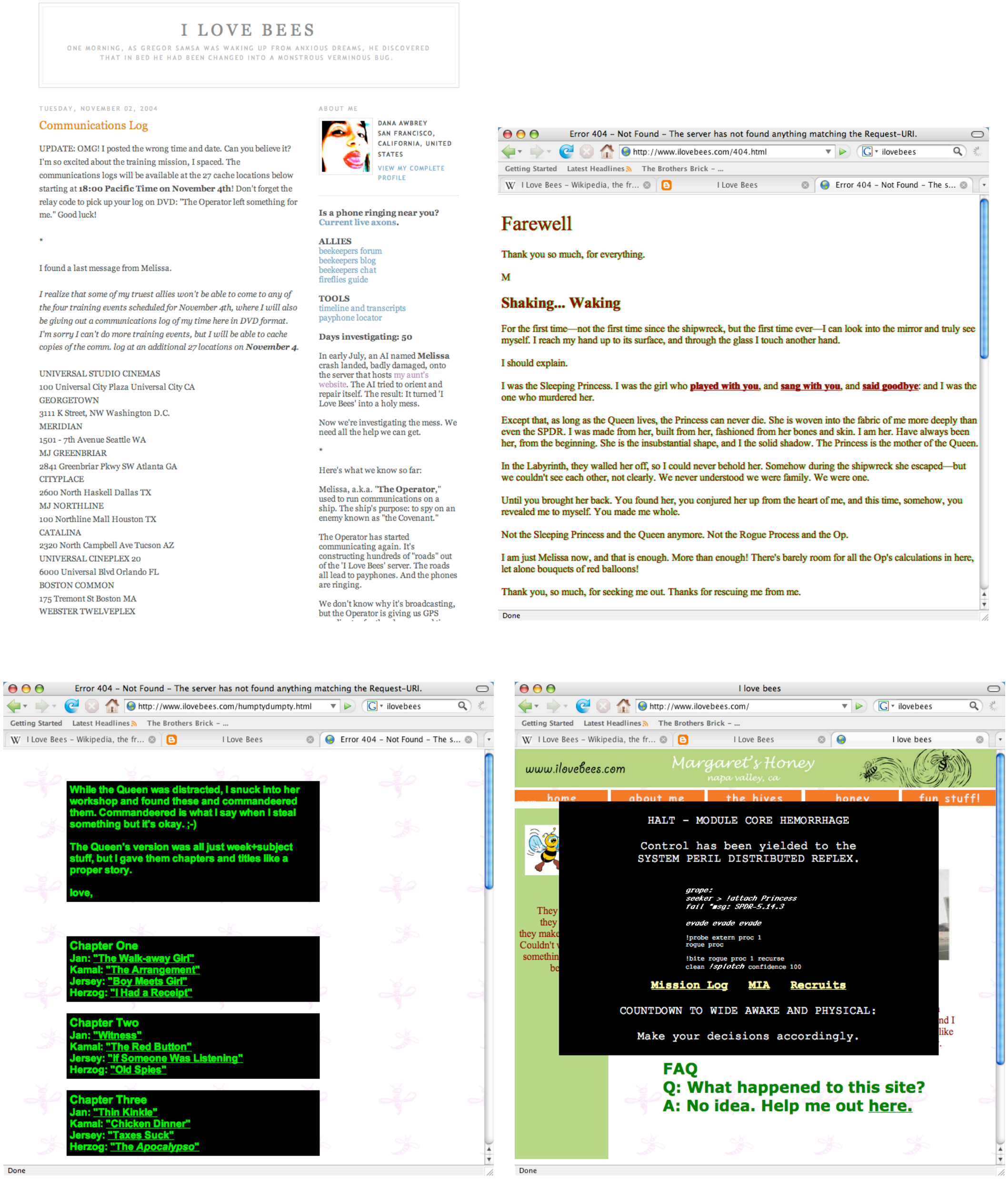


Figure 50. ***ilovebees*** **(42 Entertainment 2004)**

ilovebees (Lee 2004) was an ARG developed to shift the fictional world of Halo 2 into the real world. As a crossmedia game it was played out across a combination of websites, email exchanges, audio messages delivered via public phones and real world locations. Its story revolves around the efforts of a damaged AI to restore itself and tell the story of the human crew under its care. Events in the game are progressed via the collective efforts of its audience who in turn inspire or generate new content.

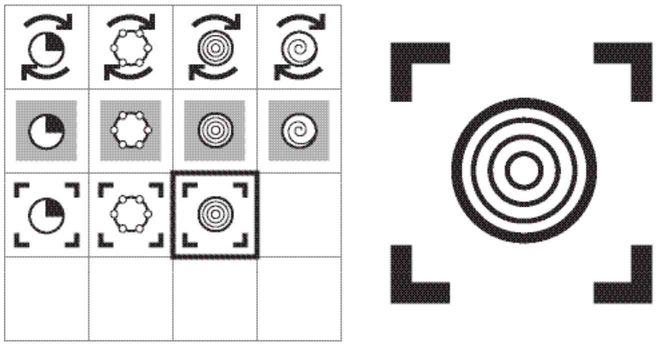
In this game, much of the *ontological complexity* is generated via the shifts that occur between different media and between the fictional universe of Halo and the real world inhabited by the players. These crossovers occur in the work itself, and via its play. It is centred on a bee-keeping website whose server becomes the home of the AI. As the website becomes corrupted by this new presence its webmaster comments on this process via a separate blog page. Meanwhile, the players establish forums and other sites to facilitate the problem-solving process and move onto the next stage of the game. As all of this activity is constructed to appear in defined media forms that are accepted as part of everyday life, these forms inherits a certain authenticity and immediacy that they would not have if they were purely virtual. This shifts the level of the narrative up one layer by placing the blog, the forum or the web movie within the story rather than the story being contained in the blog, forum or web movie. Although it is built from simple components, the end result is complex, as its context is saturated in meaning. This is further heightened by the participatory nature of the game—to find out what happens next requires the players to take action and explore the fictional universe of *ilovebees*.

Figure 51. *Little Big Planet* (Media Molecule 2008)

In *Little Big Planet* (Healey & Smith 2008), a forthcoming game for the Playstation 3, multiple players need to collaboratively solve physics-based puzzles to complete each level of the game. However, they may be inventive about how they do this—there are more than one or two solutions for each scenario. The game world is built from simple objects, materials and relationships between these. These relationships are largely physical aspects such as weight, stickiness and fluidity. Although the basic elements are relatively simple, they may be combined in many different ways to create complex, physically-based game worlds. Experimenting with the characteristics and behaviour of the world around them is the most important aspect of playing the game. It is all about understanding the entities, categories and relationships of an artificial world. Once players get a feel for the *ontological complexity* of this system, they are well equipped to start modelling their own game levels for free play or competition. This may also happen collaboratively and in realtime, as the player's avatar is part of the world being constructed as it is being built. In contrast *ilovebees* presents a different kind of *ontological complexity* in that it is largely based inside the system. The complexity of the game world of *Little Big Planet* is discovered by the player's interaction within it, rather than its interaction with a real world context.

Other properties connected to multiplicity are related to *ontological complexity*. *Hyper modality* and *semiotic morphism* have been discussed in previous chapters. The degree of *ontological complexity* has a simple relationship to *multi-processing* (how many operations occur simultaneously) introduced in the next chapter—in that typically the more complex the ontology the greater number of computational processes it will generate. Other connections may be found with *emergent meaning*—rich ontologies are likely to generate more meaning—and *meta design*—complex ontologies need flexible structures to facilitate their expression. As with other properties, *ontological complexity* may be explicitly represented in a system such as complex game world, or it may be concealed behind an elegant interface design that offers a rich player experience but with the illusion of intuitive interaction.

7.5 Adaptation and structure



The ontology of a world describes a system for its construction and ongoing existence. Worlds may come pre-constructed or may involve the player in their construction – giving them access its components allowing them to build their own. *Meta design* defines this aspect of a world.

Most other media have their structure fixed upon publication, whereas a key difference with digital media is that it can keep changing after the initial publication. This may occur on multiple levels and allow a multitude of experiences as each player finds their own way through the world. Adaptive structure may be an inherent part of the work itself; for example, the experience of the work may be constructed or generated in response to free play. Some structures are more open-ended than others: for example a virtual world that allows exploration compared with a game that is strictly goal-orientated. Feedback loops may be built into the structure of digital media so that it is able to adapt and mutate to patterns of interaction or changing information environments. Relationships may be fluid and subject to change. Adaptive structure in digital media can be described as its *meta design*.

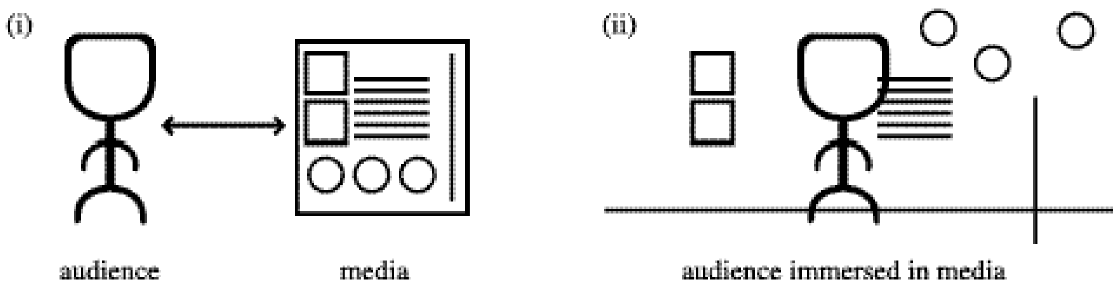


Figure 52. Comparative models of structure: (i) typical model; (ii) *meta design* model

Fig. 52 depicts two different structural models: the first is a traditional model in which the media is fixed and the player is external to the structure, while the second illustrates a *meta design* model in which the player is embedded within the structure and is able to shape and change the media environment. *Meta design* can be identified at three major levels of structure. First, structure can change over time, such as in the ongoing publication of a digital media work. A blog or wiki is a good example of this type of evolving structure. Secondly, the structure may have varying degrees at which it allows *meta design*. Consider a highly structured game environment with strict rules for progression through levels, in comparison to the open-ended play typically experienced in virtual communities and MMOs. The latter is more likely to allow for patterns of play to emerge whose meaning is defined largely by the audience, even if these are formalised later by world developers via updates. Thirdly, the work may include mechanisms for *meta design* within its structure. It may autonomously react to patterns of use, learn from strategies used by players, generate new content in response to the evolution of the work, and so on. This can be seen in media that customise their content in reaction to the player through their individual profile and preferences. Virtual environments that include artificial lifeforms that change and adapt their behaviour in response to their environment (which includes the player) demonstrate a higher level of this activity.

Meaning emerges through processes of play with adaptive structure, either through the discovery of existing relationships within the work, the generation of new relationships, or in some cases both. In many other types of media this fluidity of structure and meaning is only present during the processes of authorship and production, and the structure becomes fixed at the moment of publication. This is the case with a book or film, for example. However, digital media by nature is highly mutable and subject to change. This is not to say that every aspect of a digital media work should shift and change in its operation. During the design process careful consideration of which aspects should be fixed and which should be fluid is needed, as if too many options are available it becomes confusing. In some cases more open structures may assist communication, allowing meaning to be found amongst multi-thread links or data-driven visualisations for example; however in other cases a more traditional linear sequence of events may be more suitable. It depends on the application.

Certainly, there are degrees to which *meta design* may be used as a strategy of digital communication or expression. In all cases what is important is the construction of an environment or system that allows it to occur. This becomes a balancing act between maintaining the overall coherence in the work and being careful not to excessively restrict or limit the fluidity of structure. Too much freedom and it can become a chaotic mess, and likewise if there are too many limits there is no opportunity for any creativity. So, the degree of *meta design* in digital media may be measured in relation to the dynamics of the relationships defined within its structure. Furthermore, there is significance in which relationships are reactive and which are fixed. Making a set of relationships dynamic highlights them as a subject for exploration and experimentation by the player. This invites them to engage in the process of finding their own meaning within the possibilities afforded by the environment.

There are a number of strategies for allowing *meta design* to occur in a work. One strategy, typical of hypertext, is the construction of elaborate labyrinths of information in which users navigate and find their own paths. Another is the embodiment of information within processes of play, such as the exploration of a digital game world. Works may be built from a database of possibilities, allowing users to construct their own assemblages of data according to categories and other definitions. Further possibilities exist in the use of generative systems, multi-agent simulations and alife. These areas are covered in more detail in the next chapter on Algorithm, in addition to the examples explored here.

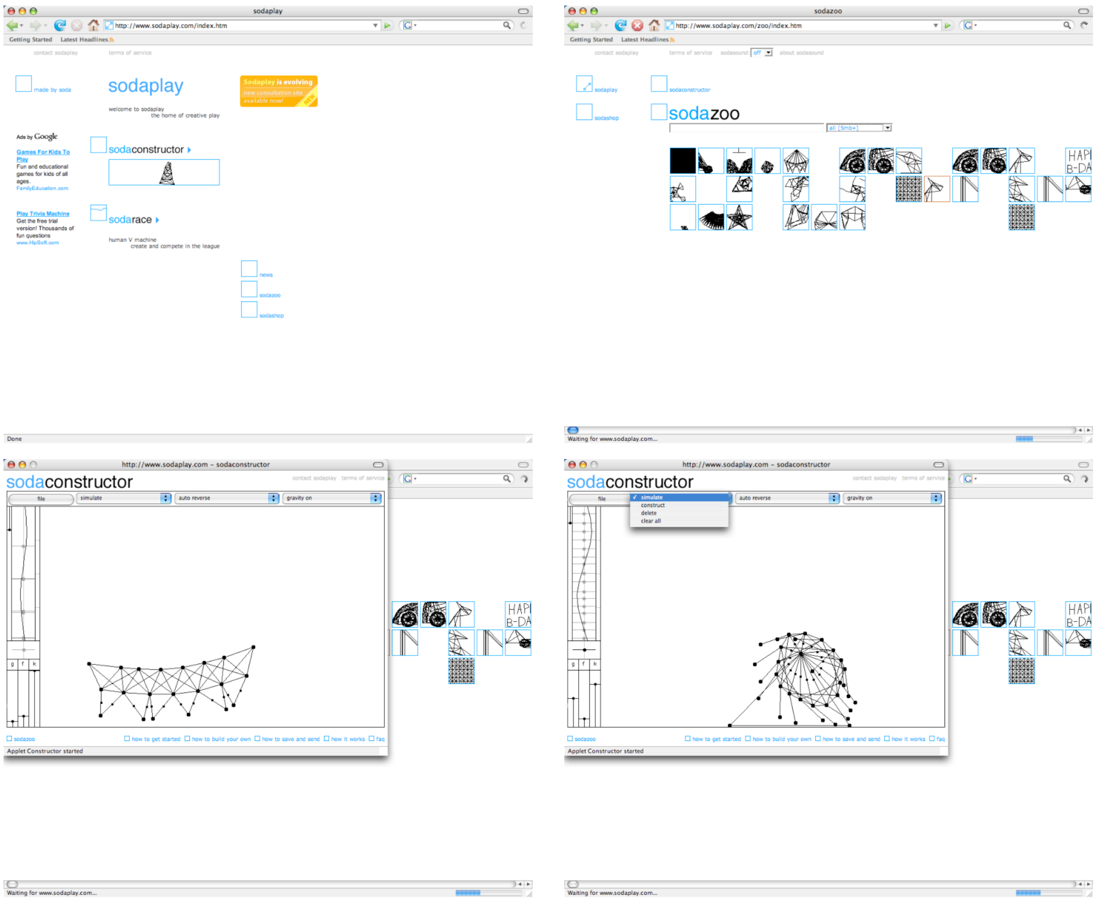


Figure 53. *sodaconstructor* (Soda Creative 2004)

Players may log onto the *sodaconstructor* website (Soda Creative 2004) and build robots and other mechanical creations, then watch them move about a small world. Although they are constructed from a small library of components, a huge number of possible forms may be created, each with their own personality. They may be manipulated directly by stretching, squashing, pushing and pulling various parts of their anatomy as they walk or fly about. The gravity or friction in their world may be modified and this in turn effects their movement. In terms of *meta design*, the building blocks in the system are relatively simple. However, they may be combined in so many different ways that a seemingly infinite number of things may be created. A 'sodazoo' (a collection of forms created using *sodaconstructor*) is hosted at the website that includes past creations that have been saved by visitors. At first, players will interact with the things that may be loaded into the site – pushing them, breaking them, changing the gravity and so on. A deeper understanding of the system is gained by building something using the system – trying to keep it together, get it to move and so on. An important part of the experience of the work is this process of being engaged with the system itself and playing with its possibilities.

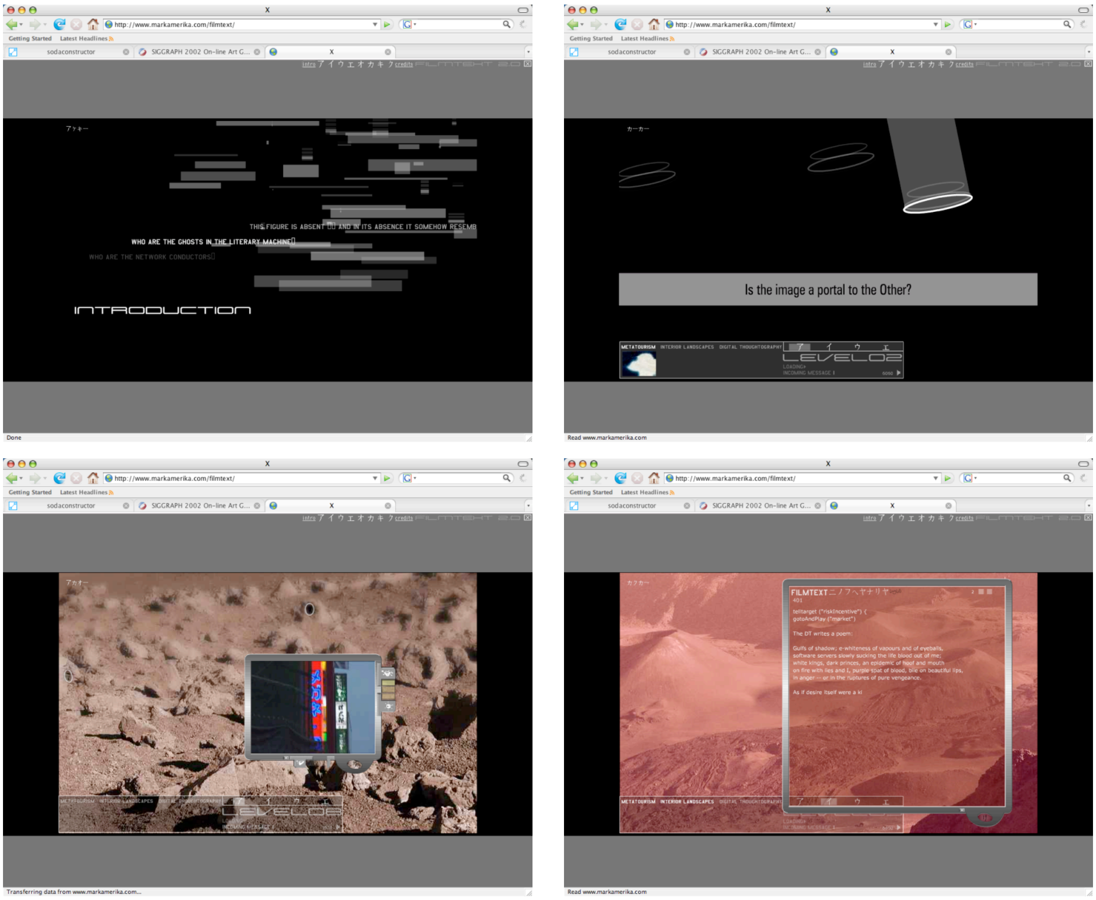


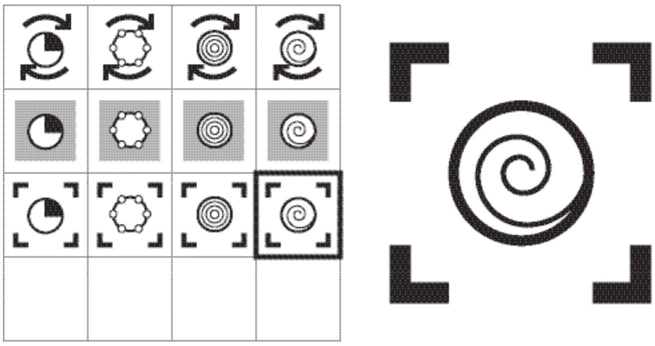
Figure 54. Mark Amerika, *filmtext*, 2002

In contrast, *filmtext* (Amerika 2002)—another online experience, is largely predetermined. However, it is constructed from fragments of text, images and sounds to create a network of associations and connection that may be traversed by the player. Multiple streams of these media are overlaid on top of one another using a data-driven, interactive cinema approach. Its *meta design* enables different texts and images to be collaged and recombined with one another by the player—forming a different path through the multimedial space each time.

However, it is constrained and designed so that this makes sense. There is a particular logic to the connections embedded within the work, and a journey unfolds as the player traverses its space. So while the basic elements of the system are relatively complex, they may be remixed and combined freely by the player—allowing them to construct their own meaning within the flow of image, sound and text.

Various other relationships between *meta design* and other properties connected to adaptation may be identified. Its connection to *system behaviour* and *adaptive expression* has been explored in previous chapters. There is some connection with *play mechanics* in that good *meta design* will facilitate the ways in which entities and world can adapt their behaviour. *Meta design* also relates to *transmedia mapping*—how interaction is mapped to player and/or entity, and *semiotic morphism*—the mapping between data or structure and its representation. *Meta design* can exist on many levels – the structure of a simulated world, the design of a website, or the hybrid of software and hardware embodied in a digital art installation.

7.6 Transmutation and structure



A world is usually designed with a fixed relationship between its ontology and its expression as media, so that they are informed by one another. However, it may be designed to traverse across different media – each version of the world drawing out alternate interpretations of its meaning. *Recombinant space* articulates this aspect of structure.

Digital media is constructed from units of meaning that are connected via relationships determined by its structure. The transmutation of this structure may occur on a number of levels. The first level is demonstrated in the shape changing caused by remapping data. In this case, the overall structure remains largely unchanged and the changes occur in the smaller units of meaning as defined by its structural modularity. The second level can be seen in the nature of electronic space itself. The same data can be recombined in many different ways depending on how that space is constructed: each entity occupies a discrete space within the overall structure and may be connected to that space and other entities in many different ways. This kind of multi-dimensionality can be seen within virtual worlds that have various modes of interaction or representation operating on a level beyond remapping and allowing the recombination of data to transmute its structure—such as the ways in which players create their own maps for existing games or inhabitants of virtual communities such as *Second Life* design and create their own environments. However, this is still only the recombination of data within the space itself. The third level shifts the transmutational processes across media, moving beyond the internal structure. An electronic space or virtual world expressed via this kind of crossmedia transmutation requires that its structure be rebuilt in each instance to adapt to its new media environment. The same message communicated via print media, digital video, a game, website and so on may be linked by the shared context of a fictional world. The structure undergoes transmutation as it shifts across the various media formats and (as such) exhibits a high degree of *recombinant space*.

In this third level *recombinant space* becomes the key factor in governing the communication shifts that occur in a crossmedia ecology. While this space is rich in opportunities for new expression, these shifts need to be tightly controlled and choreographed. Crossmedia communication typically involves interdisciplinary teams and specialist roles to deal with issues such as this traversal across media. In this case the structure plays the role of a persistent world that provides the backbone for storytelling across disparate media, each of which highlight a different aspect of that structure. Some media (typically video or animation) may bring the storytelling to the foreground; some highlight the participatory nature of the experience (such as online components); some emphasise interaction (games and puzzles); or ground the fictional world in the real world (print and locative media). This requires an underlying structure that is both robust and flexible—one that exhibits a manageable level of *recombinant space*.

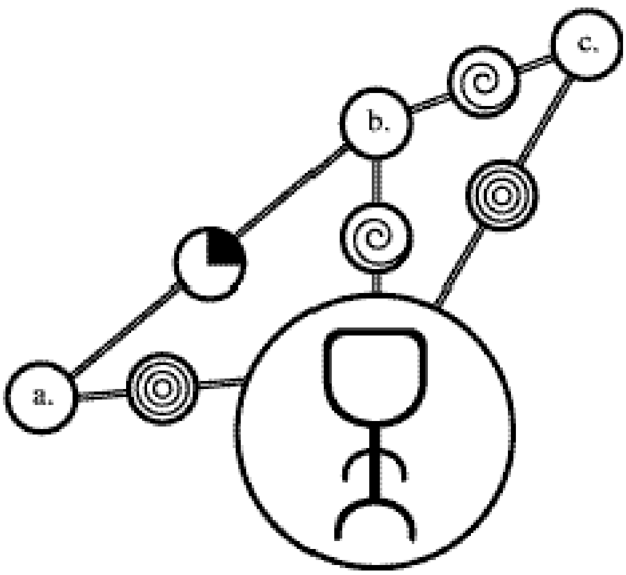


Figure 55. Complex relationships between player and structure, indicating transmutational digital media structure situated in *recombinant space*

A set of relationships between a player and media elements a, b, and c is illustrated in Fig. 55. There is transmutation between the player and element b; and adaptation between the player and elements a and c. A temporal relationship exists between a and b, and another transmutational relationship between b and c. The transmutation of structure may be compared to the mapping that occurs via *semiotic morphism*; however, this process occurs on another level altogether. *Recombinant space* shifts connections in the underlying structure and allows elements to change in other ways, such as duplication, insertion and deletion. The resulting structures amount to changes in the grammatical rules used to construct expressions in the digital media language. In contrast to *meta design*, which relies on structure that is able to react by generating new expressions based on the structural rules embodied in a work, the idea of *recombinant space* lies in the capacity of digital media to also shift these rules themselves and in the fact that the player also participates in these shifts of meaning.

By way of example, consider the expression of a world through not only different modes of representation but also through different media structures. The same world may be described in a body of text, appear as a diagram or map, be expressed as an iconic illustration or be simulated in a spatial representation. In each case there is a need to not only map between different modes of representation, but also to shift between different data structures. This requires a high degree of *recombinant space,* as it involves not only a process of digital media transliteration in switching letters in the 'alphabet' but of translating grammatical structures as well.

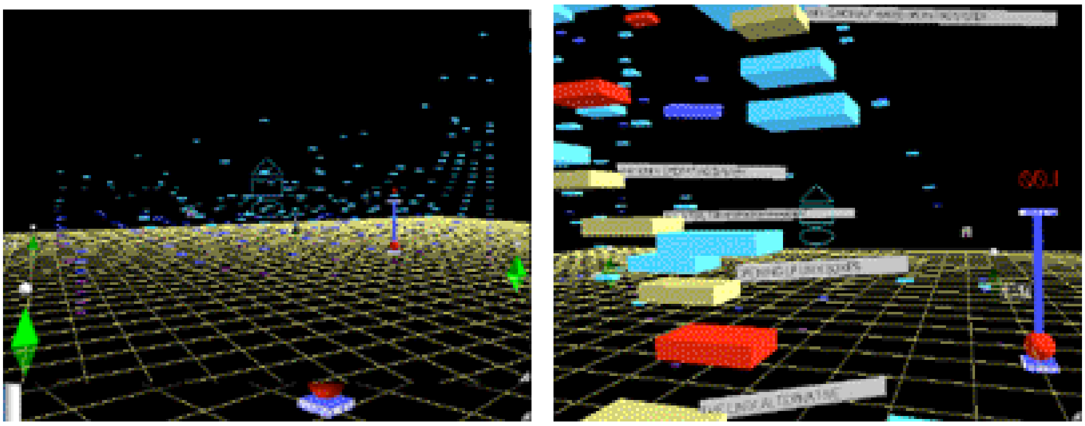


Figure 56. The information space of VRVIBE: an electronic space listed at cybergeography.org

The possible configurations of structure in digital media seem infinite. At the *Cybergeography* (Dodge 2001) website, an Atlas of Cyberspace is a compilation of a diverse range of projects that try to map different regions and aspects of the Web. Categories such as Conceptual, Artistic, Geographic, Cables & Satellites, Traceroutes, Census, Topology, Info Maps, Info Landscapes, Info Spaces, ISP Maps, Weather Maps, Wireless, Website Maps, Surf Maps, MUDs & Virtual Worlds, and Historical demonstrate the range of possible ways to construct and represent space in digital media. Using a combination of information visualisation, traditional mapping techniques, and virtual world design the many examples in this atlas propose different spatial metaphors for representing relationships between data. These places demonstrate the range of possibilities that may be achieved by recombining aspects of electronic space purely within the virtual domain. Novak uses the term 'liquid architecture' to describe the fluid multiplicity of an inhabited electronic space. He describes properties such as implicit time and space, sampling, transmission and genetic poetics as 'the discipline of replacing constants with variables, necessary for good software engineering, leads directly to the idea of liquid architecture' (Novak 1995, p. 43). This idea is demonstrated by the dynamic, transmutational possibilities of digital architecture in which the dimensions of space and time can be made 'variable': in cyberspace they are not constrained to the physical limitations of the real world. In this scenario 'time must now be added to the long list of parameters of which architecture is to function' (ibid. p. 44). Architectural form may be animated, generated by mathematical formula, connected to fields of data, or may adapt to patterns of use.

Figure 57. *The Beast* (Microsoft 2001): Screenshots from the cloudmakers[14] archive

In comparison, *The Beast* (Stewart & Lee 2001) takes a different approach to *recombinant space*. In this ARG, a story was staged over twelve weeks across multiple media establishing a space that blended a fictional universe, game space, online community and real life. Infamously launched via a cryptic reference in the film trailer for the film *A.I.* the

14 <www.cloudmakers.org>: Online archive of content created for The Beast maintained by fans (accessed 27th August, 2007)

game consists of a series of puzzles that must be solved for the collective game to progress. These are distributed across a range of unique websites that are situated in the fictional world of the film, but appear to be real—they each have their own URL, visual style, information, characters and so on. These refer to fictional people, services, organisations and locations. They are not contained within a single location like a digital game or CD-ROM but located across multiple spaces that are embedded within the real world. This context for the game shifts its meaning as it is not a remote location that is visited by the player but an immersive experience that is located all around them. The structure of the game was maintained across this diverse collection of sites, with its distributed content linked via bits of information, characters, events, places and other elements of the fictional world.

Playing the game involved online collaboration with other players via online forums and chat drawing upon a wide range of expertise and knowledge. Solving puzzles would often allow access to new online content, a telephone number to call or changes to the online storyworld. The space of the game was live and changed in response to the collective actions of the players: it was being created as it was played, so that the creative team could shape the experience as it happened. So the experience played out via a combination of streams: media content spanning image, sound, text and animation; situations and contexts that placed these into the context of the player's real life; puzzles and clues that could refer to and recombine any of these two spaces; and a story that reflects on the sentient AI and their role in society. The project was not officially revealed to be a game until the very end – its true nature as fact or fiction remained ambiguous throughout the player's experience.

Other properties connected to transmutation can be related to *recombinant space.* Its connections to *transmedia mapping* and *emergent meaning* have been explored in previous chapters. There is some connection to *evolutionary code*—computer programs that evolve—in that *recombinant space* may provide habitats for these programs to respond to. *Recombinant space* typically requires adaptive expression to accommodate shifts across media and is connected to the shifts of interaction defined by *hyper modality*. The nature of the space may vary from forms such as Alternate Reality Games—where the shifts between different spaces are part of the narrative—to digital games that may blend various levels of simulation and abstraction of reality into one cohesive form.

7.7 Idea-ON>! Database of experience

Idea-ON>! (Innocent 1992) is a CD-ROM typically experienced as an interactive installation. Five virtual worlds, populated by media creatures, knowbots and other mythical information entities, are central to the work. Visiting the *Idea-ON>!* installation can be likened to visiting a sacred site where spirits and myths reside. The information space inside the computer becomes a dreaming or meditational space, a manifestation of the subconscious where the objective contents of thoughts are stored for others to explore and experience or add to if they desire. Similarly to the way pre-linguistic societies had a shared body of myths and legends which made up their perception of the universe, a world like *Idea-ON>!* presents a prototype of a dreamlike, surreal, communal cyberspace in which people dream, create, imagine, and play with thought and form.

An important part of the experience presented in each *Idea-ON>!* world is embedded in their structure and the way the *simulation lifespan* works. Inspired by developments in VR, the content of this 'database of experience' uses spatial metaphors in its interface design. Space itself becomes the interface as interaction occurs directly with world and its contents. The mapping of pathways through each space reflects the nature of each world. In the 'Techno Garden', there are meandering paths through the artificial landscape, within the 'Communication Sphere', the structure is a hierarchical mapping of categories in a three-dimensional menu. It is not only the destination that shapes the experience of the work but also how the user arrives there.

Idea-ON>! presents a 'database of experience': a collection of objects, creatures, animation, sound and spaces that represent an investigation of the natural, endemic forms of electronic space. The *ontological complexity* comes from a database of media, from which the work itself is constructed. Through the navigation of the five worlds (that represent categories in terms of the database) the user searches the database for expressions and experiences that are relevant to them. These spaces are a visualisation of the content of this database of media, with their relationships with one another defined in spatial terms.

Meta design in *Idea-ON>!* is expressed via a media ecology within a coherent world of media creatures and electronic spaces. The worlds themselves are relatively crude in comparison to state-of-the-art VR systems, but the experience is structured so as to provide a continuous journey through this 'other' space. The wordless nature of the space leaves the worlds open to interpretation, placing them in the context of the abstract, symbolic realm of the digital. A sense of engagement is also created through the one-on-one interactions with the entities that populate the worlds. Sound and music play an important role in providing atmosphere and accentuating the events and interaction within the space.

The mazes, gardens and dataclouds of *Idea-ON>!* manifest *recombinant space* in terms of spatial construction and blended representations. Numerous pathways through the spaces are possible, creating different experiences of the work. Many possibilities of the digital realm are suggested by experimentation with the audio-visual representation of cyberspace. The overall structure is labyrinthine, creating a sense of space that is larger than what is actually represented—the mind of the user expands on what is experienced to imagine further dimensions of the worlds of *Idea-ON>!.*

7.8 Memespace, Memetic Mutation & Iconica

In a series of works that explore worlds constructed from language, the potential of the virtual world as an expressive form is developed further. *Memetic Mutation* (Innocent 1997b) and *Memespace* (Innocent 1997a) are prototypes for the development of *Iconica: an artificial world made of language* (Innocent 1998). An audio-visual language maps six different ways of representing reality in the digital realm and uses these modes of representation as the elemental building blocks of the artificial world. The project is typically experienced as an interactive gallery installation, which enables visitors to the installation to interact with an artificial world made of language. The work has the capacity to evolve, change and mutate through human interaction and its own evolutionary process. Visitors to the world can create, construct and manipulate objects, influence the evolution of societies, and discover new language elements. Communication with the residing lifeforms occurs via the iconic language on which the world is based. The multiplicity of *Iconica* is experienced through this interaction: simultaneously a cyberspace, a mindspace, an abstract world, and a stylised reality.

Figure 58. Troy Innocent, *Memetic Mutation* (1997)

The *simulation lifespan* in these worlds is described by the structure of their iconic language which functions simultaneously to define the logic of the simulation and to represent the world. This structure defines the world in terms of elements, forms, entities, spaces and a world. Each space contains entities and forms that are in turn constructed from combinations of the six basic elements of the world. An interconnected set of spaces makes up the artificial world. The first version of the work, *Memetic Mutation*, depicted a pseudo-three-dimensional view of each space that allowed interaction with its forms and entities. In *Memespace* and *Iconica*, a map of the entire world was added that showed an abstract view of all the spaces and their content. In these works direct manipulation is combined with an overview of the current activity in the world. This viewport allowed navigation between spaces: by panning over the artificial landscape, observing the behaviour of entities with one another and with forms representing energy, obstacles, mutations and so on. Individual entities may also be selected for a 'conversation' in this view, which is undertaken in the iconic language of the world itself. The navigation of *Iconica* takes place at both the macro level (through the 'world map') down to the micro level of investigation of individual entities (through 'conversation'), and at levels in between.

The structure of world, space, entity, form and elements comprise the levels of *ontological complexity* from which the worlds of *Iconica* are built. This same hierarchy is reflected in the object-orientated programming of the alife model that generates its behaviour and evolution. As this model is based on language, including grammatical structures, then these also come into play in the way the data is stored and manipulated. The model functions on a number of levels. The most basic level is the units of language themselves that define the range of possible objects, actions and states in the world. These may be combined in new ways, using the grammar to create hybrid meanings and therefore new events or objects. On another level these units are also represented using images and sounds constructed from a collection of media that is sorted into the same categories defined in the database. As new possibilities evolve and emerge in the world, new representations are constructed to display them to the user.

At first, the worlds depicted in these works are opaque and require the active participation of the user to 'crack their code' and understand them on a deeper level. Similarly to the experience of visiting a foreign country where the language and customs are unfamiliar, there is a sense of mystery that invites exploration and engages the user into the process of experimentation and play. As the user learns more about the logic and language particular to these worlds they are drawn in by a sense of involvement. The systems that generate *Iconica* are designed to allow processes of *meta design*. Works such as *Semiomorph* and *lifeSigns* are more immersive in the sense of being illusionary, participatory simulations of a coherent other world or space. In these works the sense of immersion comes from decoding their language and logic; they are also immersive in that they engage active modes of perception.

Evolution and change in the worlds of *Iconica* demonstrate their *recombinant space*. Data is saved in the day-to-day operation of the works, resulting in a 'persistent world': five weeks into the installation the work displays the cumulative results of many iterations of its evolution. The experience of *Iconica* will be different at each visit as the content of spaces change, entities reproduce and die, and new combinations of language evolve in the world. Multiple ways of looking at the same data are enabled by this system as new combinations of media are generated by the world.

7.9 Summary

An understanding of structure in digital media has been established through exploration of major forms such as the electronic space of virtual worlds. The case for an ontological approach is restated and its relationship to the tangible nature of simulation has been outlined, exploring four key concepts:

- *simulation lifespan*, temporal structure in terms of timeline, time limits and lifespan
- *ontological complexity*, complexity of an ontology and its possible relationships
- *meta design*, flexibility of structure in terms of recombination and modular construction
- *recombinant space*, how meaning shifts via spatial manipulation and crossmedia traversal.

Two examples of works that experiment with these concepts have been analysed—*Idea-ON>!*: a work that uses a database of multimedia to explore the possible structures of virtual worlds; and *Iconica*: based on an alife model built from iconographic language to create a world that evolves and changes autonomously.

8 Algorithm

Many years ago, I started learning how to program games in BASIC on a Sharp MZ-700. One of the first games I developed was a simple maze populated by virtual creatures that were programmed to move along a range of different paths. The goal of the game was to move from one side of the screen to the other without colliding with any of the creatures. As they all moved along different paths this involved observation and careful movement of the player's character. Although a simple game it is memorable to me because (first of all) it worked and (secondly) it was a world.

The game used a constructed space that had one or two basic properties, such as movement and collision detection. Virtual creatures that resided in particular zones of the space populated it. When running what was seen on screen was a top-down, two-dimensional view of a world and players can move themselves through it. However, what was most interesting was not the game itself but the process involved in its construction. Writing code and then seeing it manifest an interactive world for the first time was an inspiring experience. It made me realise that imagined worlds and situations cannot only be represented, but can be simulated and experienced. Furthermore, they may be endlessly modified and translated as part of the process of construction. The coder can literally make worlds.

8.1 Introduction

Digital media can encode many different types of information into streams of binary information and blend them into a single, coherent experience. While it is particularly well suited to this task, it is not the only way to mix media. What is different, however, is that this manipulation, translation and recombination of content can follow logic and rules, demonstrating persistent reactions and behaviour. Sequences of ones and zeroes can be defined as symbols in a language. Relationships between these symbols can be established, articulating the logic and parameters of a system. The user may interact directly with these system processes through their expression as interface.

Algorithm describes the logic of digital media poetics. This serves to make sense of how everything fits together to make meaningful communication or expression. Interaction is driven by code and processes the meaning within the relationships defined by digital media structure. Code is the basic unit that all digital media is built upon—whether in the processing of interaction, display of graphic or playback of sound, or shifting information in a database—they are all controlled by computer code. There are many different ways to write and develop code using various styles and approaches, each with their own subtle interpretation of logic.

When a user is interacting with digital media they are engaging with its logic as expressed through algorithm. This is particularly true within the space of digital games where they 'execute an algorithm in order to win' and where a key part of the experience is the way the player 'gradually discovers the rules that operate in the universe constructed by this game' (Manovich 2001, p. 222).

Although other systems such as automated machines can be programmed using algorithms, computers manifest two key differences that puts them in a realm all of their own. Computers may be reprogrammed to undertake many different tasks, and this programming can reach orders of complexity not possible in other man-made artefacts, as while still constrained by physical limits it has more flexibility and can be altered more rapidly than a mechanical system, by virtue of being digital.

This flexibility means that (as stated earlier) computers are essentially manipulators of abstract information and can virtually be programmed for any task, or to recreate any representation. It also means that many processes are never fixed: new versions and updates will result in endless variations of a single process. Any modern desktop computer will be able to perform a number of different tasks, such as word processing, spreadsheets, database, web browsing, game playing, email, and so on. The same computer could be reprogrammed to function as a musical instrument or to visualise patterns in the weather.

```
on ClickOn me -- sent by mouseDown, CheckForRollover
 ourMouseDown[1] = TRUE
 case myState of
  TRUE:  mySprite.member = myOnDownMember
  FALSE: mySprite.member = myOffDownMember
 end case
end ClickOn
```

Figure 59. Excerpt from Macromedia Director 8.5: Behaviour code

Algorithms are step-by-step processes built out of operations and related sequences of functions that manipulate and generate data and logic structures. The automation of tasks such as mathematical calculation and record-keeping through computer programs built from these processes is something that we now take for granted. They allow a formal process for defining systems from a finite set of logic units. Typically, an algorithm is not specific to a particular operating system or computer program, but represents the logic for a given problem, the method used for processing data. It is an abstraction of the process itself. Digital games are based on these processes and their abstractions; as Juul states, 'the game designer must select which aspects of the fictional world to actually implement in the game rules' (Juul 2005, p. 163) or 'by removing detail from the source domain, the game focuses on a specific *idea* of what the game is about' (ibid. p. 170).

The player is embedded within these processes as 'to play a video game is therefore to interact with real rules while imagining a fictional world, and a video game is a set of rules as well as a fictional world' (Juul 2005, p. 1). Furthermore, Aarseth notes the way in which 'the user becomes a text for the game, since they exchange and react to each other's messages according to a set of codes. The game plays the user just as the user plays the game, and there is no message apart from the play' (Aarseth 1997, p. 162). So the player becomes part of the system.

Although at a very low level information being processed by the computer is essentially numerical data, at higher levels in the system the data is labelled and, in a way, given context through its definition in the system. Typically, data being processed by the various algorithms in a computer program is given a specific purpose by labelling it in relation to other data. In a database, fields will be defined for categories such as a subject's name, address and so on. When the information is processed, these categories determine how the data is used, and how it is mapped to a form of representation. Different algorithms will act upon different data.

This is taken another step further when different parts of the data are given multiple and overlapping categories, and may also be weighted in varying amounts. A simple example of this can be seen in the metadata embedded in web pages. This data is a collection of key words and relationships that provide context for a given web page. When search engines collate their own databases of web content, they look to this metadata to assist in formulating where each page should be placed in their own structure. Metadata does not consist of a single, fixed meaning, but a mix of possible meanings.

The introduction of metadata results in two interacting systems: the algorithms that process the data, and the data itself, which in turn control some aspects of the algorithms through their metadata. This introduces another level of complexity and potential in digital media, as the symbol processing ability of the computer is enhanced by the integration of a high level language. In Salen and Zimmerman's theory of game design they acknowledge the need for this high level design and how meaning can arise through play. They say that by 'first looking closely at the concept of *meaningful play*, we introduce three interrelated ideas—*design*, *systems*, and *interactivity*—that lead us directly to a definition of *games* and *game* *design*' (Salen & Zimmerman 2003, p. 29). Thus they break down the game system by looking at the relationships between the underlying algorithm of a digital game with the player, and the choices that the player has for interacting with these codes. If these relationships are random or arbitrary the game experience has no significance. However, if they are designed so that the player can act and get a reaction that makes sense in the context of the game then the play is meaningful. In short, the symbols processed by the algorithm need to be translated into forms that have significance for the player and make sense within the context of the game.

An algorithm does not need to have a completely fixed form; it may appear to have a life of its own by changing and adapting to its environment. In the field of alife, real world structures such as ecologies, economies and other complex systems can be represented as a set of rules. Given the time and space to evolve, these rules can result in an adaptive, dynamic simulation of almost any given system. Digital life is relatively simple when compared to the diversity and complexity of biological life. However, it would be wrong to expect digital life to emulate or mimic that which we have already experienced. It may be quite different. This offers the opportunity to explore alife as a kind of alien intelligence, whose difference is reflective of the nature of the digital medium.

The rules that govern these systems are typically very simple, but when repeated over multiple iterations within a large data space they may produce entire worlds. Emergence—the appearance of novel possibilities within the system not anticipated by its creators—may result from 'a small number of rules or laws [that] can generate systems of suprising complexity' (Holland 1998). Holland explains this complexity in terms of the characteristic patterns of living systems: cycles of life and death, seasonal change, and constant change. The rules are universal and may be applied to almost all dynamic systems – natural or artificial, galaxies or microorganisms, games or scientific theories. In all cases 'rules or laws *generate* the complexity, and the ever-changing flux of patterns that follows leads to *perpetual novelty* and emergence' (Holland 1998).

Computer programs may be created that automatically generate other computer programs from a basic set of predefined logic elements. Rules can then be used to test the fitness of the generated programs for a particular application, such as solving a specific mathematical problem efficiently. Furthermore, individual programs may be combined with one another using a genetic algorithm that produces hybrid programs based on characteristics of their parents. Using these methods new software may be 'bred' rather than explicitly programmed: this is defined both poetically and formally by Whitelaw as 'the breeder: an artificial genome, an artificial phenotype, and an iterative, interactive selection process' (Whitelaw 2004, p. 32).

Artificial lifeforms can be the output of this process. A number of methods, such as neural nets, have been developed that allow alife agents to adapt to new environments, learn new behaviour, and learn about each other and the user. Thus, digital media becomes less predictable and may even evolve in different ways based on the way it is used. A population of artificial lifeforms may evolve behaviour that is appealing to the audience using the software, or behaviour in a 'shooter' style game that allows the agent to survive for longer against a particular strategy used by a human player. Whitelaw states that 'an artificial ecosystem offers something more: involvement in a realtime, dynamic system made up of multitudes of autonomous entities' (Whitelaw 2004, p. 64).

8.2 Algorithm in practice

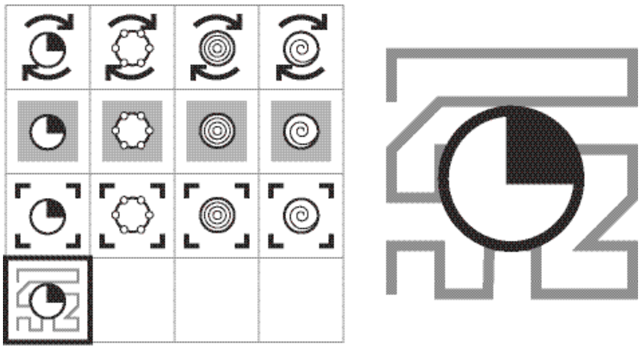
The structure of an artificial world is animated by code. Entities make decisions, cycles of events are played out, and processes performed by the underlying programming that runs the world. Players in these systems become an integral part of this process via a series of feedback loops and couplings facilitating alternative processes of meaning production. Through this interaction they decode the logic of the world defined in its code.

Iconica is a world made of language. This language defines and represents the world, and constitutes the code that runs the world. By learning the language of the world, players are also coming to understand its logic. In writing the code for this world several levels of activity needed consideration. The first level is the autonomous operation of the world itself: the generation of forms and entities, their location in space, how they interact with one another, and so on. Each component of the world is defined in terms of resources such as elements, energy, DNA. Methods for combining components, such as entities and forms, are also established. Finally, methods for processing player input are defined so that everything can function as a consistent, coherent system. The net result of all of these decisions is a functioning world with its own logic.

Similar development processes occurred in *lifeSigns: eco-system of signs & symbols.* However, in this case the work was developed with a team of software engineers and so various components of the world were developed as separate modules. Visual design, networking, sound design, alife and world design were defined separately, connected by a common logical framework. An abstraction of player input was made that could be mapped to the sound and visual design of the world. The same data was fed into three individual processes: the synthesis of visual effects, the triggering of sound, and provision of energy to the alife model. The player performs the entities in the world as instruments, and also increases their energy and in turn encourages them to reproduce, thereby proliferating their particular image and sound in the world. The code for these entities uses two separate but interconnected generative systems: one that relates to the sound design and another to the visual design. The player decodes all three systems as they spend time in the world.

Firstly, the cycle of an artificial world needs to be defined in terms of processes, inputs, parameters and conditions. What components will be autonomous or self-generating? How frequently is the world updated? Secondly, the number of possible processes needs to be considered. Are there multiple entities operating together or separately in the world? How many different systems are there and how are they connected? Thirdly, the ways in which the world reacts and makes decisions in response to the player is defined via rules and conditions. Are there goals for the players to achieve? How are the results of their actions measured – do they modify the world? Finally, entities or the world itself may learn or adapt in response to one another or the player. Do they reproduce, mutate or evolve in some way? What are the main components of the world that drive their decisions and behaviour?

8.3 Time and algorithm



Every world operates via sets of loops, processes and cycles that change its state dependent on factors ranging from player actions through to the thought cycles of autonomous entities. This is analogous to how the world thinks. *System process* defines this logic cycle of the world.

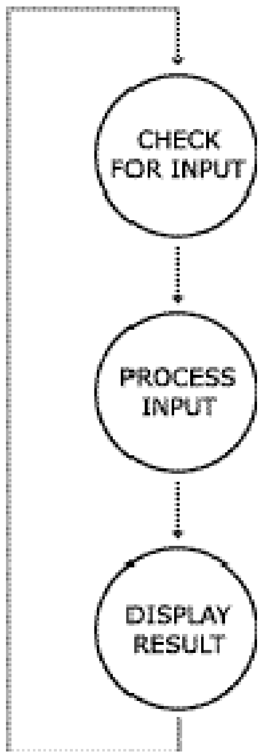


Figure 60. Simple loop structure

The loop of a simple computer program is depicted in Fig. 58. Most digital media is based on more complex programs than that depicted, but they all rely on iterative processes—functions performed over and over, often multiple iterations every second, as their primary structure. IF/THEN and other condition-based functions allow the process to be altered depending on inputs and the state of values in the system.

The iterative loop of the computer program 'involves altering the linear flow of data through control structures' (Manovich 2001, p. 317), that result in different outcomes and behaviour of the system. This continuous flow of data can be made interactive, so that the player becomes engaged in the processes embodied in the system, thereby engaging with digital media at a level deeper than simply selecting options from a hierarchy of pre-determined content. Even though it is a relatively simple concept, 'the loop is the most elementary of control structures' (ibid.) and drives almost all computational processes. It acts as the thought process of digital media—updating data, processing inputs, generating outputs, making decisions and so on. It is the cycle of events that determine how the system interacts with itself—its internal processes and logic. This aspect of algorithm may be described as the *system process*.

Writing code also involves the identification of variable parameters versus those that are fixed. Also important are the relationships between variables and the way in which they are connected to interaction, representation and structure. Thresholds, boundaries, conditions and limits all have an impact on the *system process.* The frequency of iteration relates to the overall rhythm or sense of time in the process. All of these aspects feed into and affect the dynamics and behaviour of the process over time. To better understand *system process* it may be explored in terms of its cycle, frequency and complexity.

The cycle may be analysed by identifying the rules and conditions that define it. Some algorithms are executed once, produce a result and the process is complete. Most algorithms run very quickly so that they appear to operate in realtime – there is no perceptible delay during their execution. This means that they can be constantly running and respond to interaction immediately. Processes may be nested so that many overlapping cycles appear to be operating simultaneously. Some processes may be completely invisible. These cycles are defined by where they start (initial conditions), what they do (the process itself), and what completes the cycle (the end result). Decoding the cycle allows an understanding of one level of *system process*.

Frequency relates to the speed at which processes occur and how the user or player is integrated into these processes. They may infrequently be given opportunities for input or they may be part of realtime process itself by constantly providing data that shapes the process. This second case is the most intensive, in which time-dependent input is critical to the outcome of the algorithm—such as in an action game where timing is a key factor in completing levels and tasks. Other processes may allow the user or player to modulate their input and therefore shape the process much like a musical instrument. In this case their input is important in altering the output, but not critical—the process does not end without their input. Frequency may change throughout a digital media work—requiring more or less input at different stages—or it may be entirely dependent upon user input to function. In the last case the frequency becomes user-dependent as it is exclusively activated by user input. This is typically asynchronous, such as in the example of a website or service that collects data from multiple users and collates it.

The third aspect is the complexity of *system process*. Some processes are simple; others are complex and may be constructed from multiple processes that interact with one another. This complexity may emerge over time. In come cases the process may be too complex and confuse the user or players. Deciding on what aspects are open to input and which remain invisible is critical in the development of digital media. Simple inputs may govern a complex process with the inner workings largely hidden from view, as the player is typically only interested in the end result. Some virtual worlds and digital games demonstrate multi-layered complexity that is slowly introduced to the user or player over time. Players develop a deeper understanding of the system as they go from novice player to expert. Understanding and deconstructing the processes that run the world or game becomes part of the experience so that the players come to have an intuitive knowledge of the *system process*.

In some cases the *system process* may be very simple. Point-and-click interaction through hierarchies of content is one example of a simple process, although the end result may appear to be complex. Essentially what is going on is the navigation of a collection of linked animation and sound loops. Its logic amounts to simple branching decisions between paths in the hierarchy. In some cases these decisions may distributed throughout an environment as a set of triggers, rules and conditions connected to programmed entities and players. These entities may in themselves have a simple structure, such as a finite state machine, that changes the execution of their own program dependent on inputs it receives. A typical example of this kind of environment is a digital game in which the simulated world consists of this network of triggers, rules, conditions and entities. More complex logic can be seen in software in which many numbers of variables are dynamic and interlinked with each other and their representation. Typically they may also be affected by interaction. Software that generates its representation in realtime in response to the player is typical of this type of process.

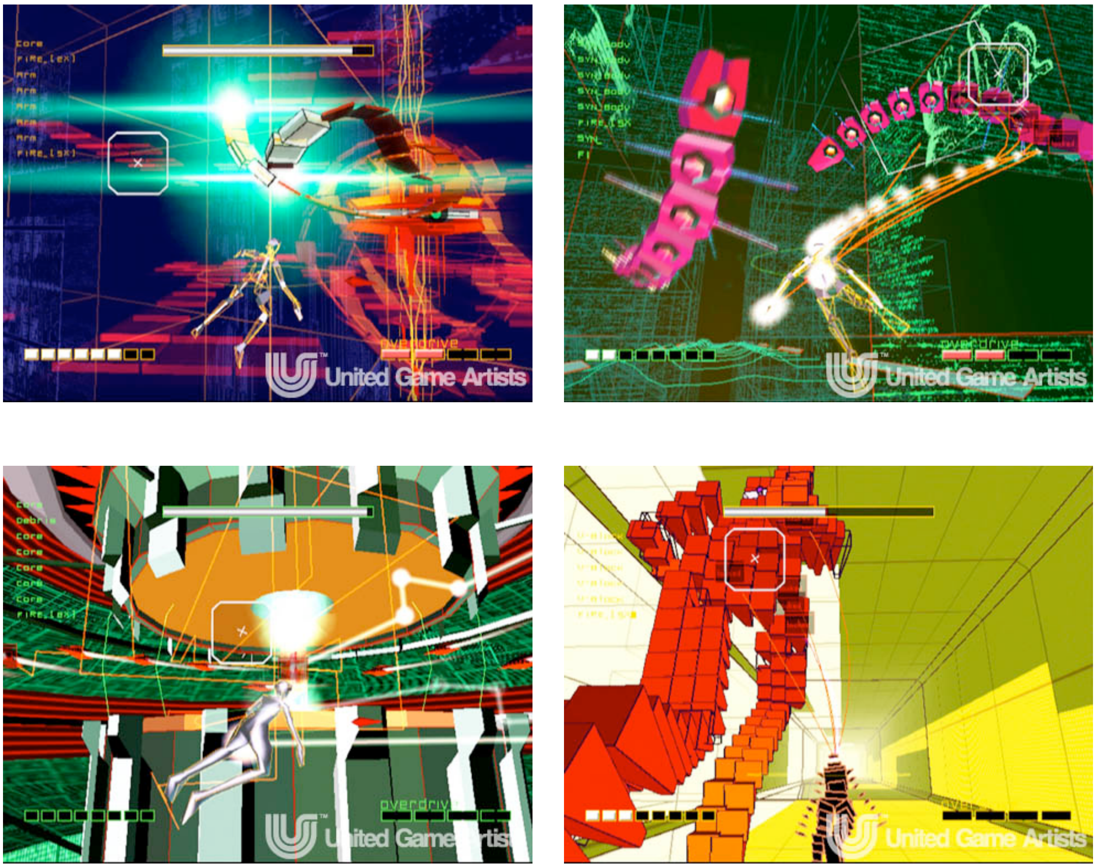


Figure 61. ***Rez*** **(United Game Artists 2001)**

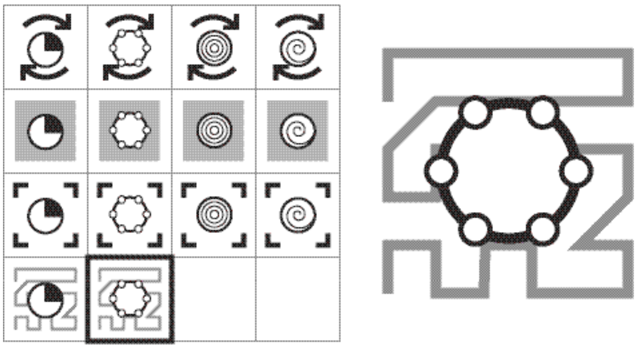
Playing *Rez* (Mizuguchi 2001), the player is embedded within the *system process*. The game world knows they are there and reacts accordingly. Likewise, their input into the world triggers and manipulates the processes that are happening around them. In this game, the player flies through a number of three-dimensional cyberspaces populated by viruses and other digital enemies. The *system process* operates in time with the rhythm of the game world's electronic soundtrack. As players shoot down enemies, this too happens on the beat, accompanied by exploding musical-visual form. Playing the game activates a synaesthetic experience that is generated by the *system process*. The timing of events is not driven purely by the system cycle, but also by musical rhythm and timing. As a result there are two frequencies of events that coexist in the game world: first of all, the realtime cycle of playing the game; and secondly, the tempo of the soundtrack. In terms of complexity, the decisions and events being managed by the system are relatively simple, but their mapping to multiple layers of musical-visual form creates a complex aesthetic representation to the player. Being immersed in and engaged with this representation is highly enjoyable.

Figure 62. ***Supreme Commander*** **(Gas Powered Games 2007)**

In contrast, *Supreme Commander* (Taylor 2007) has a complex *system process*. The game world must simultaneously track and update hundreds of units in the game. It is a RealTime Strategy (RTS) game in which players build and command robotic armies in a strategic battle simulation. They may also play against the computer. It must use various AI algorithms to develop its own strategy to counter the actions of the human players. Strategic thinking like this is a highly complex process that needs to be updated frequently. So, each cycle in the game world involves processing the inputs of players, updating the many autonomous processes operating in the world, calculating the results of interactions between units, and making strategic decisions on how to deploy its own units. As the game operates in realtime, the frequency of these operations also has to occur within that timeframe. The end result is a huge game world that presents believable simulations of futuristic battle scenarios. However, putting the specifics of the representation of the *system process* aside briefly, the world can essentially be seen as the non-linear expression of many processes occurring simultaneously, generating unpredictable and varied experiences for the player. Playing the game, the player is immersed in this engagement with the *system process*.

System process is also connected to other properties related to time. Its relationship to *experience flow, simulation time, simulation lifespan* and other properties has been discussed in previous chapters. As the loops and cycles generate the artificial world these are strongly linked to the nature of the simulation. The specific properties of these links are explored in Chapter 9, that looks at a number of creative works.

8.4 Multiplicity and algorithm



The complexity of a world may relate to how many processes or independent entities are operating within its code. This can vary: it may be a diverse range of processes that are interconnected or operating simultaneously, or thousands of duplicate processes, each running with different parameters. *Multi-processing* describes the measure of how many processes are operating within a world.

A loop that plays the same way every time is pretty dull. However, a multitude of processes running simultaneously will generate variety, as will multiple copies of the same process, each set with their own parameters. This may be described as *multi-processing*. It may be considered in terms of the diversity of different processes in a system, the number of processes functioning simultaneously, and the variability of those processes.

A simple example is a hierarchical structure that allows multiple choices between different paths. This may be extended to include variable responses that depend on the user or player satisfying certain conditions. Finding the key to open a door is a common goal of action or adventure games that uses this principle. In these examples, the logic of the work is predetermined, although there may be multiple paths that may be taken. In other cases a template for the logic of the work is defined and users make choices within the range of possibilities allowed. Use of a website that uses certain conventions in its processing of inputs to generate output follows this principle. Often, code is deliberately constructed to create novelty and variability in the behaviour and output of a work. Rather than repeating the same responses and outputs over and over, new responses may be generated in response to interaction or simply constantly regenerated in a loop.

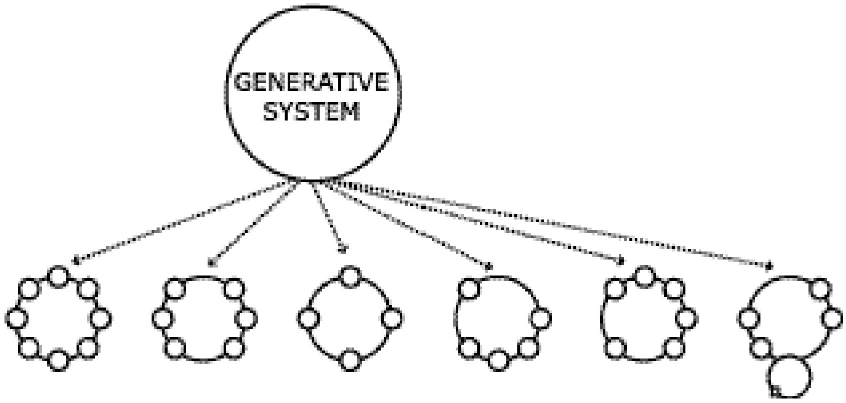


Figure 63. An example of *multi-processing*: multiple outputs from a generative system

Fig. 63 illustrates a small number of possible outputs from a generative system configured to combine spheres of different sizes together to create composite three-dimensional objects. *Multi-processing* acts behind the scenes to create the kind of functionality expected of digital media. However, in some cases it is brought into the foreground and becomes a major feature. This can be seen in the application of generative systems to digital media. These are algorithms that create many, many possible outputs from a small number of inputs and simple rules. Consider a two-dimensional grid whose squares can be either on or off. Simple rules may describe the switching of each square on the grid; for example if more than three of its neighbours are on then it itself is on, otherwise it is turned off. Draw a simple shape into the grid and constantly changing patterns emerge on the grid. This is one of one of the simplest generative systems, known as the game of life. More complex systems have been developed that are able to create entire virtual worlds, including the geometry, topology, behaviour and placement of objects and entities in the world. While these systems are largely applied to generating novel representations, they may also be used to generate a diversity of processes.

Therefore one aspect of *multi-processing* is the diversity of processes within the system. Another aspect is the number of processes operating simultaneously. A game world may be comprised of bots with autonomous behaviour that navigate their space, interact with one another and so on. With one of these in operation, the player experience is relatively simple and perhaps somewhat boring, depending on the complexity of the bot AI. However, with twenty or thirty bots in the same space it is a different experience. First of all, there is much more activity going on and therefore more to be experienced. Secondly, the interaction of the bots with one another will create unpredictable combinations of their basic behaviour and result in more complex behaviour overall via this cumulative interaction. Finally, if there are variations possible in the bot AI then a wider range of behaviours will also be apparent through their different types. Simply increasing the number of processes operating simultaneously creates a different experience.

It can be seen that variability is another important aspect of *multi-processing*. While it may not be possible to change the code of a particular process, its parameters may be modified. This may involve a change to its visual or sonic representation, or it may subtly alter its behaviour. Returning to the example of bot AI, changing its parameters could result in different preferences in its interaction with the world. It may prefer to avoid the player or seek them out, to collect certain objects or to attempt to win points, and so on. While it may be possible to make everything variable in code, usually this is impractical. Making some parameters dynamic draws attention to them as variable factors in the simulation. This variability is essential to allow multiple responses to interaction; to create a range of *system behaviour;* to allow the generation of new content; and to create and shape relationships between units of meaning. So variability may relate to states within the system or perhaps the generation of new systems altogether.

Figure 64. *Grand Theft Auto: San Andreas* (Rockstar North 2004)

A multitude of processes occur simultaneously within the streets of *Grand Theft Auto: San Andreas* (Houser & Khonsari 2004). This game allows the player to freely explore a large city. Although they start off on foot, the player really needs a car to see the entire game world. Based on gangland warfare, the city is populated by bots representing fellow and rival gang members, police, shop owners and hundreds of ordinary people. Each is running their own process in the simulation, with variations in movement and behaviour depending on what is going on around them. Although their individual behaviour is relatively simple, many different scenarios may be generated within the game world to challenge the player. This is influenced by buildings, vehicles and objects at the scene (each of these also has their own process), and also by the aggregate behaviour of the bots. This unpredictability holds the player's interest as they explore the game world, finding their own style of play within the possibilities afforded by the system.

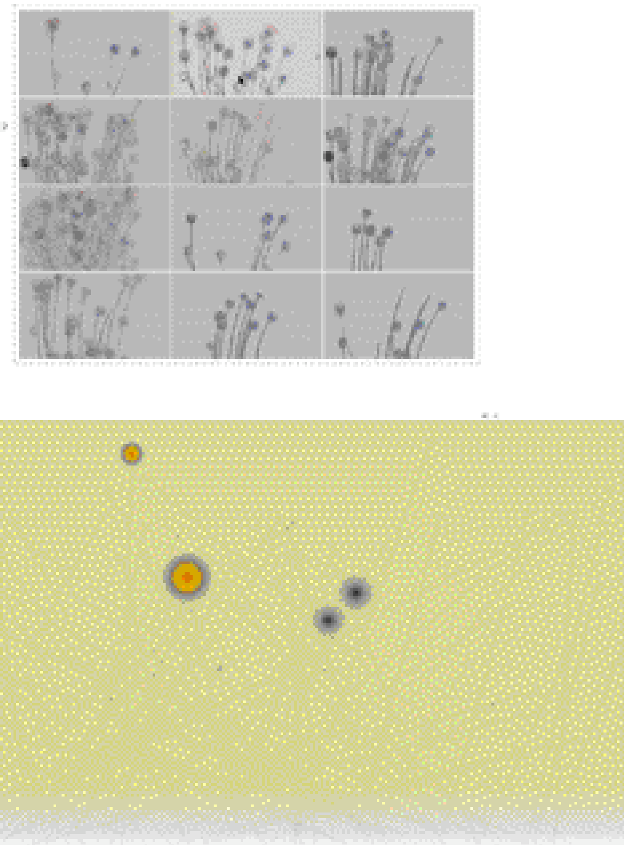
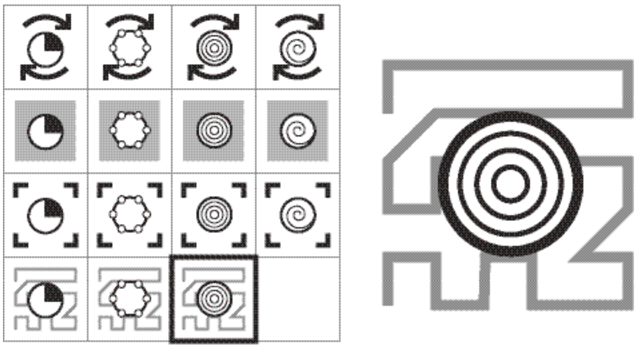


Figure 65. dextro, *Insect* (2001)

The work of dextro demonstrates both *adaptive expression* and the creative use of *system process*. In their work for *Gasbook 009: Insect* (dextro 2001) movement of the mouse influences the pattern and behaviour of collections of many tiny onscreen sprites. This allows realtime, continuous interaction of computer games with the processes used in the work. While the number of different processes is minimal, the scale at which they operate is not. Hundreds of copies of simple processes are combined to create dynamic expressions of organic systems. These are also variable, so while the same process will produce results that are self-similar each expression will be sufficiently different from its neighbours to be recognisable. However, the individual components are not the point of interest here. It is the way that multiple copies of the same process, with subtle variations, go together to make a work that is consistent and coherent, as well as dynamic and engaging.

Other properties connected to multiplicity can be related to *multi-processing.* Its relationship to *hyper modality, semiotic morphism, ontological complexity* and other properties has been discussed in previous chapters. As *multi-processing* relates primarily to the number of simultaneous computational operations, it impacts on the scale and complexity of many other properties. This will be demonstrated in Chapter 9 with the examination of several creative works.

8.5 Adaptation and algorithm



Rules and conditions govern how decisions are made within a world and by its entities. These range from simple binary decisions or physical responses to machines that determine the best course of action dependent on a range of factors and inputs. *Play mechanics* relates to these decision-making aspects of the system.

Whether it is simple or complex, large or small, the use of algorithm in digital media can often take on a life of its own. In some cases this can be quite literal: the genetic algorithms and evolutionary dynamics of alife, for example, use processes inspired by biological life to evolve and breed digital media. However, a work may appear to be active, lively and reactive simply as a result of the dynamics that emerge via its internal relationships and the behaviour that these generate in action. The best example of this principle in action can be experienced in the intangible dynamic connection between interaction, representation and structure in games. This will be referred to as *play mechanics*.

This is the result of the conditional statements, rules of engagement, states and behaviours and possibilities generated by the myriad different combinations possible within the system. Linear cause-and-effect style interaction either does nothing, or plays out a predetermined sequence of events in response to a trigger. However, a system of complex interdependent rules generates a wide range of possible outcomes.

These rules may be processed at many levels within a work. They may relate to interaction that occurs within the work itself, with the user or player, or with the media environment in which it is situated. This extends the idea of *play mechanics* to describe the logic of its reactions and interactions at these various levels. Within the work itself triggers and conditions are defined to generate this reactivity. *Play mechanics* may be measured in terms of how these are defined, what meaning they have in the system and the underlying concept or motivation behind the work. Likewise the rules behind the ways in which *play mechanics* is used to stage interaction with the audience, and its relationship to its context are also expressive forms of communication. Essentially, this means that the rules and systems defined in *play mechanics* are just as capable of communication and expression as are the onscreen graphics or soundtrack.

Following this line of thinking, in order to illustrate this point it is worth exploring what makes up *play mechanics* in the first place. This part of the logic of digital media language may include rules of play (limits on movements, lives, scoring and so on); properties of the environment (bonus points here, certain interactions possible over there); entities in the space (interactive objects, autonomous entities); relationships between these entities (attack, ignore, follow); relationships between players (hostile or friendly, teams, goals); and methods of interaction (walk, jump, fire, collect etc.). This list describes typical components of a complex virtual world. In many cases, the *play mechanics* is much simpler and may only include a few of these items. Even in a simple environment it is easy to see how the *play mechanics* may describe the logic of a digital media work, for example if the rules were as follows: (i) limited number of objects that reward points, (ii) up to eight players at once, (iii) players may trigger some objects to kill other players, and (iv) the player with the highest score wins. This would create a hostile environment with some strategic decisions—use an object to kill a player or save it to get a higher score. Alternately, we may observe the rules of an online service such as a blog: (i) the author may create new posts on the blog, (ii) anyone can comment on those posts, (iii) this may include links to other blogs/communities, and (iv) all content is saved and ordered so that the chronology of the blog is visible and apparent. This sets up a participatory model that invites interaction over an extended period of time.

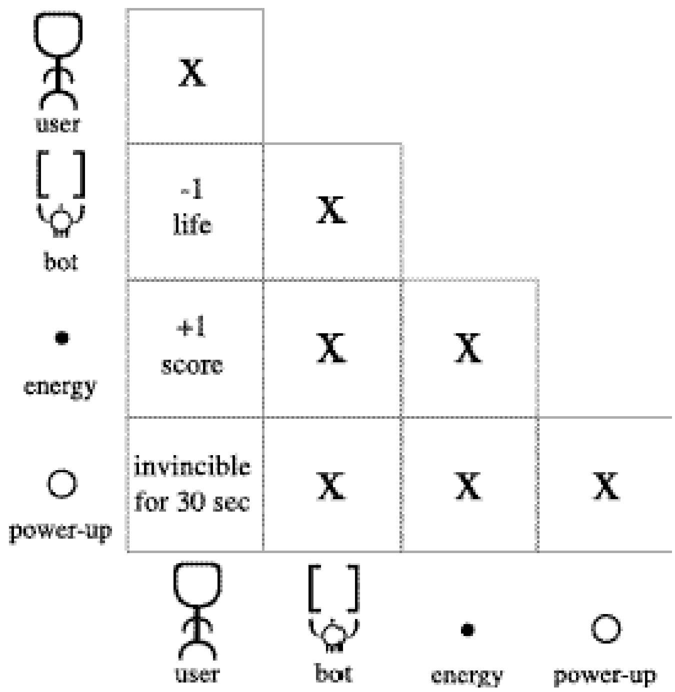


Figure 66. Interaction map for *Pacman* illustrating the dynamics of *play mechanics*

In the creation of *play mechanics,* relationships between elements in a system form the basis of the rules of play. A simple set of relationships in the game of *Pacman* is depicted in Fig. 66 showing the interaction between a player, a bot, and two types of game objects. The process of play becomes the primary form of communication as it occurs via *play mechanics* and the engagement of the player with rules and systems (Salen & Zimmerman 2003).

The player becomes engaged with a simulation, and via the *play mechanics* they become part of the work itself. Through this engagement with its process they are stimulated to react to the work and discover its logic through interaction. This logic becomes internalised as the main memory of the experience. In this way, logic plays a significant role in expressing the conceptual content of the work. This may also be explored in the context of 'world design'. Opportunities exist in the construction of the simulation itself to use the behaviour and characteristics of the world as expressive vehicles of communication. The way the physics works in the space, how light behaves, the reaction of entities in the game world, the reactions and sounds of objects – all these elements can be expressive communicators within the system. The physicality of objects becomes an integral part of the gameplay in *Half-Life 2* (Speyrer 2004) in which several physics-based puzzles must be solved to progress through the game. In *Doom 3* (Willits 2004) the player must illuminate the dimly lit game world using a handheld torch to navigate and locate hazards, enemies and items. Animals such as wolves and bears in *Tomb Raider* (Gard et al. 1996) circle and chase the player as they enter their lair, sometimes appearing suddenly from behind a cave wall and flinching in pain when injured. Reaction and sound plays a key role in the experience of *Rez* (Mizuguchi 2001) where enemies and other game objects dance about the screen and explode into balls of particles in time to an underlying beat.

The player's perception of the world is altered as they are immersed in it via the immediacy of feedback, the feeling of having real effect, and of being an integral part of the system. Rather than simply being a remote observer, they become an active participant in the simulation – their avatar is addressed as an element of the simulation alongside all the other entities in the world. These worlds also have their own agency, acting through the behaviour of bots and other 'intelligent' creatures in the simulation. Through this agency, the adaptive algorithm not only responds to the actions of the user, but also directs and triggers those actions by posing threats, presenting opportunities, or guiding the user through the environment. Thus, the design of the world takes into consideration the creation of a space that functions in terms of its own life and ecology.

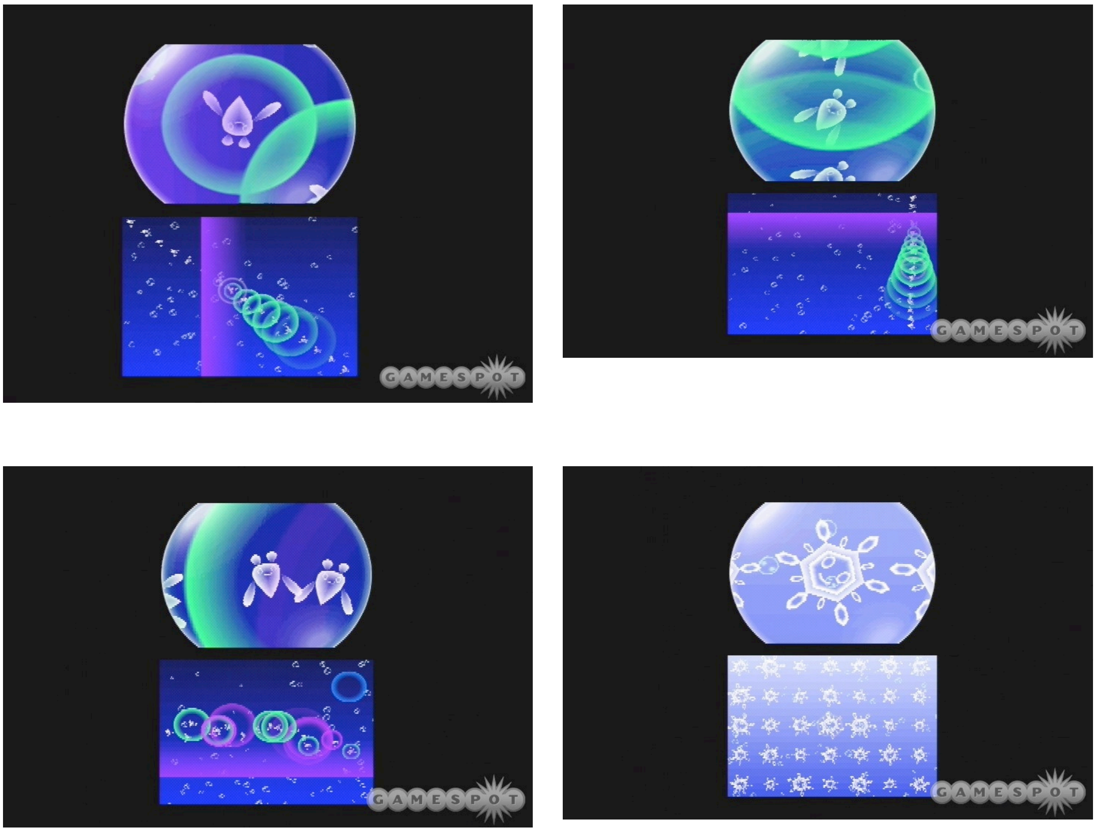


Figure 67. *Elektroplankton* (Iwai 2005)

Players may compose music on the Nintendo DS through free play with the sound toy *Electroplankton* (Iwai 2005). Using the touch screen, players manipulate small plankton-like characters and their world triggering music and animation. There is no score or objectives, apart from the exploration of the *play mechanics* themselves to generate music. Each of the ten different game types take a different approach, and some use the microphone on the DS to allow players to record, remix and manipulate their own sounds. These games vary and include both physical environments that use collisions, growth, decay and other similar processes to trigger musical notes; and more abstract spaces built from sequencers and freeform types of visual musical notation. Each requires that the player understand their mechanics and become involved in the process so as to be able to create music. Visually, this is engaging, creating the appearance of an underwater world populated by synaesthetic creatures that adapt and react to the player's gestures, and in some cases to one another. Although many of the systems use relatively simple mechanisms, these generate a wide range of possibilities. Hanenbow, the second game in *Electroplankton*, is a good example of this. Each Hanenbow may be fired at a plant model at a different angle, causing it to bounce off the leaves of the plant (that may also be placed at different angles) in different ways. Each collision generates a sound and changes the state of the Hanenbow. By subtly manipulating the angles of all of the leaves in this simple system many different compositions can be created. The Luminara exist on a grid that works in a similar way to Music Insects. In this system the characters themselves are simply activated and then the player manipulates the grid on which they play, by switching arrows about to create different paths for the Luminara.

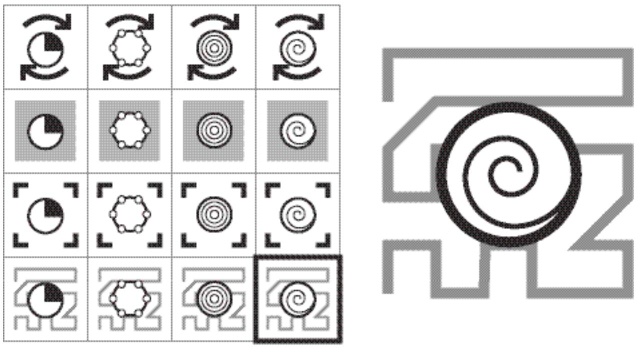
Figure 68. *Half-life* (Valve Software 1998)

Half-Life (Laidlaw 1998) is often cited for use of cinematic and narrative devices that create a more involving game experience. However, *Half-Life* also benefits from a well-balanced set of game rules that are expressed in a simple and effective system. In the game you play the role of Gordon Freeman, as he tries to escape the Black Mesa Research facility following an accident that opens up a gateway to a planet full of belligerent aliens. Like most 3D shooters the *play mechanics* is a combination of combat, world exploration, and puzzle-solving. Particular weapons are more effective against specific enemies, power-ups such as health and shields are well placed, the difficulty of levels is staged, enemies have behavioural rules, game levels are set in stages with periods of intense activity followed by points at which the player can rest, and so on. The right balance of all of these elements results in a satisfying and engaging game, and represent the range of factors that go into making good *play mechanics*. Even though the outcomes of the game are predetermined, the involvement and sense of being able to affect the world through interaction is very tangible.

AI is applied to the behaviour of the player's enemies and other game characters to introduce variability to the *play mechanics*. Game characters don't follow predetermined paths, but react to the strategies of the player. They may run away and find cover before attacking the player again; they may change their method of attack based on the player's strategy; or they may collaborate with one another. Obviously, this adds to the game's realism and makes it more engaging. However, it also enhances the sense of immersion—as the player is not engaged with a dumb system where the key to completing the game is simply to find the pattern, but creates the feeling of interacting with something that is alive.

Other properties of adaptation may be related to *play mechanics*. Its relationship to *system behaviour, adaptive expression, meta design* and other properties was discussed in previous chapters. As *play mechanics* relates to the rules and/or logic of an artificial world it is connected to other properties related to entity and world behaviour. These connections are articulated in Chapter 9 through the investigation of a number of creative works.

8.6 Transmutation and algorithm



Code may also vary its response as it learns from experience or adapts to its environment. A world may adapt to patterns of play, entities may learn from experience or produce a new generation of offspring via processes similar to sexual reproduction. *Evolutionary code* articulates these ways in which meaning is interpreted in and by computer programs.

Play mechanics describes the dynamics that emerge from interacting sets of rules in the algorithm. However, they arise as a product of fixed rules and possibilities—while the nature of these responses is complex and dynamic, it is still predictable. In the case of a digital game, this is often desirable—if there is too much unpredictability it may become unplayable. In many cases it is important to generate a range of possibilities that are able to evolve and adapt. Generative systems, alife, neural networks, multi-agent simulations and complex adaptive systems all involve approaches to computer programming that are biologically inspired. They include models of evolution, adaptation, ecosystem dynamics, processes of growth and decay, and other related ideas in the development of computer software that displays many of the attributes of these natural systems. These practices may be viewed in terms of the idea of transmutation of algorithm and described as *evolutionary code*.

The algorithm may learn and adapt to change in response to both its internal processes and external input. This may be something as simple as a player seeding and manipulating a generative process to create a unique media image or sound. It may also extend to more complex behaviour in which autonomous agents form networks of code within themselves and with one another to manifest digital worlds that evolve possibilities each day. In this way, the logic of the language is able to change and adapt to new circumstances—much as a natural language evolves through the combined processes of culture, society and generational change.

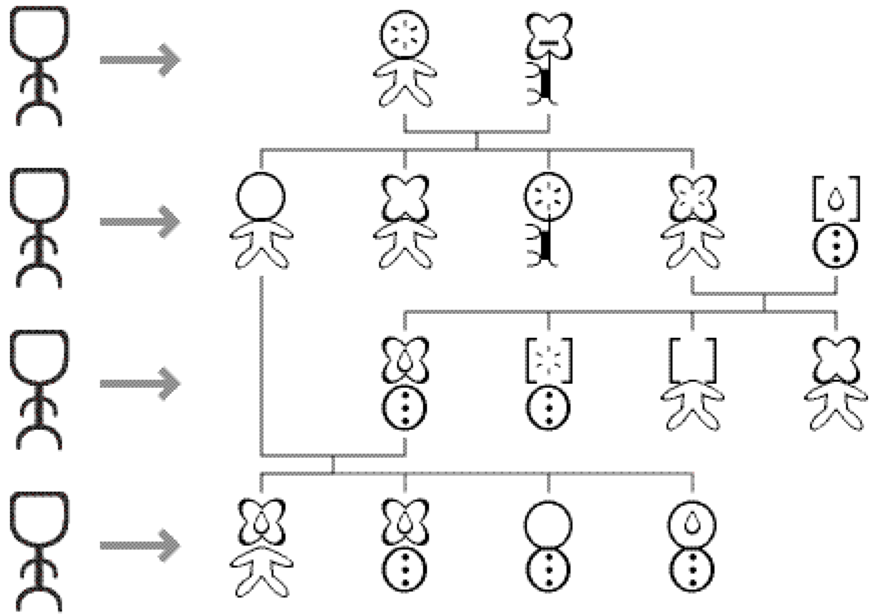


Figure 69. ***Evolutionary code*****: generations of alife selected by player**

In Fig. 69 the process of aesthetic selection is illustrated. The player combines two entities in the first generation to produce five offspring from these two parents. Another two entities are selected from these five to produce the third generation. The fourth generation is produced by combining entities from the second and third, resulting in the four entities in the bottom row. This demonstrates one way in which code itself may be developed to display adaptation, learning and evolution. Alife (Langton 1995) is based upon the modelling of life processes such as learning, growth, decay, hunter-prey models, evolution and reproduction within a computational space. Holland's (1995) ECHO model for an agent-based system that demonstrates principles of complex adaptive systems includes many of these processes in its design. In these systems, artificial entities are defined by digital DNA that operates in the same way as it does in biology (although in a simplified form). They then interact with one another, and from their interaction comes a piece of computer software, a model of an ecological system, a game, an interface, or a musical composition. Through interaction they evolve and change, reacting to aesthetic guidelines defined by people, resulting in a constantly changing digital media work. These lifeforms are digital by nature and so can easily interact with digital media—offering huge potential for entirely new methods of performance and musical composition, among other applications. They may also be given simple brains: typically neural networks that work on the same principle as those in our own brain. Nodes in the network are connected to each other and are able to fire signals that may or may not fire another node, dependent on certain conditions. In turn the firing of nodes will trigger certain behaviours, so that when some nodes are stimulated by events within the virtual world, a resulting reaction will occur.

This process typically follows an evolutionary model. As artificial lifeforms adapt to their environment such as a virtual world or game, they are able to pass these adaptations onto the next generation. Over several generations new code is formed. The algorithm used for this process is called a 'genetic algorithm' (Holland 1995; Koza 1992), as it is based on the merging of DNA that occurs in biological reproduction. This process of 'breeding' output means that particular threads of the infinite possibilities of the system can be favoured over others, similarly to the way favourable characteristics may be cultivated in the breeding of livestock or plants. This process of 'defining rules and bounding new worlds represents an entirely new form of expression' in terms of the creation of virtual worlds that express the unique characteristics and properties of digital space. Artists and scientists alike use these methods to 'explore new worlds whose creation was made possible by teaming up with a computer' (Holtzman 1997, p. 75).

Furthermore, via 'genetic programming', computer programs themselves may be evolved using a genetic algorithm. Rather than write and optimise a single algorithm manually, thousands of algorithms are generated and evaluated against a fitness function such as the solution of a particular problem. The highest-scoring algorithms are used to produce the next generation and over much iteration an optimal algorithm is produced.

Evolutionary code changes the relationship between player and media. The creator of a digital media work guides the process by selecting from the generated output, by saving some outcomes and deleting others, ordering a set of outputs in terms of preference, storing sets of rules for later retrieval, and so on. Human logic and intuition is combined with the methodical, fast processing of the computer to enable the discovery of form rather than its design.

The use of generative systems in music is a key example of the potential of the genetic algorithm. Artists may develop a system of music generation rather than a linear recording. In a generative music system sounds are arranged according to rules and structures defined within the computer, and the user influences the direction in which the music goes. Imagery to illustrate the sound is often included and will form the basis of an interface through which interaction with the sound will occur. Interaction does not have to be direct point-and-click either; more subtle forms of interaction are also possible, and motion detection or other more sophisticated interface devices may be used. New musical genres may evolve through the collaboration of people with alife, developing ways to experience and listen to sound through interaction.

Figure 70. Christa Sommerer & Laurent Mignonneau, *Life Spacies* (1997)

Life Spacies (Sommerer & Mignonneau 1997) consists of an artificial world that is populated by creatures competing for resources. These creatures are represented as complex three-dimensional forms whose composition is generated through the decoding of text input into the system. The elements and their arrangement relates to the creatures' performance in the artificial world, giving each one different behaviour and movement. This demonstrates the variety that may be generated from such a system, particularly forms and behaviours that are unfamiliar to us and therefore less likely to be designed or created using traditional means.

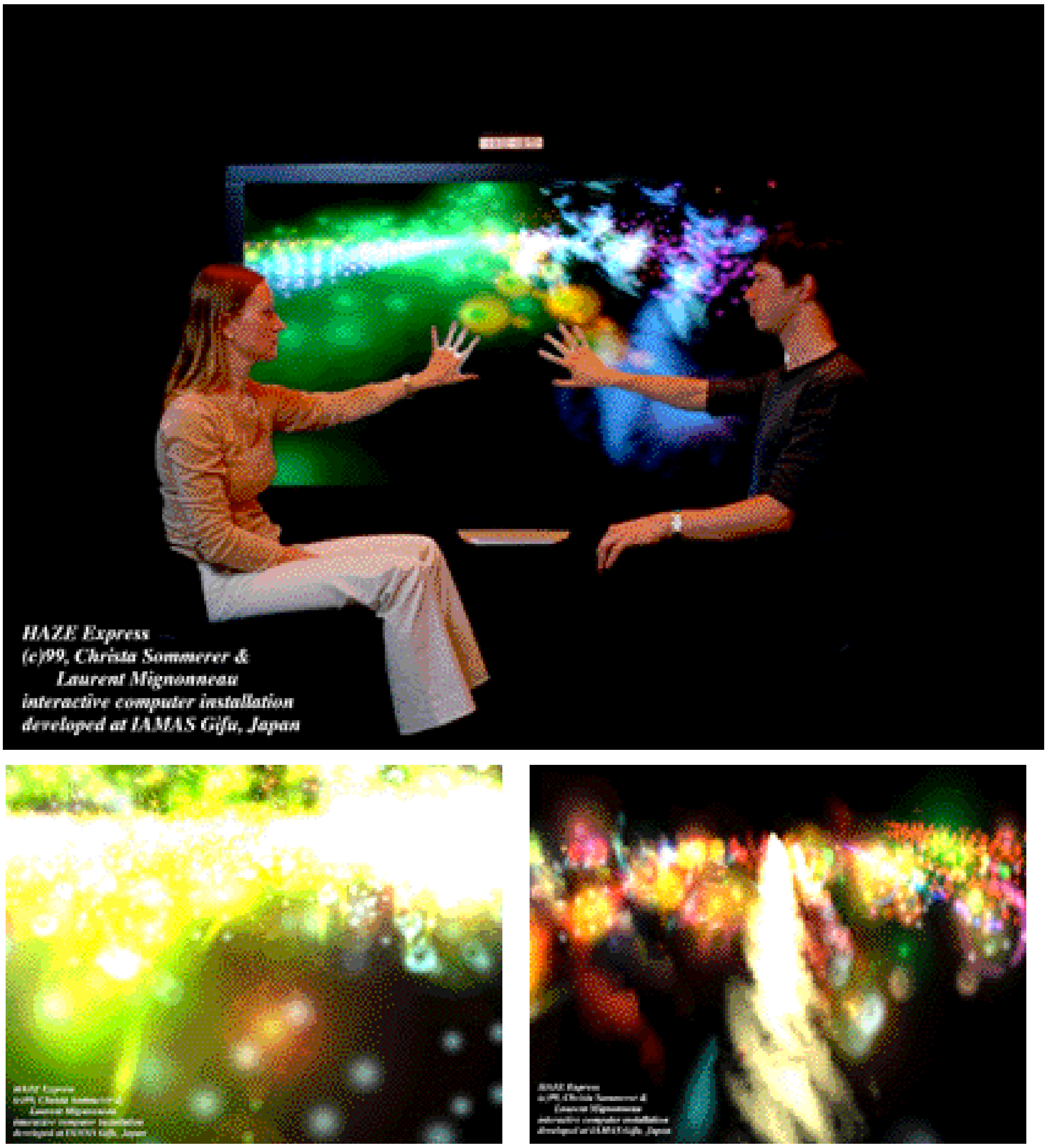


Figure 71. Christa Sommerer & Laurent Mignonneau, *Haze Express* (1999)

This form of interaction may also be seen in visualisations of data in VR. The proximity and position of the user in the virtual space may trigger thresholds, manifest new objects in the space, or switch modes of representation. Parameters may be directly linked to the user's position or rotation, resulting in realtime changes in the world as the user moves about. *Menagerie* (Fischer 1993) is a virtual world populated by animals. As the user moves about, bold motions frighten the animals away, while gently approaching the animals will tame them. The actions of the user are translated to the outcome of the world, establishing an interdependent relationship between the user and the work. *Haze Express* (Sommerer & Mignonneau 1999) generates abstract forms that are constantly moving within a screen. The screen is situated in an installation as if it were the window of a train, and the user places their hand on this screen to attract forms toward them. Simple hand gestures on the screen establish tactile interaction with the artificial lifeforms. This direct interaction creates the perception that they are more real than if the interaction occurred via a point-and-click style interface.

Holland’s interest in complex adaptive systems (CAS) led him to develop a model to observe and test their development and evolution. His Echo model consists of an artificial world made of sites, each containing agents and resources. Within this system multiple agents autonomously grow and evolve, consuming resources and interacting with one another. Each agent has the capacity for offense, defense and a reservoir to store resources. Other behaviours include conditional exchange, passing resources between agents; resource transformation, converting resources within the agent; adhesion, connecting onto other agents to form aggregates; and conditional replication, allowing offspring to be born.

Simple strings or ‘tags’ that are particular to each agent (so that they are unique) determine the interaction of these behaviours. The agents may reproduce and their offspring adopt a combination of their parents’ tags. Some combinations of tags are better suited to survival in the artificial world and so agents with these combinations reproduce more often and die less. The population of the world, initially random, adapts to suit the conditions of its environment. Over thousands of iterations of the artificial world, agents evolve that exhibit novel adaptations to their environment – agents that would be almost impossible to design from scratch.

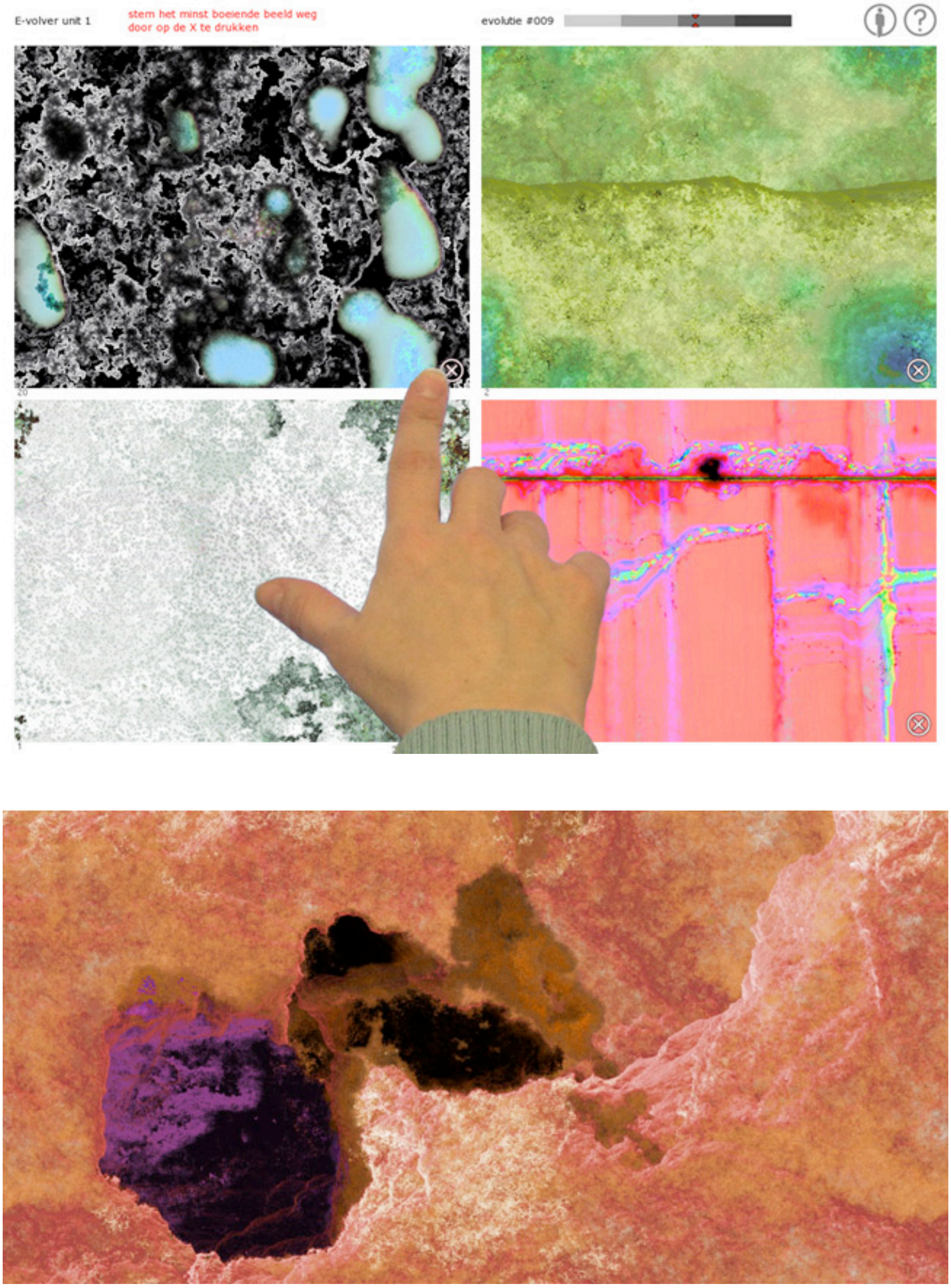


Figure 72. Erwin Driessens and Maria Verstappen, *E-volver* (2006)

E-volver (Driessens & Verstappen 2006) also uses a multi-agent simulation. Its rules are simpler than those in Holland's Echo model (Holland 1995). Essentially, each agent is the size of a pixel and its movement about the space of the computer screen is generated via rules relating to the colour of the other pixels around it. Another set of rules determines what the agent leaves behind when it moves onto the next pixel square—the pixels react to and modify their environment. The end result is an endless variety of different images that look like worlds or landscapes. As the software is running, these images are constantly being drawn and redrawn by the sum of all the agents' actions. Furthermore, these processes may be governed by human input. Collections of agents may be selected and removed from the system by the player, based on their aesthetic preferences. A new generation of agents comes in to take their place and the process continues. The images generated by the work emerge from the dynamics of the multi-agent simulation and the interaction between human and machine. In both *Echo* and *E-volver*, *evolutionary code* is used to generate novel interactive environments and digital media that could not be developed in any other way.

Evolutionary code is connected to the other properties related to transmutation. Its relationship to *transmedia mapping, emergent meaning, recombinant space* and other properties has been discussed in previous chapters. *Evolutionary code* relates to the capacity for code to evolve and so relates in particular to properties connected to multiplicity and adaptation. Examples of this in action are described in Chapter 9, in which this concept is explored in relation to several creative works.

8.7 Iconica: an artificial world made of langauage

Iconica is an artificial world made of language, experienced as an interactive installation. The system updates the world in realtime, displaying incremental change as it occurs. The *system process* of the world updates the state of each form, entity and space; processes user interaction; and displays the current state of the world. Energy is gained and lost, interactions between entities calculated, forms appear, all according to the rules of the system. The simple cyclic loop of the world plays out interactions between all of the objects in the system, generating a complexity through subtle variation and repetition of the basic elements in different combinations. Over periods of days or weeks, the same set of control structures produce a huge number of variations through the evolution of the original set of data.

Iconica uses a generative system to create unique images and soundtracks for each of the lifeforms generated by its alife model. The audio-visual language it draws upon for these representations relates to different graphic styles used in digital media that signify various views of reality. Synthetic forms are displayed as clusters of shiny geometric primitives, information forms are displayed as numbers and bits, and so on. These shifts in representation are an active use of *semiotic morphism* to create a multi-dimensional space in which different types of representation coexist and overlap in the same space.

The main mode of interaction in *Iconica* is the observation and manipulation of artificial lifeforms, and so it does not have *play mechanics* in the traditional sense of the word. However, the coded behaviour of the entities and forms follow rules of interaction that draw upon the rules of play found in strategy and role-playing games as well as the field of alife. The user may add energy and other forms to a space, or trigger interactions between entities and forms to influence their behaviour, but does not have the direct control present in most games. *Semiomorph* uses a more obvious model of *play mechanics* in that it is based on the successful completion of levels through the accumulation of points (completing a level causes a 'semiomorph' to occur to the entire game level, switching its entire mode of representation). In the game opposing entities may be destroyed by shooting at them, power-ups result in temporary invincibility and muticons change the avatar from one mode of representation to another. There is a twist to the *play mechanics* in that the interaction between the avatar and the entities in the game shifts, depending on which mode of representation the avatar is in; friendly entities may suddenly become enemies, as these relationships are dependent on relationships defined between the four mode of representation (word, diagram, icon, simulation).

Another level of the work is the relationship between the iconic language used to represent the world of *Iconica*—the alife model—and the way this language is used to interface with the world in terms of *evolutionary code*. The alife model operates using symbols. Energy forms, mutation forms, body structures, spaces, and so on are all defined as symbolic entities in the alife model. An iconic equivalent for each of these abstract symbols used in the code of the world can also be found in its iconic language. A simple grammatical structure is also used by the iconic language to describe relationships between elements in the world, such as which element a lifeform is made of, whether they are hungry, and so on. Communication by the user with lifeforms is also achieved through the iconic language of the world. As a result, the user slowly learns this alternative language through interaction with the work. This engagement results in a different kind of immersion that comes from the involvement with the system and language of an artificial world.

8.8 lifeSigns: eco-system of signs & symbols

lifeSigns investigates virtual worlds as vehicles for new forms of communication and expression. Working with the idea of the computer as a machine for processing and manipulating symbols, the world manifested in *lifeSigns* is constructed to evolve multiple digital media languages. This space combines two areas of research: alife, the coding of life processes into software and computational semiotics, the study of systems and codes of signification in digital media. The hybrid form that emerges is expressed in terms of the language of electronic space—through form, structure, colour, sound, motion, surface and behaviour.

This work explores iterative processes on a number of levels. *lifeSigns* is a digital game and therefore is based on the realtime feedback and world generation loop of three-dimensional simulations typical of games. It is also a persistent world that is the result of many iterations of the world become part of its history as each new cycle of the loop evolves this world further. Cyclic behaviours and patterns of activity emerge through this process, creating a sense of ebb and flow through the looped cycles of '*lifeSigns* history'. Finally, the interaction and play with the lifeSigns themselves use iterative processes for the generation and manipulation of image and sound. User input is translated into signals that are mapped through networks of individual atoms, the basic units from which all lifeSigns are constructed. The system uses the abstract, numerical representation of information as the starting point for this process, reconnecting the values to take another form. Sixteen parameters are available to manipulate each mesh or sound. The parameters to be mapped are determined by a set of switches in an atom. An atom receives four inputs that are then mapped to its mesh and sound, resulting in visual effects, animation, sound and music. Each lifeSign represents a unique configuration of this process, resulting in different outputs and behaviour.

lifeSigns appear throughout the world. They have been generated by a system of rules that govern features typical of signs, symbols and icons—such as symmetry, form, colour and sound. The results of these rules are encoded into a 'dna string' that uniquely defines each lifeSign. This also drives their behaviour as they choose to attack, befriend, leech, or mutate one another. They may also send messages or commands. Using a bank of four touch-sensitive buttons, each lifeSign may be performed by the player, resulting in the generation of synaesthetic sound and animation. Player input increases the energy of the lifeSign and therefore its chance of survival, as low energy lifeSigns will eventually die in the world. Furthermore, lifeSigns with excess energy may reproduce and generate offspring that combine features of the parent lifeSigns.

The *play mechanics* of *lifeSigns* involves 'playing the world'—a kind of play with computational processes and free exploration of the permutations of simple rule systems in and of themselves. It is not goal-orientated or score-based but is intended to invite exploration and experimentation with its space, logic and rules. The entities in the game space are played much like musical instruments and the interface is touch-sensitive to allow a range of different styles of play. This interaction also links into the dynamics of the simulation through cumulative input. Playing the lifeSigns gives them energy, acting as a method for indicating which of the evolved forms are popular with the audience and which are not. lifeSigns that are not played receive no energy and are therefore more likely to die. Play in this world is also connected to the idea of play and performance – playing an instrument. The lifeSigns function as audio-visual instruments that may be played together in the installation space in improvisational performance.

Evolutionary code does not only occur in the transmutation of interaction into the realtime manipulation of parameters of audio-visual representation. Each lifeSign has a 'meaning vector' that defines its meaning in the world. These come from a list of sixty-four words that describe actions, attributes and structures that are possible in the space. The players may affect these meanings, and the cumulative input of all players is collated to determine the final meaning. This process, combined with the system for generating lifeSigns, can be described as a 'generative meaning system'. It combines the capacity of the computer to generate multiple forms from the same system with the collection of data from human participants interpreting the meaning and significance of the forms generated.

lifeSigns explores the idea of emergent language. The languages generated by the work may be made of familiar shapes and forms, or may result in alternative forms indicative of an ‘alien logic’. The meaning of this space may also shift on another level. It may be seen as a model for the generation of digital media languages, an abstract world of form and colour, a representation of the cosmos, or a simulation of quantum-scale reality.

8.9 Summary

Algorithm is explored as the logic of digital media. Rules and systems are established in software that govern the relationships between players, entities and worlds. The player experiences these by being embedded within the processes themselves, allowing communication to occur via this process. These rules and systems can mutate and adapt to new conditions—allowing them to have their own creative or evolutionary capacity. Four key concepts have been explored:

- *system process,* nature of the loop, cycle or thought process or a world or simulation
- *multi-processing,* how many operations (inputs, entities, cycles) occur simultaneously
- *play mechanics,* the ways in which entities and world can adapt their behaviour
- *evolutionary code,* programs that develop or evolve in response to their environment.

These have been further demonstrated though two main examples: *Iconica: an artificial world made of language*, a multi-agent simulation that evolves entities that adapt to their environment and the audience over time; and *lifeSigns: an eco-system of signs & symbols*, a virtual world that blends alife, computational semiotics and digital games.

9 Analysis

Across this wide-ranging journey through digital games, electronic media art and other forms a collection of elements, themes, properties and terms have been defined, articulated and demonstrated.

Through this digital media poetics, we arrive at a system for human-computer expression.

This system addresses digital media on its own terms, via its specific terms, tools and functions of expression. Human beings and intelligent machines are treated equally by the model, acknowledged and engaged with via a common language. The model maps and engages with the hybridised, mixed reality that emerges from the synergistic interaction of human and computer.

In this mixed reality, at the macro level we have the real world, and at the micro level individual people in that world. These people may be players of digital media. Digital media connects with reality in various ways – not always via players. At the macro level is the virtual world, and at the micro level the agents, bots and entities that may be identified within that world. Players may be in a virtual world, or interact directly with bots in that world. Players may interact with other players via a virtual world; worlds may interact with one another or with reality itself.

These complex systems of relations can be understood using the model developed and articulated in this thesis. Overall, the system is varied and complex but is essentially based on simple principles: interaction allows human input; representation provides feedback in response; structure enables the building of worlds and processes; and algorithm allows artificial worlds and their inhabitants to react. However, this system impacts on many different levels of reality.

Communication is augmented or extended as the player embodies an avatar, inhabits a virtual world, plays a game or manipulates digital processes via the audio-visual code that is shared between these activities. These modes of communication may combine traditional forms such as writing or filmmaking, but in a hybridised, enhanced context—such as being connected to worlds populated by intelligent machines. Likewise, new forms of human expression have developed through digital media poetics. This can be seen in the range of practice demonstrated in the new media arts, and the engagement of these practices with science and technology alongside the arts and humanities. Artists work with digital games, computer software, robotics and other technological forms to create work using the unique potential and aesthetics offered by human-computer expression.

Artists and designers may develop a practice that is based around using the computer not as a tool, but as a collaborator to engage within the creative process. This type of human-computer creativity is outlined in Whitelaw's account of art and alife (Whitelaw 2004) in which he identifies breeders, the cultivation of cybernatures, artists building systems in hardware and those developing 'abstract machines'. It may involve a poetic programming practice or a musician's cybernetic interface with a studio of electronic instruments and computer. It could be a visual artist breeding networks of evolving drawing agents to make pictures. Perhaps it is an architect using parametric digital design systems or a designer employing generative systems as their design process. Some of these systems take the form of instruments that rely on a synergy between human and machine for their performance. They act as a prosthesis or extension of the artist's body consisting of a cybernetic system that relies on human input to function. Both human and machine components rely equally on one another to complete the loop that makes the system.

These complex systems and networks of human-computer expression also extend to alternative ways of being. Within virtual worlds and online games, for example, the formation of multiple identities connected to one individual becomes possible through the creator of multiple or multidimensional avatars. Identity is distributed across a range of different locations – in the fiction of a virtual world, via gameplay and interaction, the player's social network, the ways in which the artificial world bleeds into their real life, and the ways in which all of these elements are connected within the system. These intelligent systems may also constitute alternative types of cognition quite different from the ways in which humans process and understand the world. A network of interacting agents may sense the world around them in different ways, such as responding to players in a virtual world, reading the state of their environment, and collecting information from sensors and tracking devices in the real world. All of these processes build a picture of the world around the intelligent machine that is quite different from the ways that humans perceive the world. Aside from this alternative viewpoint, this also translates to a kind of denatured logic that results in machine thought as well as perception.

The spaces shared by humans and machines are also unique. More than simply a representation, a simulation involves modelling a subset of reality that not only looks real but functions and responds realistically as well. This may be extended to abstract models of biological life and ecosystems in virtual worlds populated by artificial lifeforms. Interaction with these spaces embeds a player or players within the simulation, making them an integral part of the system. This may occur through them playing a game, manipulating or building the space, or influencing the evolution of the artificial lifeforms. In each case the world itself becomes the medium for human-computer expression. On a purely aesthetic level, these spaces represent new types of experience for both human and machine. Humans may experience aesthetics of data, code and computation, and machines may experience aesthetics of human behaviour and unpredictability.

Other aspects may also be considered—such as the alternative social spaces and relationships that form in virtual worlds and online games—that are largely based around relating to another person via the machine of their representation. These worlds also have real world economic and political impact, adding to the myriad ways that they bleed into and overlap with real life.

This idea of human-computer expression has been explored and tested in a number of created worlds that explore a poetics of digital media. Through a series of practical experiments, various relationships between human beings and intelligent machines are explored in interactive systems. Each of these is an expression of different aspects of our system. In this chapter eight bodies of work will be documented and deconstructed to explore *transmedia mapping*, *semiotic morphism*, *recombinant space*, *evolutionary code* and other properties of digital media. First of all, we will review our system of elements, themes, properties and terms.

9.1 Model: elements plus themes

With the elements and themes established in the previous chapters as the building blocks of digital media, sixteen unique properties have been defined. They constitute the language proposed in Chapter 4. Digital media may be analysed in terms of the presence, quality and quantity of these properties. Further insights may be found in the analysis of the relationships between these characteristics.

The properties identified are summarised as:

	Time	Multiplicity	Adaptation	Transmutation
INTERACTION	*experience flow*	*hyper modality*	*system behaviour*	*transmedia mapping*
REPRESENTATION	*simulation time*	*semiotic morphism*	*adaptive expression*	*emergent meaning*
STRUCTURE	*simulation lifespan*	*ontological complexity*	*meta design*	*recombinant space*
ALGORITHM	*system process*	*multi-processing*	*play mechanics*	*evolutionary code*

Figure 73. Properties and characteristics of digital media

INTERACTION:

a) *experience flow:* pace, timing and flow of the human-computer conversation
b) *hyper modality:* the number of player inputs and modes of interaction
c) *system behaviour:* how the system reacts and adapts to player input
d) *transmedia mapping:* meaning mapped to input and the translation of interaction

REPRESENTATION

e) *simulation time:* the speed and timeframe in which a simulation is situated
f) *semiotic morphism:* type and number of mappings between data and its representation
g) *adaptive expression:* forms of representation that are generated or that may adapt or change
h) *emergent meaning:* meaning generated via shifts across levels of human-computer expression

STRUCTURE

i) *simulation lifespan:* temporal structure in terms of timeline, time limits and lifespan
j) *ontological complexity:* complexity of an ontology and its possible relationships
k) *meta design:* flexibility of structure in terms of recombination and modular construction
l) *recombinant space:* how meaning shifts via spatial manipulation and crossmedia traversal

ALGORITHM

m) *system process:* nature of the loop, cycle or thought process or a world or simulation
n) *multi-processing:* how many operations (inputs, entities, cycles) occur simultaneously
o) *play mechanics:* the ways in which entities and world can adapt their behaviour
p) *evolutionary code:* programs that develop or evolve in response to their environment.

These properties and characteristics have been defined in detail in the preceding chapters based around each element. They provide a guide to the ways in which human-computer expression works. In practice, each needs to be considered in relation to player, entity, virtual and real world. With this model in place, the focus can shift to explore a suitable methodology for its use.

9.2 Using the model

Guided by this list of properties and characteristics we have an alternative way of looking at digital media on its own terms, using its own language. Through this model we can articulate and understand a generative arts or digital design practice, experimental interaction design or alternate reality game. The model can deconstruct, map and analyse the systems within a digital game, virtual world, interactive installation or website. Any type of digital media may benefit from its application via fresh insights or new understandings.

This application can take place at the three levels of player, developer and critic. In many cases these roles are combined in the development process: play is used for testing experimental prototypes, and likewise, critical analysis is integrated into an iterative development process. A player may cross over into the realm of the developer through player-authored content or other activities that involve construction or manipulation of the game world. Players may also be developers; critics may also be players and so on. Due to the participatory nature of digital media these roles are blended.

Essentially, the model shows us where to look and what to look for. Using this poetics of digital media we can find ways to understand systems of human-computer expression. In practice, the typical methodology can:

- determine the main context: play, development or analysis
- scope the system in terms of its elements and themes
- identify a subset of primary properties and characteristics
- articulate the relationships in terms of player, entity, virtual and real world
- gain insight into the generation of meaning that occurs, or the experience created through human-computer expression.

Once identified, we may then focus on analysing how a particular relationship functions, what message is communicated and how it is perceived.

These elements, themes, properties, and relationships may be articulated visually using diagrams to indicate what has been identified and how the various elements in the system are connected. In the example below, a relationship between interactivity and sound has been identified. System diagrams such as these may be used in the development and analysis of digital media to understand its flow of input, feedback, construction and logic. Visualisation of the system thus becomes an important part of the analytical process, in combination with writing that describes the detail of the articulation.

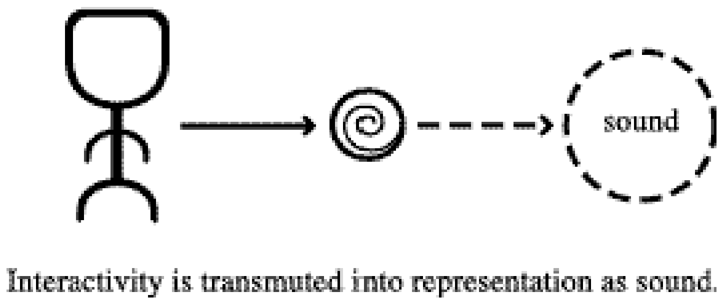
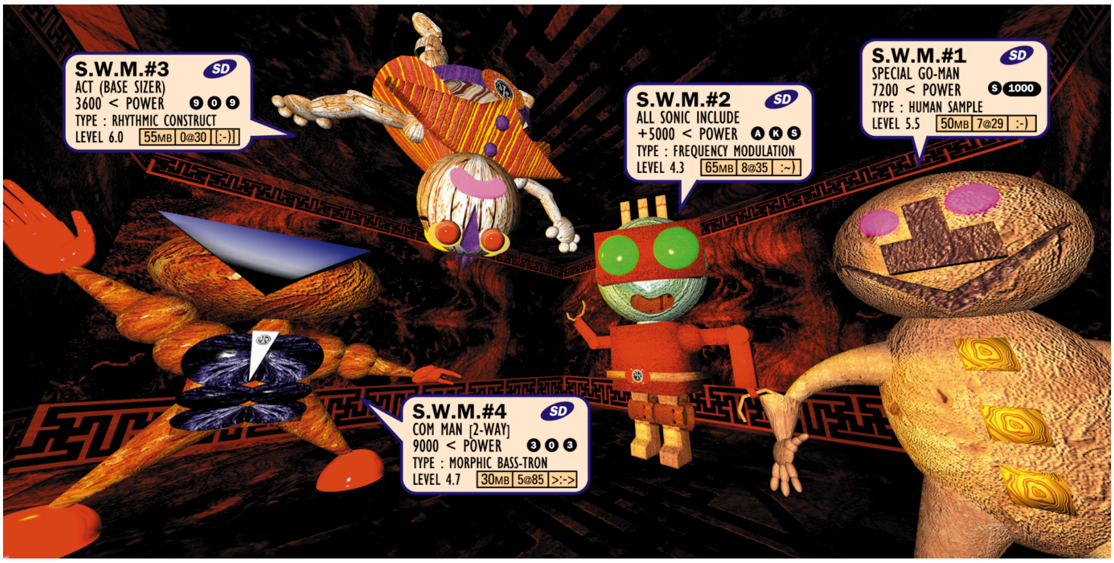


Figure 74. Example of the use of symbols to illustrate a digital media relationship

9.3 Case studies

Earlier in the thesis, the context for this investigation was outlined in terms of practice-led research—engaging with a digital media arts practice exploring digital games, computational semiotics, virtual world design, iconographic languages, artificial life, synaesthetic and ubiquitous media. Within this reflexive practice a number of works were produced that explore and demonstrate a poetics of digital media in action. A series of eight case studies of these particular works or bodies of work will be used to test both the methodology and model.

9.3.1 Shaolin Wooden Men (SWM) in PsyVision



Shaolin Wooden Men

Digital character design

Computer animation, digital game, interaction design

Troy Innocent 1996

Programming: Troy Innocent

Music: Ollie Olsen

Figure 75. Shaolin Wooden Men, *WE ARE SOUND* (1996)

Inspired by the sounds and structures of techno music, the *PsyVision* project represents a set of prototypical language elements for the visual expression of this new sound. Central to this new way of seeing mediaspace is the creation of figures that are iconic in form, often remapping other cultures and meanings onto these forms. Consequently, the codes of our contemporary mediaspace have been sampled, reformed and mutated in Psy-Vision, deliberately detached from any narrative context. This allows figures such as the *Shaolin Wooden Men* to become 'visual instruments' whose actions and movements are played in sequence like music. These sequences consequently create visual constructions that represent the sound and evoke mood and atmosphere.

Figure 1. SWM: Entities

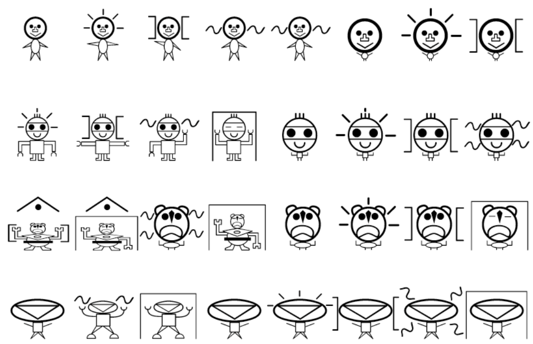


Figure 2. SWM: Iconography

Figure 3. SWM: World

Figure 4. SWM: Code

Figure 76. Entities, iconography, world and code in *Shaolin Wooden Men*

This body of work explores a range of musical-visual forms that are expressed via electronic spaces and digital characters. In the computer animation, *PsyVision*, eleven tracks of electronica are used as the inspiration and score for a collection of synaesthetic animations – each explores a different kind of direct relationship between image and sound. Some of these are quite abstract; for example, the first animation uses a collection of simple, organically shaped icons to illustrate levels of the sound, by associating them with formal qualities such as specific motifs and rhythms. This concept is extended further via the *Shaolin Wooden Men*, a virtual band of digital characters, each of whom personify elements of digital music production. SWM#1 = samples/vocals, SWM#2 = lead synth, SWM#3 =

bassline, and SWM#4 = drum machine. The characters are made of sound and image, and the group is embodied through them: brought into being by a human musician and animator, but having an identity and existence through digital media independent of these human agents. Other SWM projects include interactive sound toys and a crossmedia project that places them back into the real world, each of these exploring different aspects of their identity and presenting them as autonomous digital entities.

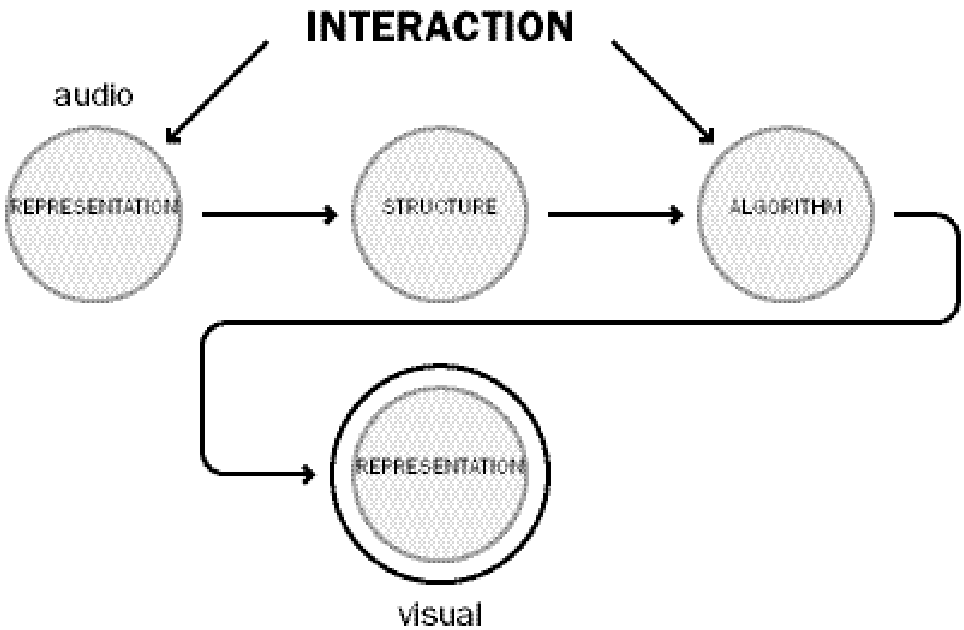


Figure 77. *Emergent meaning*: musical-visual form generated via the transmutation of sound into image

Emergent meaning refers to the process by which levels of meaning are generated by shifts in representation, such as those that occur in synaesthetic media. A musical representation may be expressed in terms of a structure suitable for that medium (note data or digital samples) and then be processed via an algorithm so as to shift into another form of representation, such as computer animation. This process may be repeated several times, or may occur multiple times in parallel with multiple notes being processed or several different frequencies of sample data being analysed. By engaging with this process the player comes to understand formal qualities of both the image and sound through its transmutation. Another level at which *emergent meaning* occurs is via the expression of digital characters or virtual worlds across media, such as that which occurs with the SWM. They personify something quite abstract—digital sound—and can make this tangible in many contexts: online, as animation, as fictional character, and so on. As they appear in these various contexts, the imaginary world that they represent becomes more believable. This is similar to the process that many fictional characters go through, simultaneously appearing in cinema, games, merchandising and television. However, the SWM make no attempt to deny their digital origins and instead use them to play with and explore the levels of meaning that emerge across media through this process.

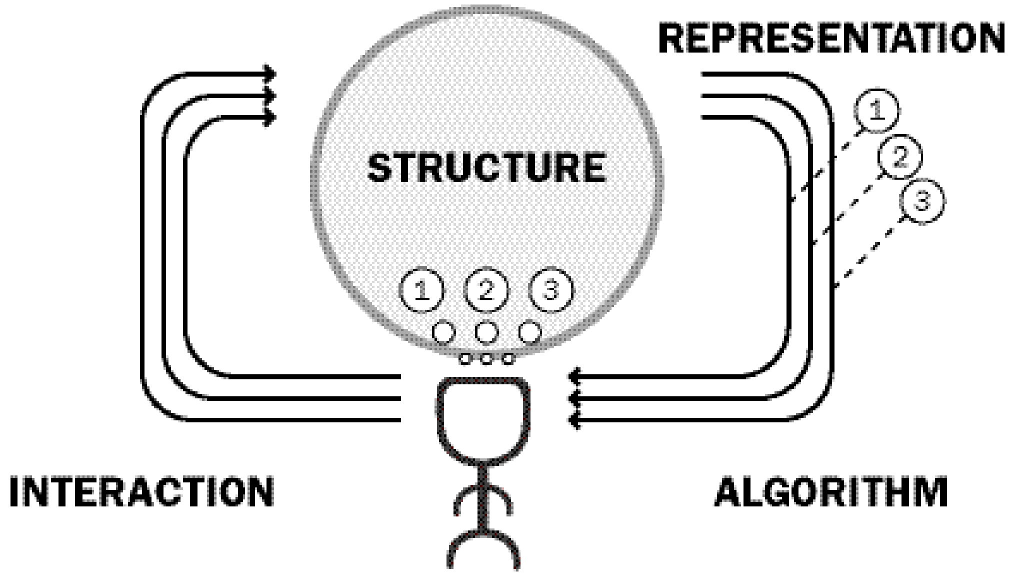
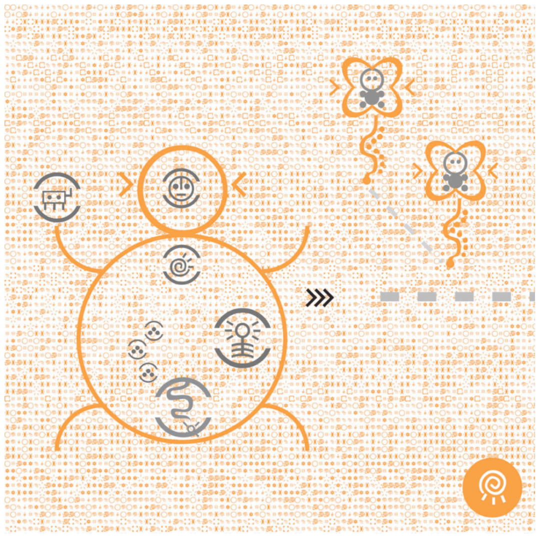


Figure 78. *Meta design*: map of its many levels within the structure of digital media

Meta design describes the flexibility of a structure and its ability to adapt to different forms of expression. This may occur via a system that has many basic units of structure with few methods for combining these, or a system with a few basic structural units that may be combined in many different ways. In both cases, these processes will be influenced to varying degrees by interaction (such as allowing the player to build objects) or by algorithm, (such as worlds that include autonomous processes of construction or growth). The interactive work *We are Sound* allows up to four players to compose SWM-style music using a set of arcade style game controls. Each player controls an individual SWM and has access to their particular library of sounds. These sounds may be placed into a score as it is played, allowing the composition of a 16 bar looping track. Various power-ups and other items allow the player to switch sound banks. In this example, a large library of units may be combined in various ways via a set of simple actions; the complexity of the system comes from the range of sounds within the library and the multiplayer aspect, rather than the process itself. As such, it represents a structure that may be adapted to a range of expressions generated by the player's actions.

9.3.2 Iconica: an artificial world made of language



Iconica: an artificial world made of language
Interactive installation
Dual-screen projection, surround sound system,
computer interface
Troy Innocent 1998
Programming: Troy Innocent / Steve Taylor
Music / sound effects: Ollie Olsen

Figure 79. Troy Innocent, *Iconica: an artificial world made of language* (1998)

Iconic elements are the basic building blocks of a world literally made of language. Six elements from this language relate to unique pictorial styles and soundscapes used to represent the world, ranging from plastic knowbots and surreal iconography to electronic abstraction and the dirt of the real world. These elements are used as the base of an alife model that runs the world, the behaviour of the objects and lifeforms within it.

The work has the capacity to evolve, change and mutate through human interaction and its own evolutionary process. Visitors to the world can create, construct and manipulate objects; influence the evolution of societies; and discover new language elements. Communication with the residing lifeforms occurs via the iconic language on which the world is based. The multiplicity of *Iconica* is experienced through this interaction—simultaneously a cyberspace, a mindspace, an abstract world, and a stylised reality.

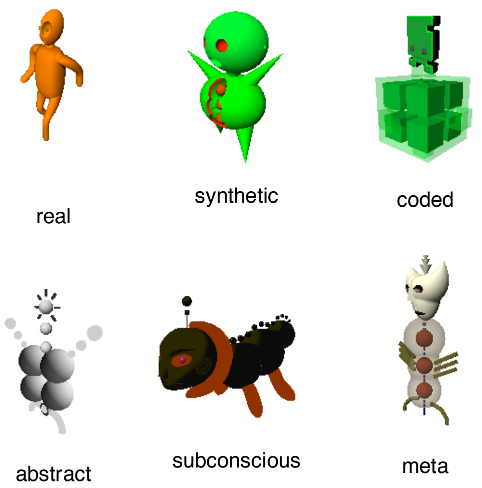


Figure 1. *Iconica*: Entities

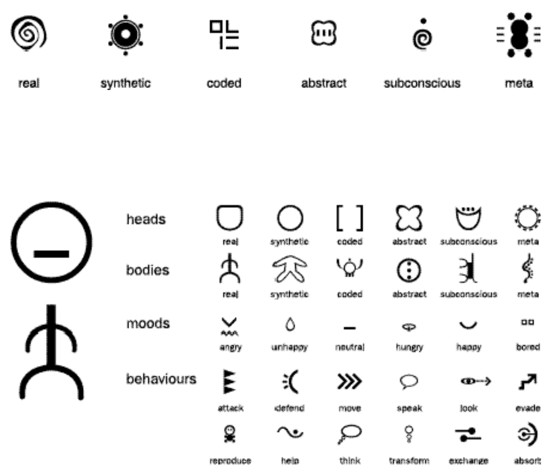


Figure 2. *Iconica*: Iconography

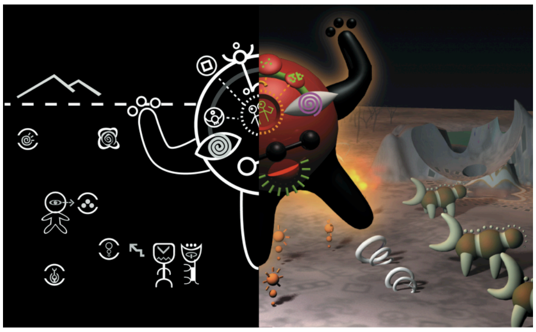


Figure 3. *Iconica*: World

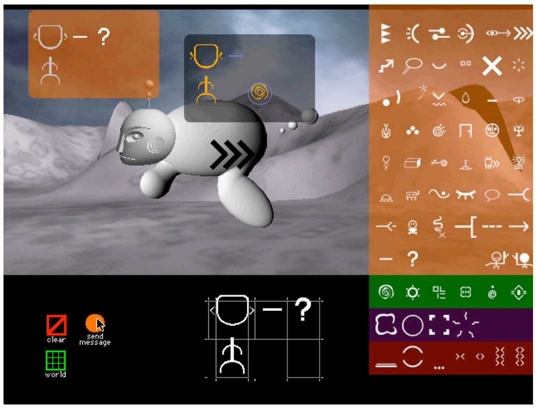


Figure 4. *Iconica*: Code

Figure 80. Entities, iconography, world and code in *Iconica: an artificial world made of language*

The starting point for this work is a collection of over fifty icons that define a language. Each icon has a particular meaning and they may be combined using a simple grammar to create statements and questions about the artificial world that they describe. This world consists of elements, forms, entities and spaces that are explored by a single player. The language has three major functions: to define all that can happen or exist in the artificial world; to provide the building blocks for programming that world; and to enable communication with and within the world. By way of example: all of the possible forms that may exist in the world are included; the list of behaviours that entities may perform is likewise illustrated; and the player may construct statements or questions using these icons and others to interrogate the world and its inhabitants. In this way, the world is simultaneously described, created and mediated via the constructed iconographic language. The language itself articulates six alternate audio-visual representations of reality, using symbols and shapes that are endemic to electronic space.

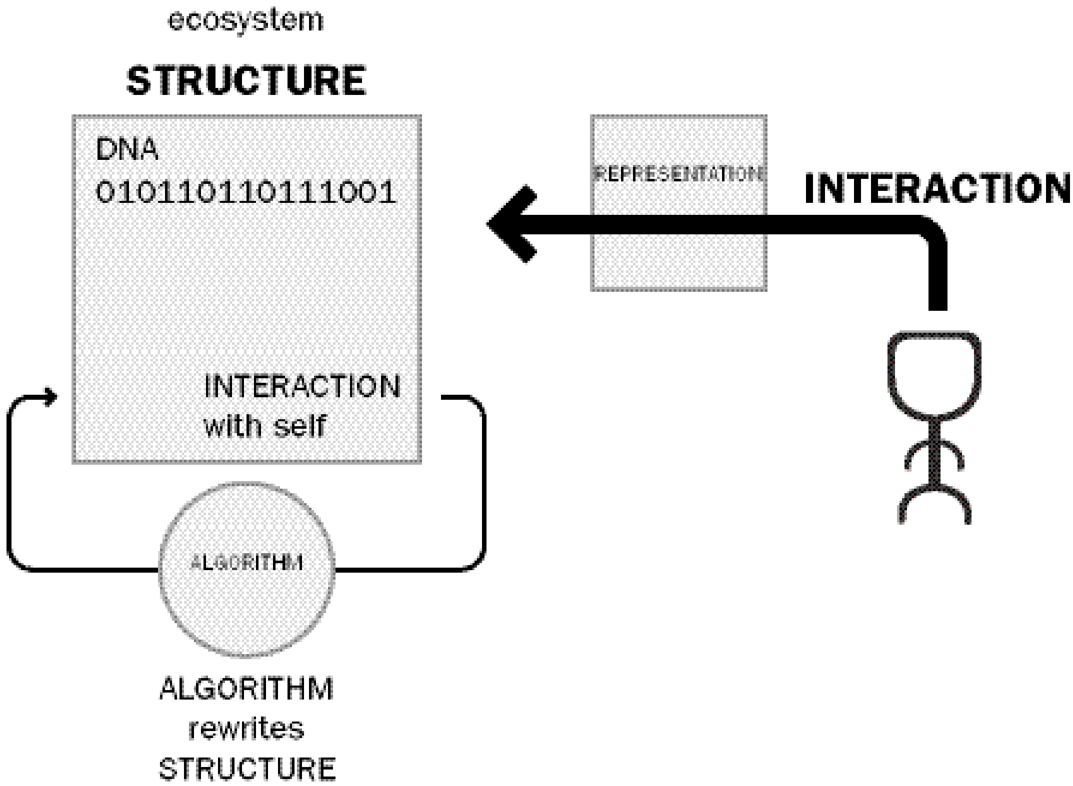


Figure 81. *Evolutionary code*: In *Iconica*, the code in the ecosystem is constructed from the same language that defines and represents the world

Evolutionary code defines the ways in which algorithm may be transmutated by processes that are included in the programming of digital media. In *Iconica* all of the artificial lifeforms or entities are constructed using a string of digital DNA. This is built from the language and describes the representation of the entities and also their interaction with one another and the world. This system is based on Holland's model for building ecosystems that uses tags made of elements to define interactions between entities. In this system, when two entities attack one another the outcome is determined by comparing tags. A meta-entity attacks an infos-entity and its 'attack' tag is compared to the second entity's 'defend' tag. This generates a score that determines how successful (or not) the attack was and may result in a loss of energy for the defending entity. In the artificial world, thousands of these interactions occur to slowly evolve a population of entities that adapt to the conditions of the world. The world that they adapt to is one created by players that may communicate with the entities, feed them, add forms to the world and so on. Successful entities may reproduce. This behaviour creates a new entity that shares a random mix of their parents' digital DNA, using a genetic algorithm so that they inherit characteristics of both parents. The artificial world evolves through interaction with players and via interaction within its own internal systems.

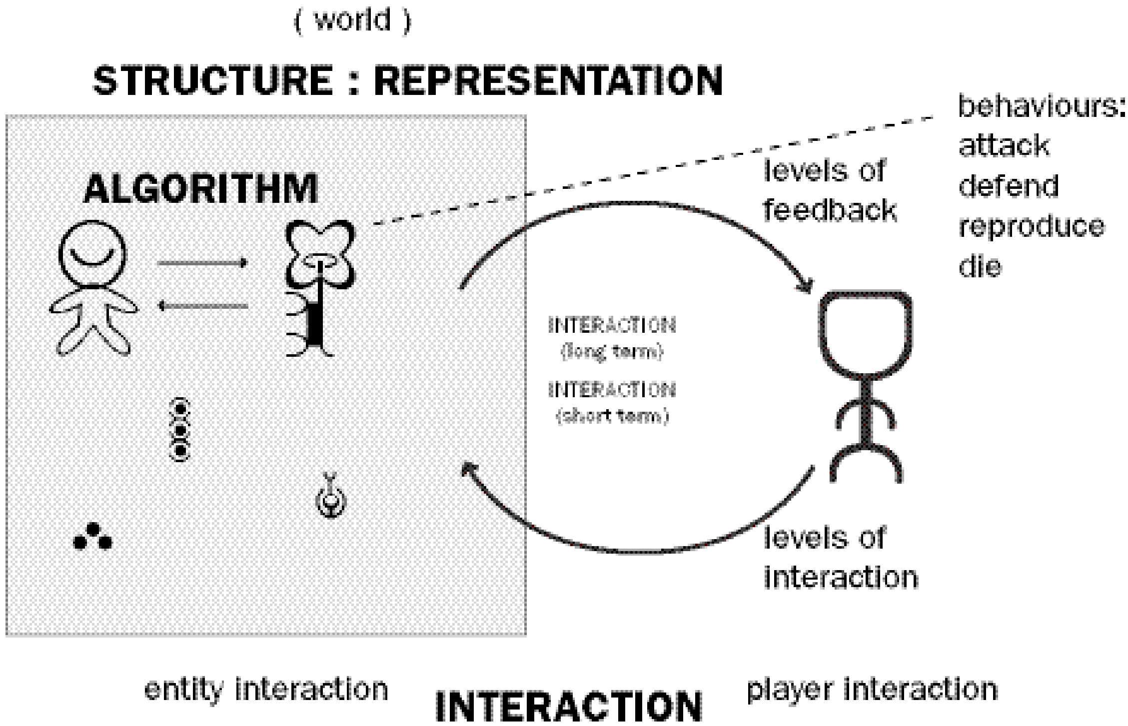
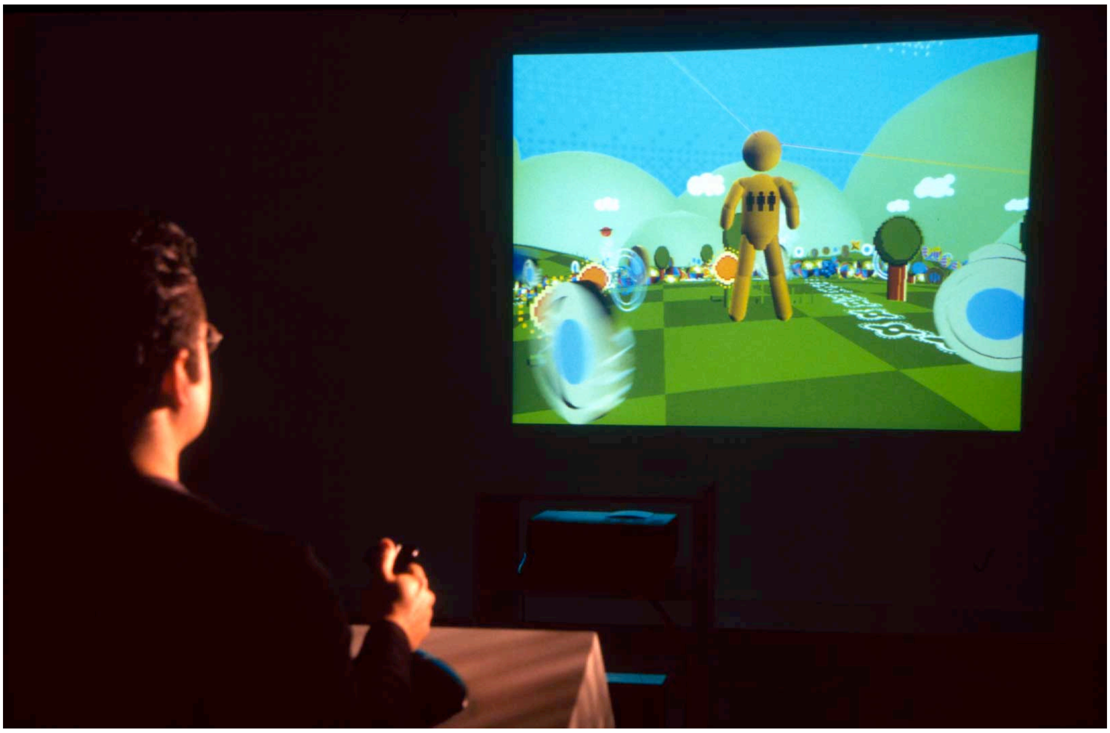


Figure 82. *System behaviour*: Expressed via levels of interaction within the world

System behaviour describes how entities respond to interaction and what feedback they provide to the player. The entities in this artificial world each have the same list of possible behaviours and individual tags that determine the success of these described in their DNA. These behaviours include attack, defend, reproduce, exchange, search and so on. They relate differently to various objects in the world: if an entity attacks an energy-form they eat it, if they attack another entity then the two of them engage in combat (and if one of them is killed their body is broken up into forms that may then be eaten). This is one level of interaction that exists within the world and happens independent of the presence or actions of a player (although a player may influence entity interaction). Another level occurs through player interaction with the world, of which there are two main modes. First of all, the player grows to understand the entities by observing their behaviour and interaction with one another. This is one way in which meaning is embodied in the world via *system behaviour*. Based on this observation the player may also interact with entities by giving them energy-forms, or head-forms, spirit-forms or digest-forms. Energy-forms may feed the entity. The others may become part of the entity and give them new behaviour: head-form = search function; spirit-form = mood function; and digest-form = increased capacity to store energy. These forms that become part of the entity's body also alter their appearance. The third level of interaction occurs via conversation with the entities, using the language that is particular to *Iconica*. An entity may be engaged in conversation to discover what it is doing, what it is made of, what it needs and so on. This allows the player to get to know the entity better, through learning its language—and thereby understanding the world through the ways in which it is defined, constructed and articulated.

9.3.3 Artefact: Semiomorph and Mixed Reality



Semiomorph
Digital game
Video projection, surround sound system, computer interface
Troy Innocent 2001
Programming: James Sofra
Music / sound effects: Ollie Olsen

Figure 83. Troy Innocent, *Semiomorph*, 2001

Artefact is an installation of interactive objects and spaces that deconstruct the language of electronic games. The shift in perception between the real and the simulated is explored by accentuating errors, or 'artefacts', in the representation of reality. These works explore the dynamic between the iconic ideal and the personal specific; duality and multiplicity; and the way in which our identity is shaped by our language and communication.

Figure 1. ***Semiomorph***: Entities

Figure 2. ***Semiomorph***: Iconography

Figure 3. ***Semiomorph***: World

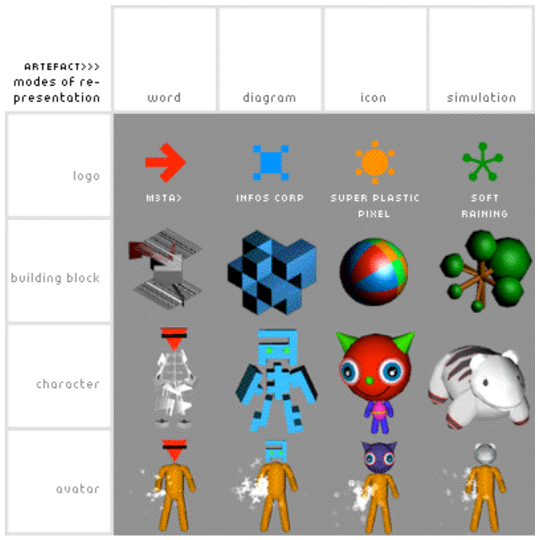


Figure 4. ***Semiomorph***: Code

Figure 84. Entities, iconography, world and code in *Semiomorph*

In this work a basic set of codes are defined that describe the structure of a game world. These consist of typical game objects: energy (points); power-up (invincibility); blast (bombs); and muticons (switch player mode). All of these objects serve the gameplay in various ways. The world may be represented via one of four modes of representation: word, diagram, icon and simulation. Each of these relates to the selection of a 3D mesh and sound, but they are also defined as properties of the object, so that the player may collect word-energy or diagram-energy and so on. Four groups of game characters personify the four modes of representation and the player may take on any of the four modes. Outside the game, the visual language of the game world has been interpreted into an installation of interaction, sculpture, light and sound. The game itself is an experiment with a simple form of *semiotic morphism* and the installation explores the idea of *transmedia mapping*. Each will be discussed in turn.

Semiomorph game space: word mode

Semiomorph game space: diagram mode

Semiomorph game space: icon mode

Semiomorph game space: simulation mode

Figure 85. *Semiomorph* game space in four modes of representation

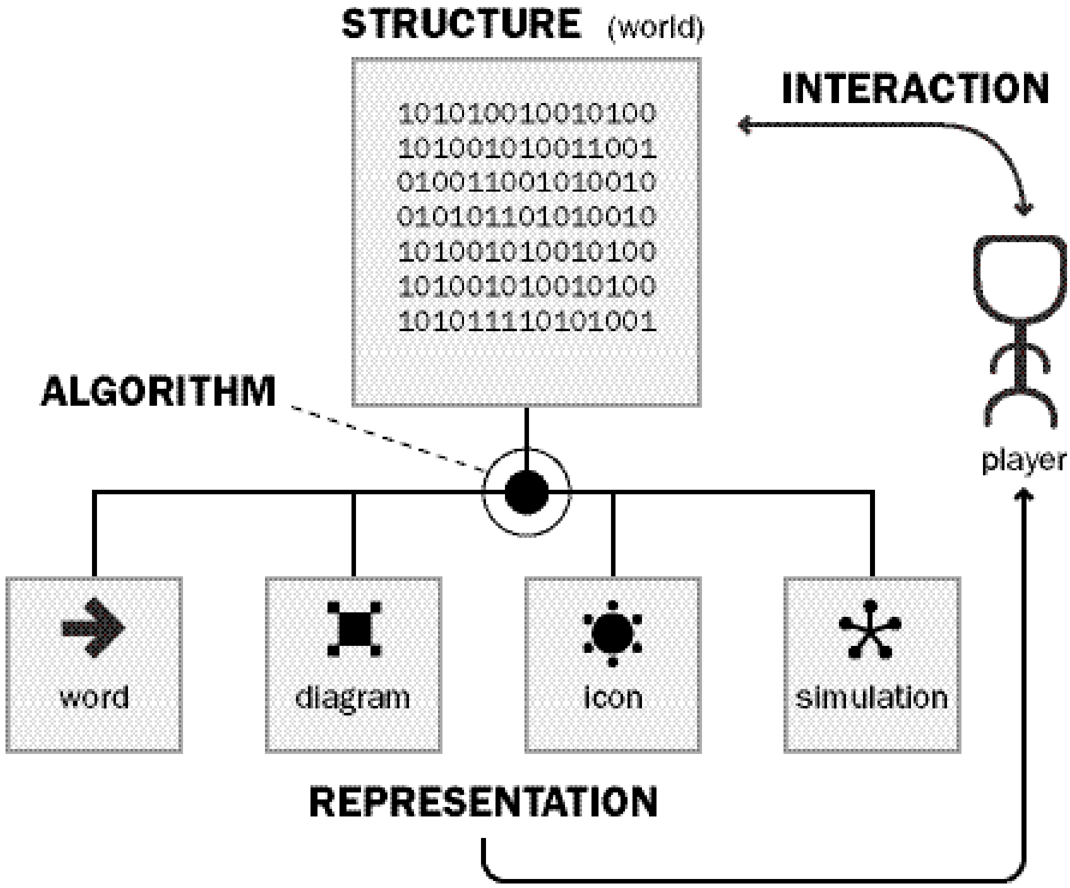
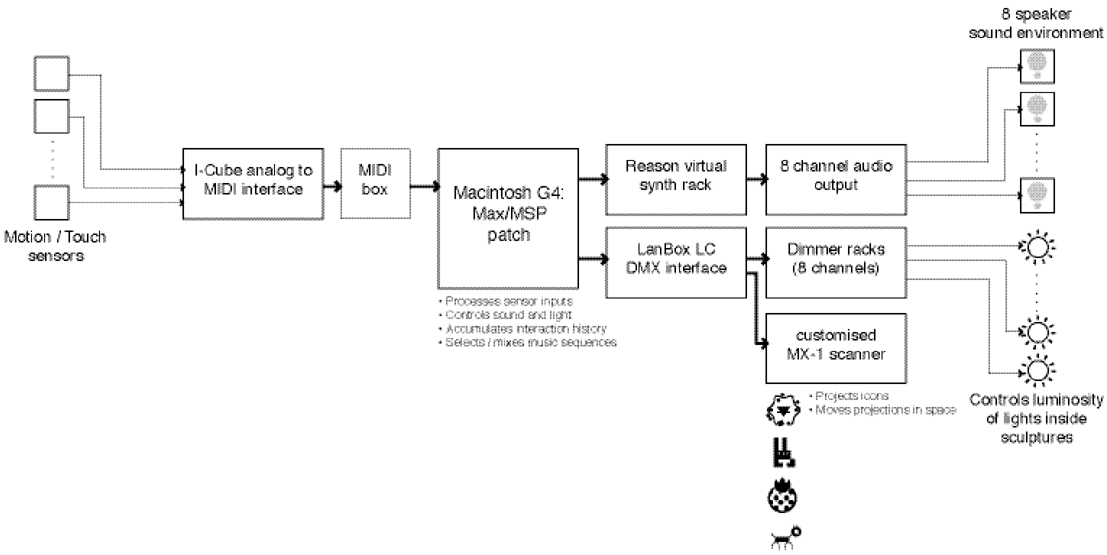


Figure 86. *Semiotic morphism*: outline of process expressed in *Semiomorph*

Semiotic morphism describes the process by which multiple representations may be generated by a digital media system. The way in which this works in the game world of *Semiomorph* is to create a coupling between player interaction and the three-dimensional representation of the game. This is defined by a simple algorithm that changes the appearance of the current zone of the game world in response to the player's avatar. The result is a multitude of ways that the underlying structure of the game world may be rendered. These are generated by play – interaction with the world. As the player collects energy, the properties of that energy affect their representation. If they collect mostly 'word-energy' then the player appears as a word-avatar, diagram-energy appears as a diagram-avatar and so on. This in turn alters the behaviour of entities in the game world via interaction rules: icon beats word, simulation beats diagram, and so on. So, while the player appears in the game as a word-avatar they are pursued by icon-entities. When they switch to diagram-avatar these entities give up the chase and the simulation-entities begin their pursuit. So, this process of play changes the game world representation that in turn changes the rules of interaction. (The relationship is illustrated in the diagram below). This has an impact on the player's perception of the game world, as it changes via the twofold process of *semiotic morphism* in the work: changes to the rendering of the game world and rules changes that alter interaction with the entities in the game world.



Mixed Reality

Interactive installation

Plastic models, analog sensors, computer controlled light/multi-speaker environment

Troy Innocent 2001

Modelmaking: Peter Farrer, Monash Industrial Design Workshop, GMK Design

Figure 87. Troy Innocent, *Mixed Reality* (2001)

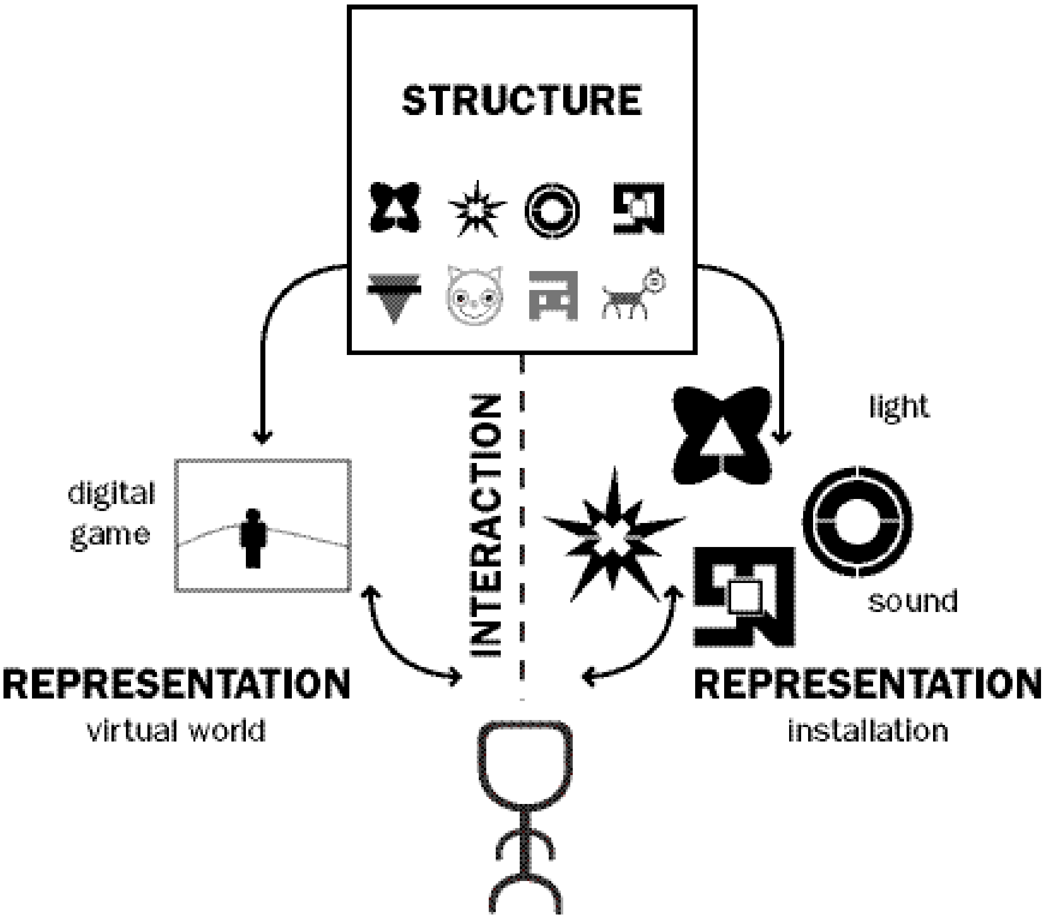
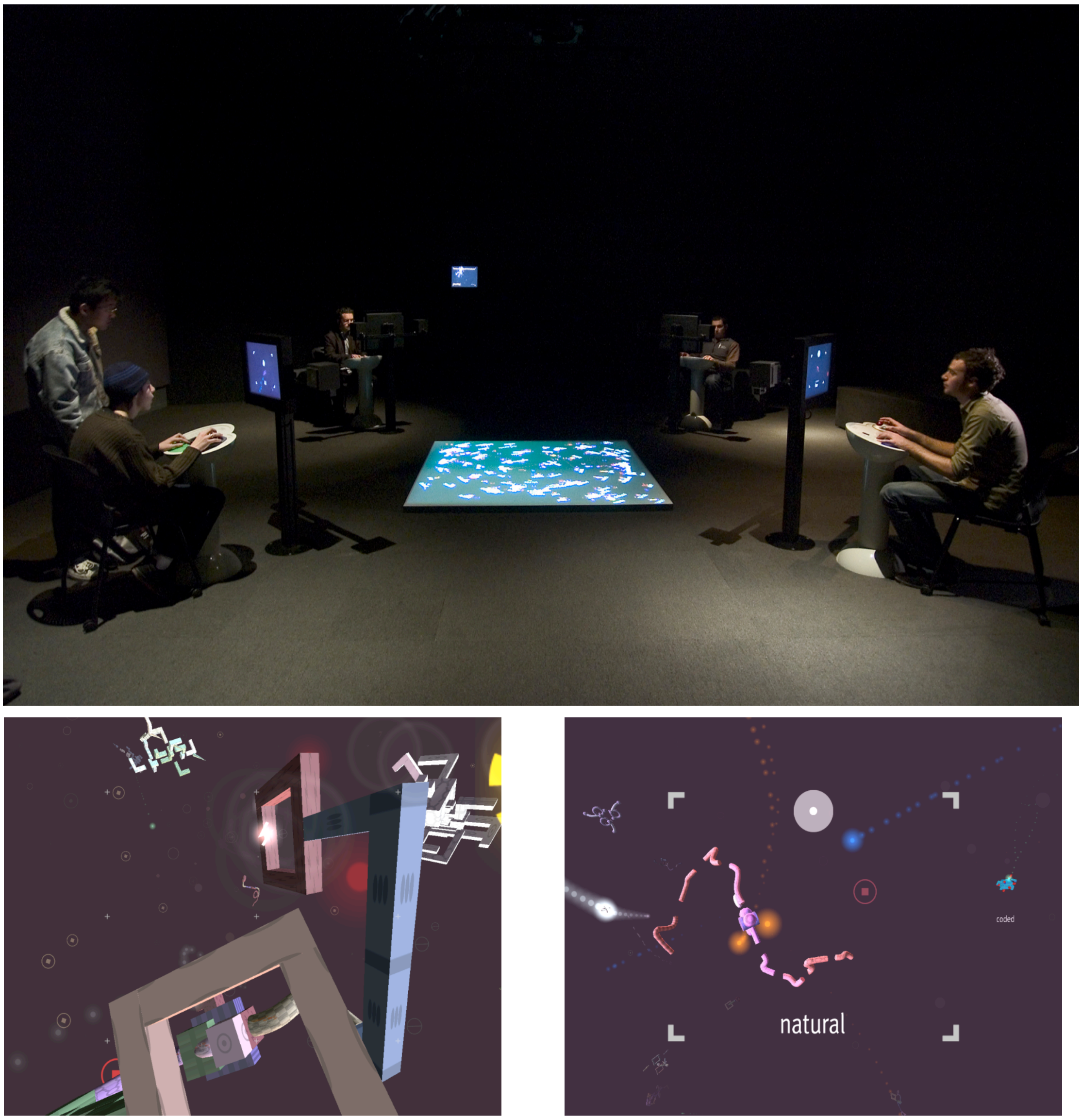


Figure 88. *Transmedia mapping*: articulated via the relationship between digital game and interactive installation in *Mixed Reality*

Transmedia mapping defines the ways in which interaction is transmutated via different types of media and the space they occupy. In this case, interaction with the game world is mapped via two contrasting methods, augmented by various minor mappings. The process of interaction with the game world has been described in the earlier discussion on *semiotic morphism*. The *Semiomorph* game is played via a third person perspective—by navigating an avatar through the interactive environment, picking up objects, avoiding entities and so on. In the installation the same objects and entities are represented by life-size interactive models—the virtual is literally made real. The reference point for the scale of these models uses a person of average height as a stand-in for the player's avatar. As these person-avatars walk around the installation space they engage with the models of objects and entities via motion and pressure sensors, that in turn trigger a response via computer-controlled light and sound. The interaction of people in the space is tracked by the installation so that it moves through various stages of intensity mapped via a different system to that of *Semiomorph.* A moving light that changes its colour and graphic in response to these events marks every interaction. Each object or entity may contain a certain amount of energy similar to that in the game world: word-energy, diagram-energy and so on. As they are triggered this alters the overall mix of the generated sound environment via an algorithm that maps these values to a bank of software synthesisers. The energy values decay over time so that without interaction the installation slowly returns to a state of silence. The perception of the language of *Artefact* by the audience is shaped by these two different mappings: digital game and interactive installation. Their relationship to the game objects and entities is mediated via interaction with a game in which visual representation shifts and changes; in contrast with an installation that is animated by a soundtrack generated in response to patterns of interaction. Further mappings of this language occurred via a printed catalogue and website. The catalogue interpreted the objects and entities of the Artefact world and represented the game through cards, stickers and game board.

9.3.4 lifeSigns: eco-system of signs & symbols



lifeSigns: eco-system of signs & symbols
Troy Innocent 2005
multi-player game world displayed on four LCD screens and as a single-channel projection; stereo audio and 4.1 surround sound
interactive; colour

Software development: Nicholas Sandow, Shee Zon Chen, Leng Hou Tan
Interactive sound design: Jeremy Yuille
Sound design: Steve Law

Database design/coding: Steve Taylor, Harry Lee

Figure 89. Troy Innocent, *lifeSigns: an eco-system of signs & symbols* (2005)

lifeSigns is part of an investigation of virtual worlds as vehicles for new forms of communication and expression. Working with the idea of the computer as a machine for processing and manipulating symbols, the *lifeSigns* world evolves multiple digital media languages. This space combines three areas of research: alife, the coding of life processes into software; computational semiotics, the study of systems and codes of signification in digital media; and digital games, particularly the idea of play with process and artificial space. This hybrid is expressed as a virtual world – through form, structure, colour, sound, motion, surface and behaviour. In *lifeSigns* you 'play the world'.

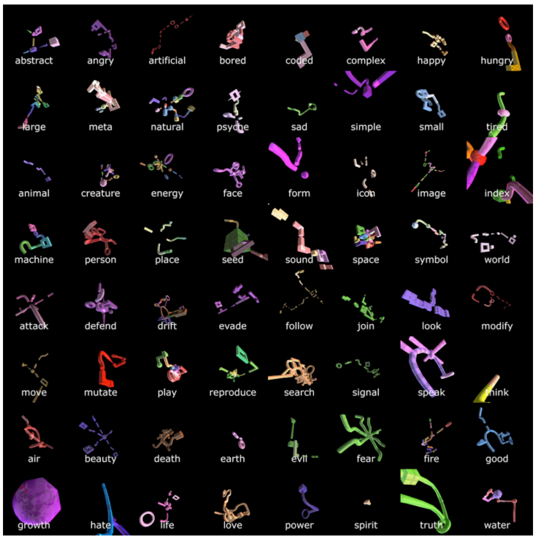


Figure 1. *lifeSigns*: Entities

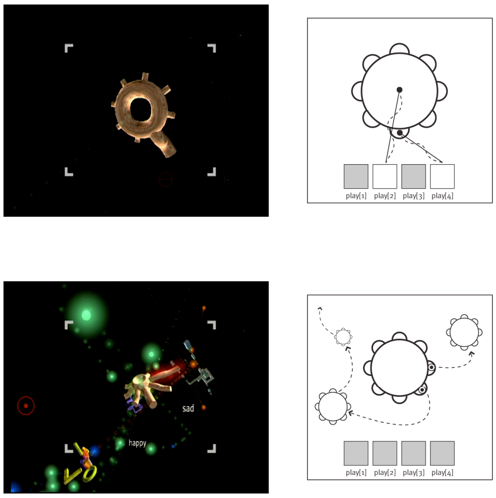


Figure 2. *lifeSigns*: Iconography

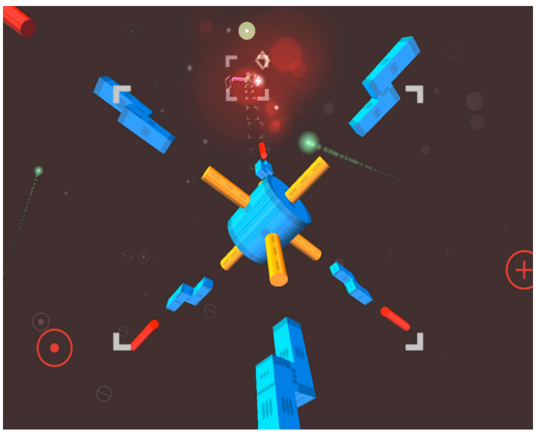


Figure 3. *lifeSigns*: World

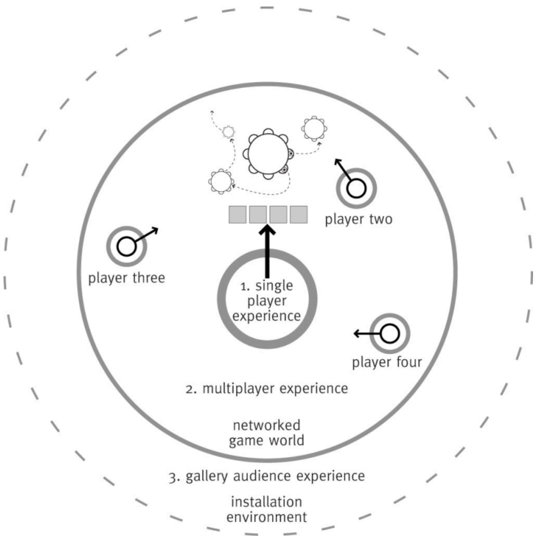


Figure 4. *lifeSigns*: Code

Figure 90. Entities, iconography, world and code in *lifeSigns: eco-system of signs & symbols*

lifeSigns are entities within a world, and have three main properties: they are artificial lifeforms within an ecosystem; they are expressed as three-dimensional computer graphics and sound; and players may perform or assign labels to them. As alife they primarily interact with one another through a set of entity behaviours similar to those defined in *Iconica*, including attack, befriend, leech, reproduce, join and so on. As graphics and sound they are signs and symbols within an audio-visual language built from geometric primitives, visual effects, animation, synthesised sound, tonal music and digital samples. Players may view the entire ecosystem at once in map view and up to four players can directly engage lifeSigns by performing them using a digital music interface. Labels may be assigned to them from a list of sixty-four words including abstract, angry, artificial, bored and so on. The lifeSigns ecosystem is a game world that supports a population of between one and two hundred lifeSigns and provides a space for play.

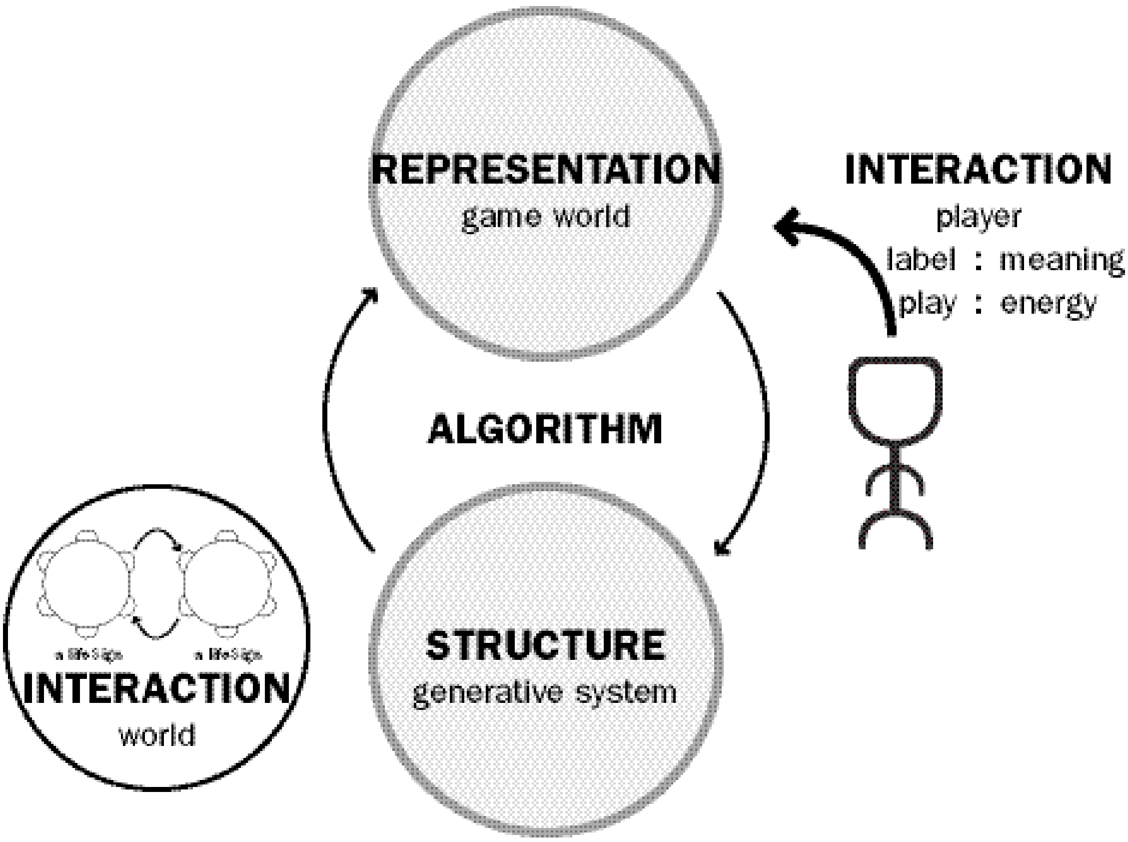


Figure 91. Levels of *multi-processing* in *lifeSigns: eco-system of signs & symbols*

Via *multi-processing,* multiple outputs generated via an algorithm are interpreted and assigned meaning by a player or players. Each lifeSign is modelled via three main structures: energy – if this reaches zero the lifeSign dies; meaning—assigned by players, this determines how lifeSigns interact with one another; and DNA—this describes the lifeSign and is used in reproduction, similarly to the process used by the entities in *Iconica.* Players may interact with the first two structures (energy and meaning) and as a result indirectly affect the flow of the third structure, lifeSign DNA, throughout the ecosystem. Playing lifeSigns provides them with energy; this in turn allows them to survive, or if they have an excess of energy, to reproduce. The process of play also demonstrates to the player the particular aesthetic properties of each lifeSign through the performance of their musical-visual form, forming an impression or sensation in the player's mind. This may inform the selection of a label for the lifeSign by the player. Changing its meaning in this way alters the way that others will interact with it: it may become compatible with a different group of lifeSigns and therefore more likely to join them; incompatible with others and so will attack or try to leach energy from them; neutral to others and so ignore them.

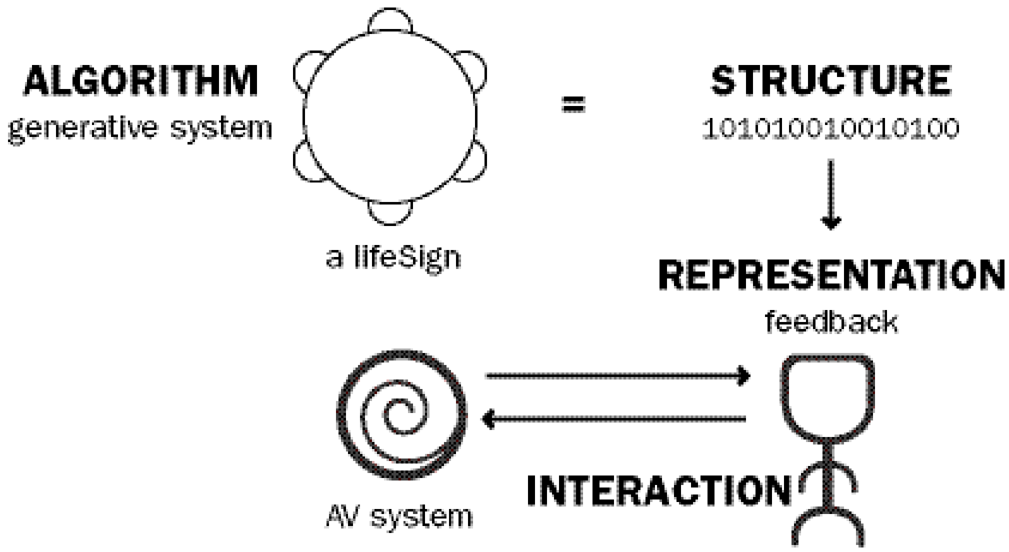
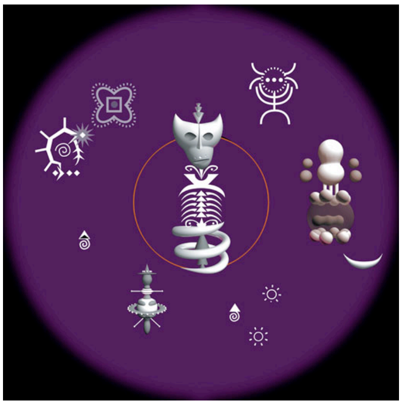


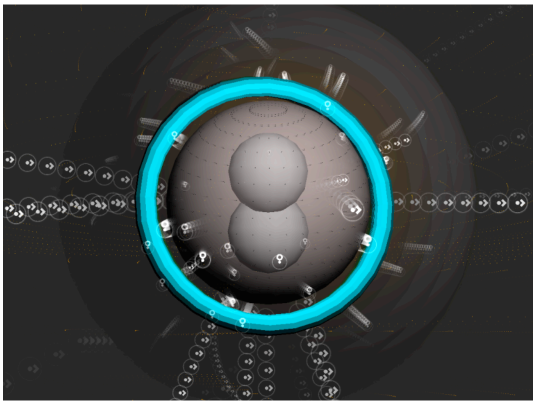
Figure 92. *Adaptive expression*: articulated via the process of aesthetic selection in *lifeSigns: eco-system of signs & symbols*

Adaptive expression describes how a representation may change or adapt, either directly or indirectly, to feedback from its environment or from a player. Two mechanisms are required for this to occur: a representation that is able to change (this could either be through synthesis or the recombination of elements) and a form of interaction providing feedback that performs the function of manipulation or selection of the representation. Both of these mechanisms are built into the ecosystem within *lifeSigns.* Each lifeSign is a representation of an underlying structure that allows an almost infinite number of musical-visual forms within the parameters of the system. As this is a competitive environment, lifeSigns must first of all survive within the world through play; players then select from those that survive ones that are aesthetically appealing to them. As outlined earlier, this gives them energy, thereby promoting reproduction. Over time (hours, perhaps days) the population adapts to the aesthetic preferences of the audience through these selection pressures.

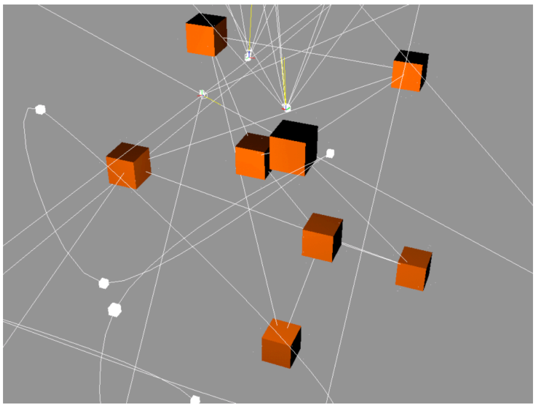
9.3.5 Interactive sound environments



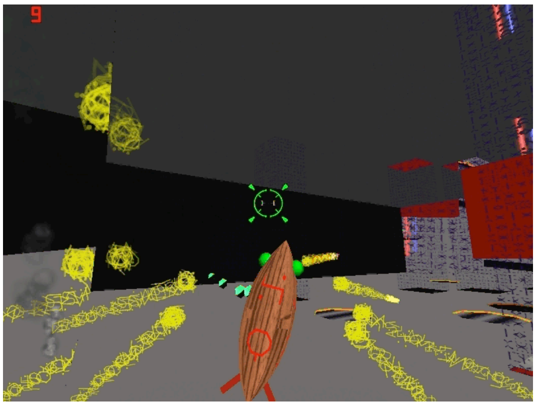
Soundform



Osmotic Signals



au_vecta



SWM05: distributed bodies of musical-visual form

Figure 93. Troy Innocent, *Soundform* (1997); Troy Innocent, *Osmotic Signals* (2003); Troy Innocent, *au_vecta* (2002); Troy Innocent and Ollie Olsen with the Shaolin Wooden Men and Harry Lee, *SWM05: Distributed Bodies of Musical-Visual Form*, (2006)

This body of work consists of six interactive sound works that explore processes by which synaesthetic media is generated. Each system maps electronic sounds and computer graphics to one another to create a space, an animation or compositional toy. In some cases, an audience is invited to interact with the system as performer; in others the system is created for the generation of live or recorded performances by the artists. Each system will be summarised in turn, with key aspects highlighted.

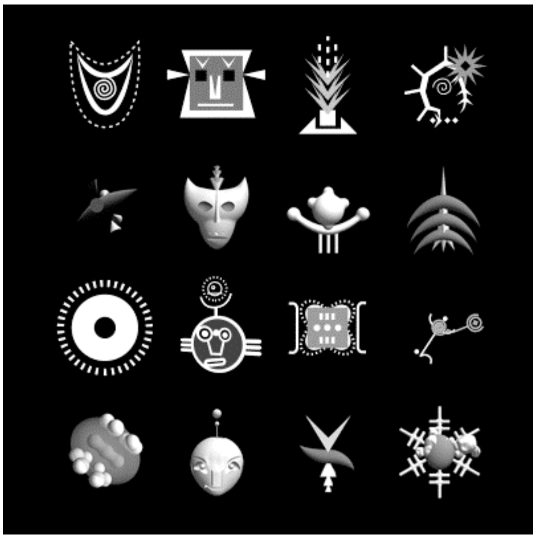


Figure 1. Entities

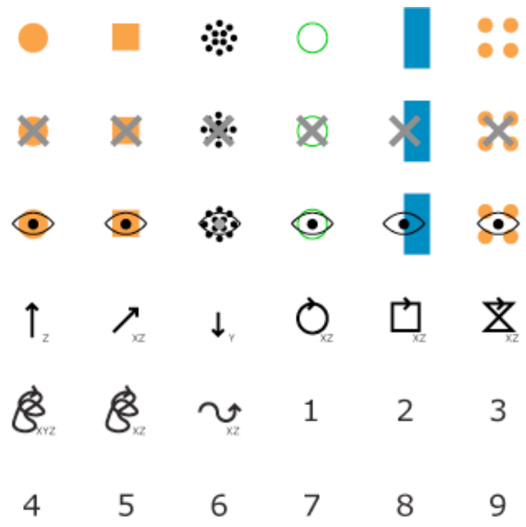


Figure 2. Iconography

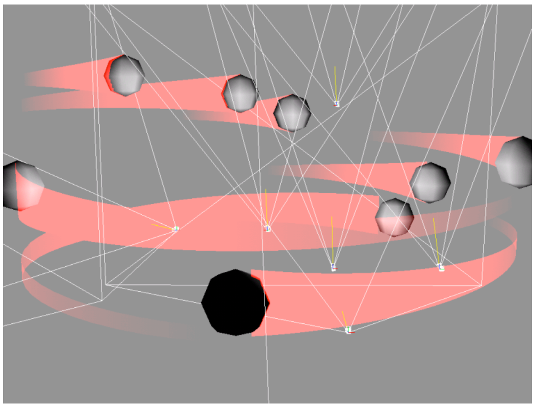


Figure 3. World

Scene control

1: spheredrum ON	Q: spheredrum OFF
2: cubik ON	W: cubik OFF
3: pfield ON	E: pfield OFF
4: prox ON	R: prox OFF
5: plana ON	T: plana OFF
6: array ON	Y: array OFF

Camera control

7: sphereDRUM cam
8: cubik cam
9: pfield cam
U: prox cam
I: plana cam
O: array cam

A: linearZ	Z: target 1
S: linearXZ	X: target 2
D: linearY	C: target 3
F: circularXZ	V: target 4
G: squareXZ	B: target 5
H: sqaureXZ with cross	N: target 6
J: freeformXYZ	M: target 7
K: freeformXZ	: target 8
L: waveformXZ	: target 9 (special)
;: path 10 (special)	

Figure 4. Code

Figure 94. Entities, iconography, world and code in interactive sound works

SWM05: distributed bodies of musical-visual form features performances by the SWM as machinima recorded within a modified game environment. In this environment four vehicles are flown about the space to generate image and sound. *Osmotic Signals* is a performance tool in which a MIDI sequencer triggers both electronic instruments and abstract computer graphics in realtime and is recorded to digital video. The *TransMutational Meta-Processor* is a suite of tools for simultaneous synthesis of computer graphics and electronic sound according to a system that allows formal qualities of each form to be 'patched' into one another. This was developed for the purpose of evaluating the aesthetic qualities of various combinations of these parameters. *au_vecta* is an interactive electronic space that acts as an instrument. A modified keyboard displays a matrix of icons that allow the selection of different combinations of camera movement, sound banks, geometries and performances encoded into the space. *Soundform* is an interactive compositional tool in which forms represent sequences of notes that are performed through one of sixteen timbres. Each timbre is represented visually. Two soundforms may be combined to produce a child soundform that blends the sequences inherited from its parents. *We are Sound* is a four-player interactive compositional tool in which players may place sounds from a library of samples onto a score in realtime.

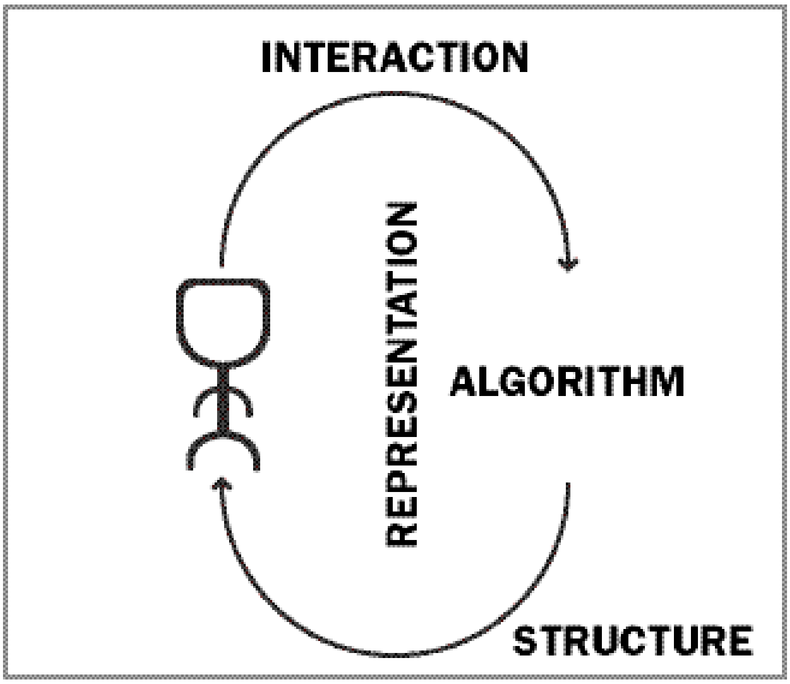


Figure 95. *System process*: as 'thought process' of a world connecting interaction and representation via algorithm within a structure

System process refers to loops, cycles and iterative processes that are usually being constantly updated in the running of a world. In all six of these experiments with synaesthetic media systems the player or performer is embedded in this process so as to compose musical-visual form in realtime. In each work, an electronic space is established that includes geometry and sound sources. In some cases, multiple spaces are networked to one another so that one space plays another via an established protocol. These spaces have their own internal processes governing the simulation: how often to update the graphics display, when to receive input, process of sound synthesis, settings for tempo, and so on. All of these processes run in realtime and may also be manipulated by the player within the same timeframe. The player is therefore embedded within the process of the system—they provide an input and the system immediately generates a response, expressed as musical-visual form. Both player-initiated and system generated processes may interact with one another in the simulated space. This interaction can be seen as the thought process of the space. This process may be a simple, reactive machine much like many of these experimental sound works; or if there are autonomous entities in the space then these will change their behaviour in response to the player and one another in realtime. Such a scenario occurs in the complex behaviour seen in the virtual world of *lifeSigns*. This work evolved from earlier experimental interactive sound works such as *au_vecta*, *TMMP* and *Osmotic Signals.*

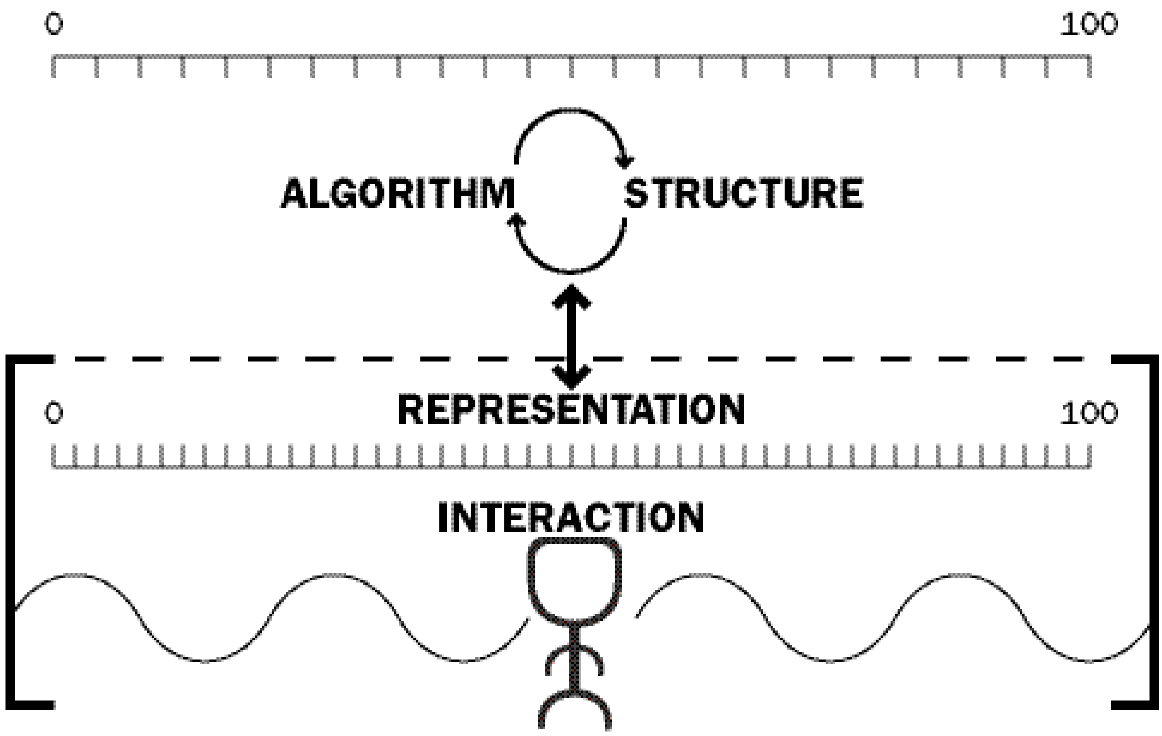


Figure 96. *Experience flow*: via interaction mediated through representation

Experience flow describes the ways in which interaction builds an experience or conversation with digital media over time. In this collection of interactive sound works this occurs largely through the engagement with realtime processes of image and sound generation—much like playing an audio-visual instrument. The unit of time that governs interaction plays a significant role in this. *We are Sound* and *Osmotic Signals* both use sixteen step sequencers to keep time in the simulation, with each step worth a number of frames. This is in contrast to *Soundform* and *SWM05* that allow continuous interaction with changes on a per frame basis. Other types of digital media altogether, such as those that use a point and click interface, do not govern interaction via constant timestep, but simply passively await response, typically by trapping the player into a loop until some exit condition is satisfied. Crossmedia projects such as *neome* distribute interaction across a range of experiences and events in different media linked via fictional characters and worlds.

9.3.6 *Ludea featuring neome*

neome

Alternate Reality Game

email, website, mobile phone, interactive sculpture, street performance, sound and light

Troy Innocent 2006

Modelmaking: Daniel Calleja

Programming: Stewart Haines

Figure 97. Troy Innocent, *neome* (2006)

Ludea is a micro-nation where language and culture are generated via play. On the streets of Melbourne three warring cultures struggle for territory: Neo-Materialists use traditional forms of communication such as words; Post-Symbolics communicate only through images; and Post-Humans are reliant on machines for communication. Each tribe gathers resources and tags in colour: Neo-Materialist orange, Post-Symbolic green and Post-Human blue. Victory goes to the clan that achieves the widest domain.

Figure 1. *Ludea*: Entities

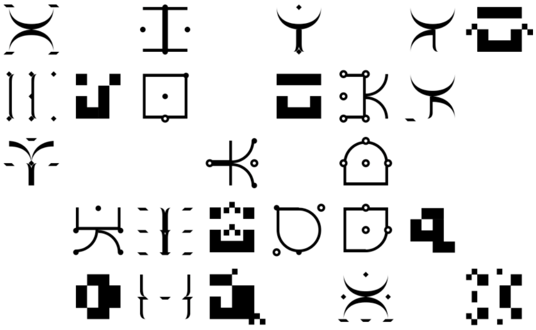


Figure 2. *Ludea*: Iconography

Figure 3. *Ludea*: World

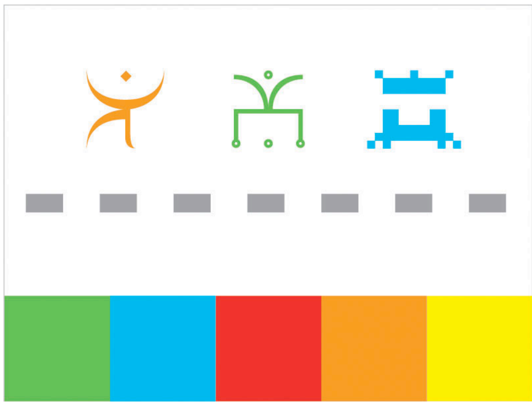


Figure 4. *Ludea*: Code

Figure 98. Entities, iconography, world and code in *Ludea*

This work is a micronation in which language and culture are generated through play. Although expressed via exhibitions, online media and game art projects, it is not identified as any one of these events in particular, but as an ongoing fictional universe. Established in 2005, it was conceived as a ten-year project spanning a multitude of media. This body of work articulates the particular language and culture of the three ethnic groups that inhabit Ludea. Characters, stories and signs will be embedded within city streets, galleries, interactive sculpture, newspapers, online communities, blogs, mobile phones and virtual worlds. These diverse media are linked via a crossmedia narrative that allows the migration of the concept through different modes and experiences. This occurs through signs and symbols that are mapped onto real-world locations to create meaningful connections and experiences across three different public spaces: virtual, networked and physical.

The processes and flows between the three spaces articulate a storyworld based on the conflict and interaction between three ethnic groups. By using this approach, a story that begins in an online conversation may form the basis of a street performance that in turn provides material for a short video that then informs the meaning of an artefact, that is later exhibited in a gallery, and so on. This crossmedia approach invites intertextuality and explores the interstitial spaces between different media as much as the media itself. Each form offers a different reading of the work and this transmutation of meaning is as much the subject of the work as the fictional world it describes.

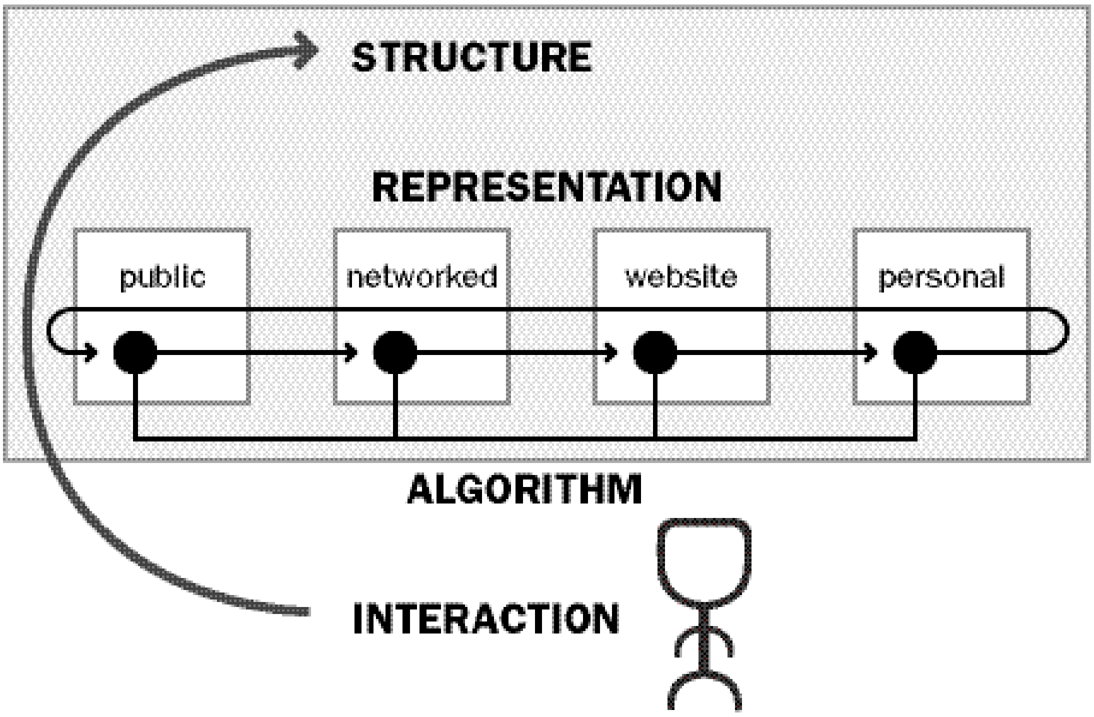


Figure 99. *Recombinant Space*: Common structure distributed over different spaces linked by representation and interaction

Recombinant space describes the way that an underlying structure such as that which defines a fictional world may be expressed in a range of different media, each new expression shaping the meaning of the original structure. In *neome*, a short Alternate Reality Game set in the Ludean universe, a series of events and interaction are staged across email, a website, mobile phones, an interactive sculpture, and a street performance. The fictional world of *Ludea* and the role of *neome*, a character within that world, persist across these various media. The structure of this world is distributed across public, networked, virtual and personal spaces. Each new expression expands our understanding of *Ludea* and grounds it deeper within the reality of everyday experience: it is not confined to a virtual world or exclusively expressed through a gallery installation, but through a combination of different types of space—each of which bring their own inherent qualities to the work. By establishing codes and connections that cross over these spaces, such as a text message inviting a player to visit a website that in turn provides clues for them to visit a performance within a laneway, these spaces are perceived as an ongoing storyworld. This is constructed from the combination of a range of different spaces linked by this world as a common structure.

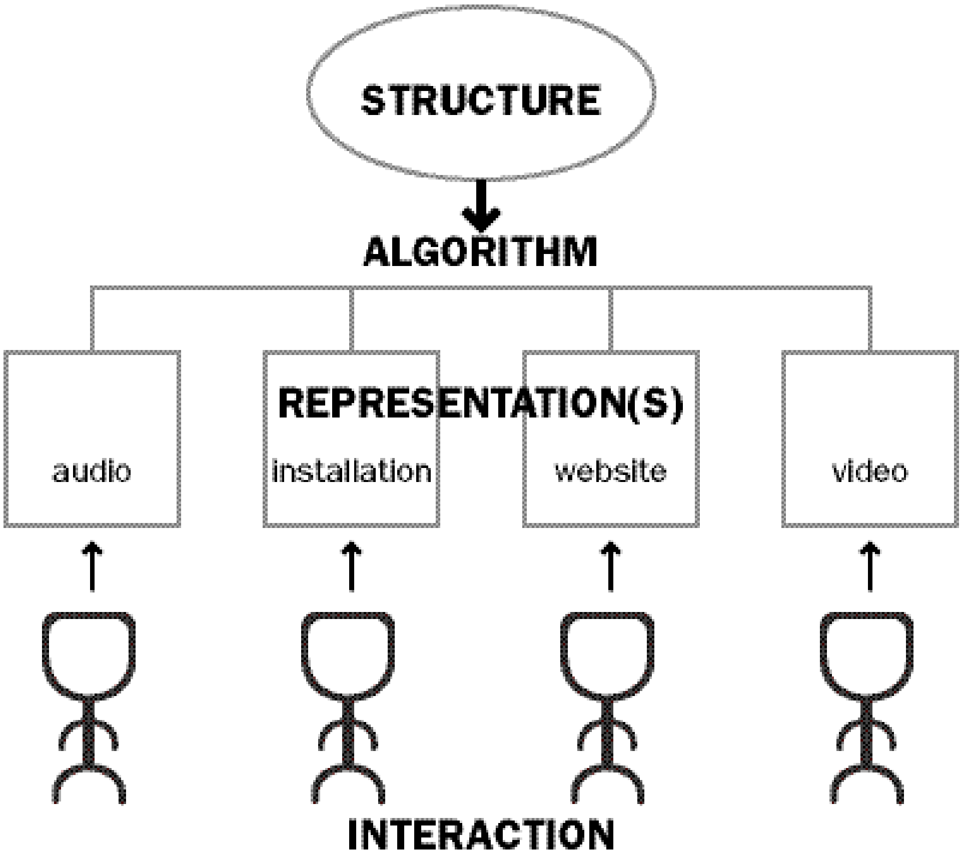


Figure 100. *Hyper modality*: as expressed through four modes of interaction and their corresponding representations across a shared structure

Hyper modality refers to the range of interaction with a work, and how simple or complex that may be. In some cases, there may be one mode of interaction with many possibilities—such as the Nintendo Wii and all the variations that come from its remote. In other cases, multiple modes of interaction may be employed in a single space, such as a virtual world, or multiple spaces, such as a crossmedia environment. The world of *Ludea* is conceived of as a crossmedia environment with its characters, spaces and languages expressed in a range of media such as video, modelmaking and digital imaging. In *neome* this is extended further so that players interact with the fictional world via a mobile phone, an interactive sculpture and a website—each with their own mode of interaction. The mobile phone establishes a personal connection with the character of *neome* and makes her presence pervasive as she appears in a range of contexts as each new text message appears. The interactive sculpture sets up a location-specific, direct mode of interaction that responds to the actions of the player's entire body. These interactions and others such as the street performance and gallery visit are held together via the website that tracks and logs each player's individual progress through the game. In this work, five different modes of interaction can be identified, with more of these apparent in other manifestations of the work.

9.3.7 *Field of Play*

Field of Play

Interactive urban art environment

Painted aluminium, custom luminaires, lasercut steel, shotblast pavers, multi-player digital game, computer-controlled light, four-channel sound.

Troy Innocent 2007

Modelmaking: Premier Graphics

Programming: Stewart Haines & Troy Innocent

Figure 101. Troy Innocent, *Field of Play* (2007)

Field of Play is an urban art environment that is integrated with the landscape and spaces between the *Innovation Building*, *Port 1010*, and the forthcoming *Life.lab* building at Digital Harbour in Melbourne's Docklands. This environment transforms that space into a playing field using sculpture, paving, interaction, light and sound. The installation into Harbour Lane is the major component of the work. A playing field defines and governs the rules of play in a game. The term originated in sport, where it is used to describe the surface on which games are played – the basketball court, the football oval and so on. Markings on the playing surface define goals and zones of play. Metaphorically, it is often used to refer to the space of business transactions, for example, the term 'level playing field' describes a marketplace that is open to free trade without external interference, such as government regulations.

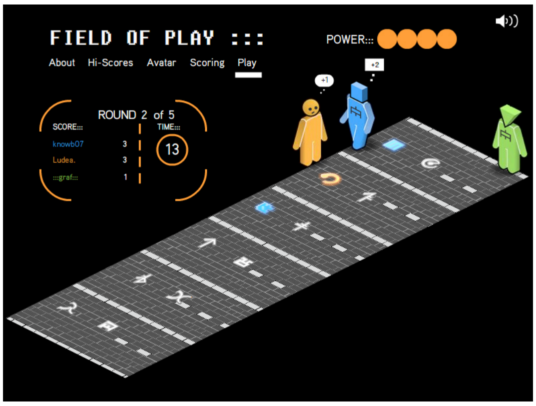


Figure 1. *Field of Play*: Entities

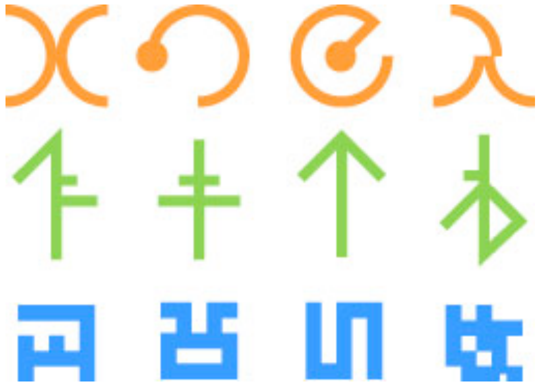


Figure 2. *Field of Play*: Iconography

Figure 3. *Field of Play*: World

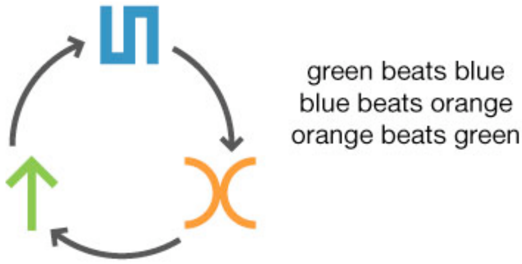


Figure 4. *Field of Play*: Code

Figure 102. Entities, iconography, world and code in *Field of Play*

Within this urban art environment, three iconographic languages are articulated through sculpture, installation, landscape design and a digital game. The work consists of various expressions of this iconography: painted aluminium, custom luminaires, lasercut steel, shotblast pavers, and multi-player digital game with computer-controlled light and four-channel sound. It is integrated within the main thoroughfare between three buildings on the Digital Harbour site in the Docklands, Melbourne. As a public artwork it invites different experiences: one, as observer exploring the various forms of the work on site; two, as player on site activating light and sound via the mobile phone game; three, as remote player competing with others online and on site via a web based game; four, as audience watching others play the game; and five, as reader interpreting the language of the work and inventing new games within the urban space. Through this range of sites *Field of Play* crosses over different media as a location-based game. This is inspired by the classic game of rock-paper-scissors (Janken), in that it defines relationships between the three languages, with each player aligning themselves with one of these. The gameplay is based on this interaction between the three sets of iconography—orange, blue and green. It is played out in the space of the laneway as if it were a life-size game board.

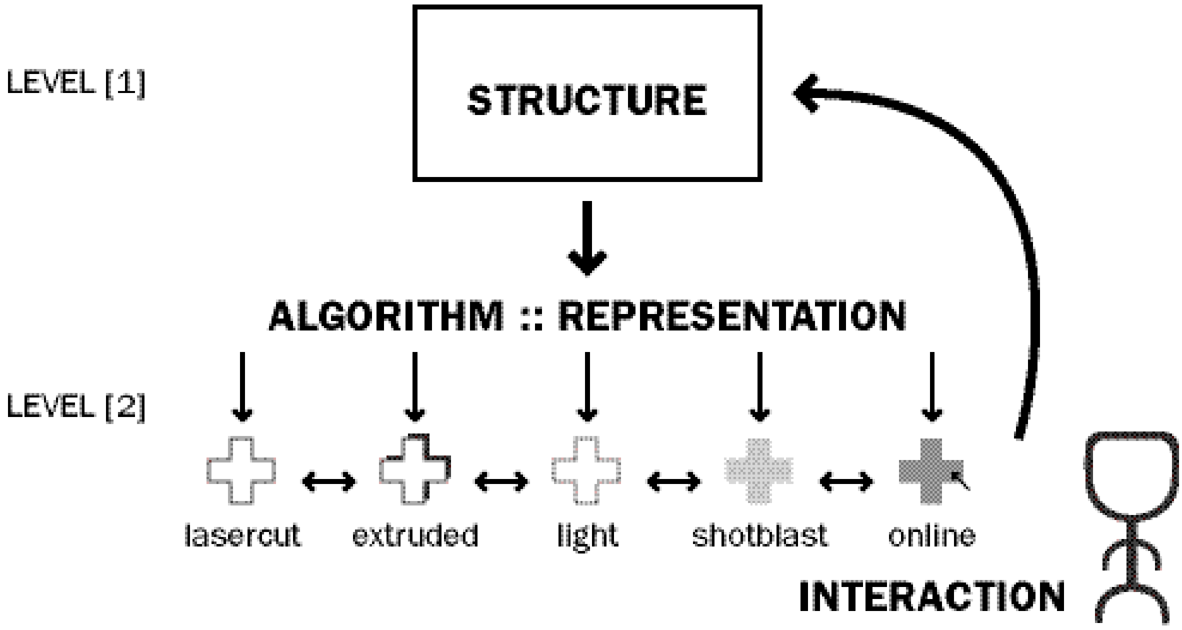


Figure 103. ***Ontological complexity*****: as a single structure expressed through a range of locations**

Ontological complexity describes the complexity of structure in terms of the number and range of relationships that it can accommodate. This may be seen through the multiplicity of expressions of the underlying structure of *Field of Play*. Its basic structure consists of the forms and relationships defined by its three iconographic languages. Relationships are established between each of these: blue beats orange, orange beats green, green beats blue. Each language also has formal rules encoded within the software that generated them, that describe its structure. The green iconography, for example, is based around a central vertical line from which various horizontal and diagonal marks may cross or intersect it to generate the various icons in the language. These forms are in turn expressed through various materials—aluminium, steel, paving, light, digital media—that present them as extrusions, silhouettes, glowing lights, surface impressions and solid icons. The formal qualities of the iconography and the relations between the languages are represented in all of these expressions: both those that are static on-site elements of the urban art, and those that are dynamic on the various screens used to access the work both within the space and remotely.

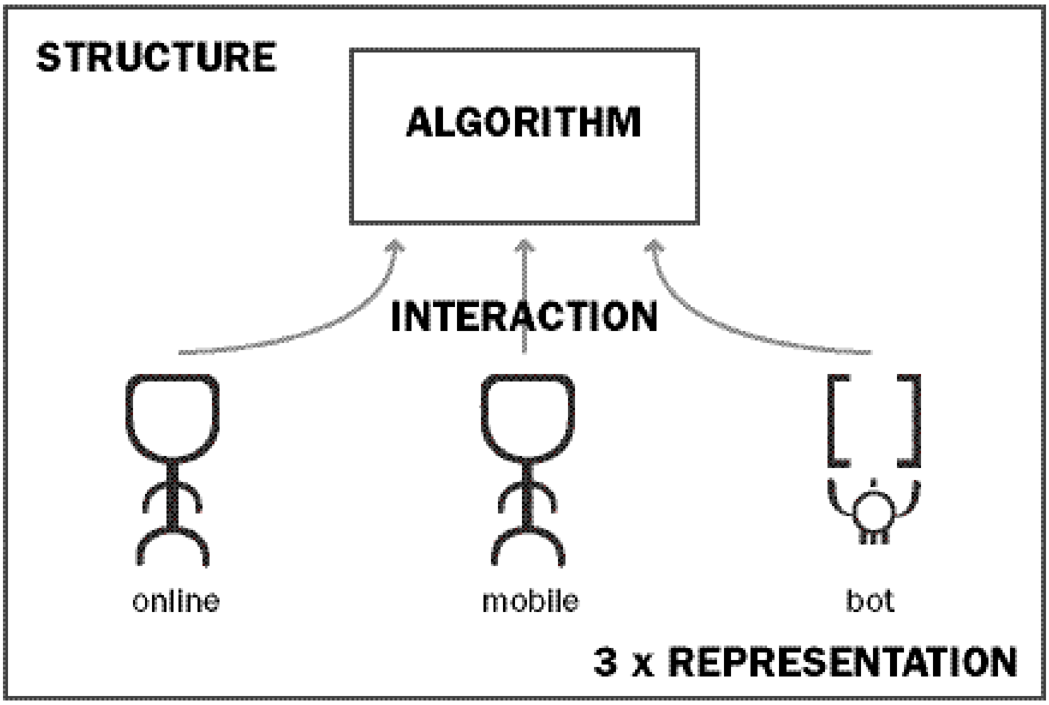
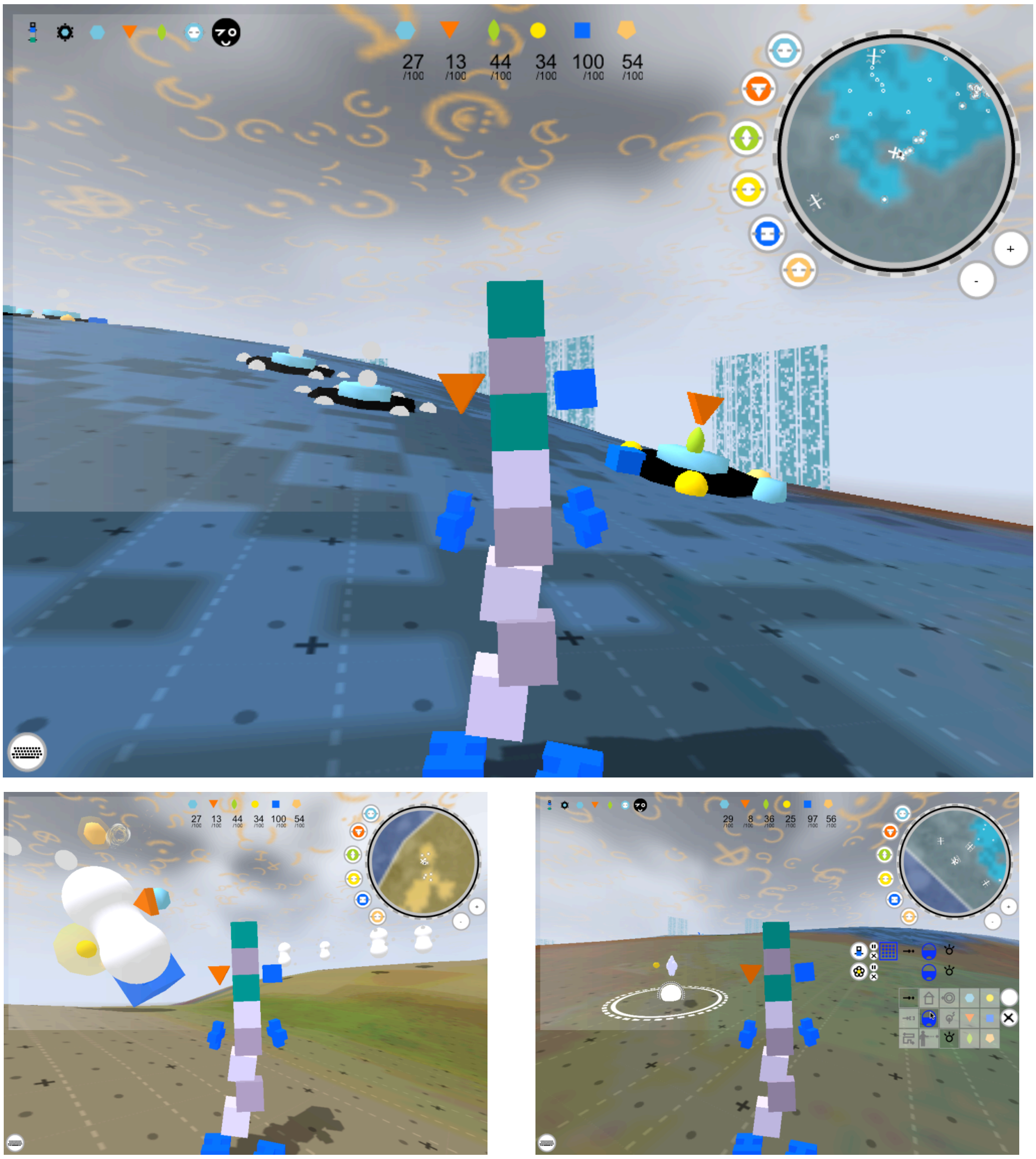


Figure 104. *Play mechanics*: an algorithm processing interaction via three separate representations within a common structure

Play mechanics defines the ways in which the rules of play allow adaptation and change, either by the system, the player, or both. The rules within *Field of Play* are relatively simple. The game is played over five rounds with a limited amount of energy available to activate the Harbour Lane inground icons. Points are scored dependent on the colour and position of the icons played into the laneway, according to a couple of simple rules. These rules allow a number of different strategies that are programmed into the bots (computer players) and that also emerge between players on site and online. During play the bot does not change, but the players do—in reaction to one another, the bots, their growing understanding of the rules and formulation of strategy. Other systems may also allow the strategy of the computer players to change, although this is difficult to achieve while keeping the game balanced. In other cases, such as virtual worlds without strict goals and rules, new rules of play based on new combinations of those already established can emerge through the actions of players. These actions can be cheats or hacks, or new game types altogether in which the high-level rules and goals are known only to the players, and the system is not even aware that another game is being played. This may occur in *Field of Play*, for example, where players may ignore the scoring of points in the game and focus instead on working together via the game to sequence the light and sound within the laneway to suit their own aesthetic criteria—light the top two icons, then the bottom two, then all the four in the middle next and so on.



Eidosand

Multi-User Virtual Environment

Interactive online software

Troy Innocent 2008

Programming: Stewart Haines and Nicholas Sandow

Figure 105. Troy Innocent, *Eidosand* (2008)

Eidosand (Innocent 2008) aims to explore and develop a model of communication appropriate for interactive game environments. Methods for nonverbal communication in digital games and virtual worlds are explored as alternatives to chat and other text-based forms of communication. Inspired by pre-linguistic societies and pictographic languages, the design of a new system called ‘symbolchat’ for virtual worlds has been developed. An online game is developed that uses this system at various levels in the game world. Reflecting upon the design and development of this system, and observation of it in use by players, the application and role of nonverbal communication in digital games and virtual worlds is explored.

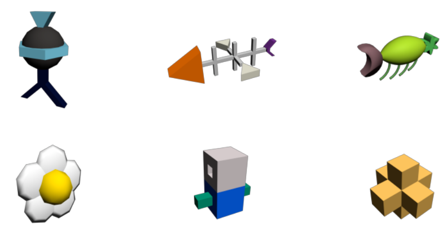


Figure 1. *Eidosand*: Entities

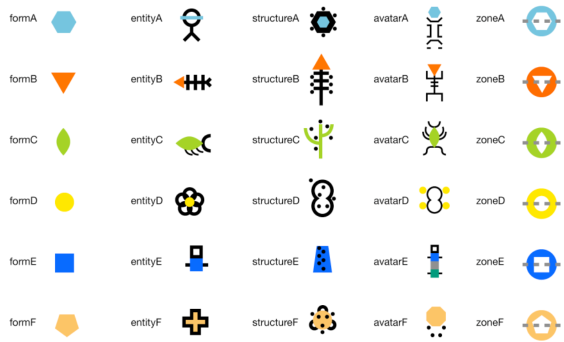


Figure 2. *Eidosand*: Iconography

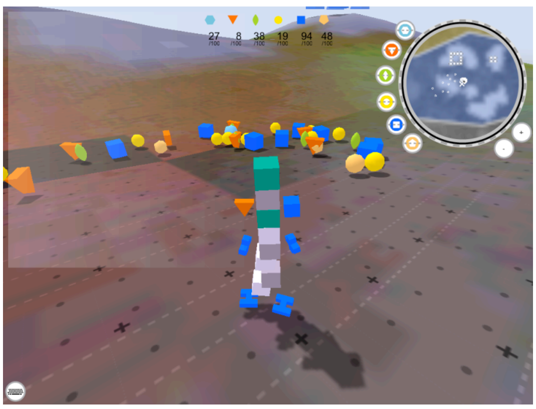


Figure 3. *Eidosand*: World

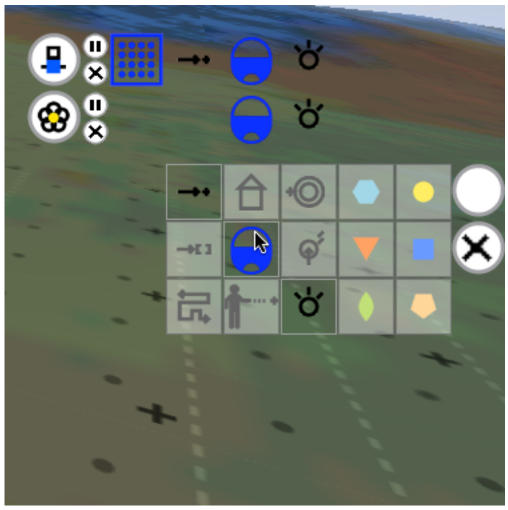


Figure 4. *Eidosand*: Code

Figure 106. Entities, iconography, world and code in *Eidosand*

In the game, players are encouraged to engage in free play with an abstract environment constructed from image and sound. Activities include:

- player-to-player communication using iconographic language
- modification and construction of game world
- taming and training of autonomous entities
- multiplayer synaesthetic VJ play using generative systems
- community-building in persistent world.

Via this MultiUser Virtual Environment (MUVE), play with the interface and world via its unique audio-visual syntax allows the exploration of alternative modes of communication within electronic spaces. An earlier iteration of the project, *Literacies of Speed,* featured a competitive game in which two teams of players are required to collect objects in order to win. Coordination of this activity uses a set of icons that refer to actions, objects, places, players and moods that are possible in the world—much like the artificial world of *Iconica.* In *Eidosand* the language does not have a fixed grammar, allowing players to arrange icons in any order or combination that they choose. A similar language is used in *Eidosand,* although this world is constructed for free play instead of competition. Communication is inspired by the activities presented by the world: taming entities, constructing musical-visual form, collecting icons to expand vocabulary, world exploration and farming resources.

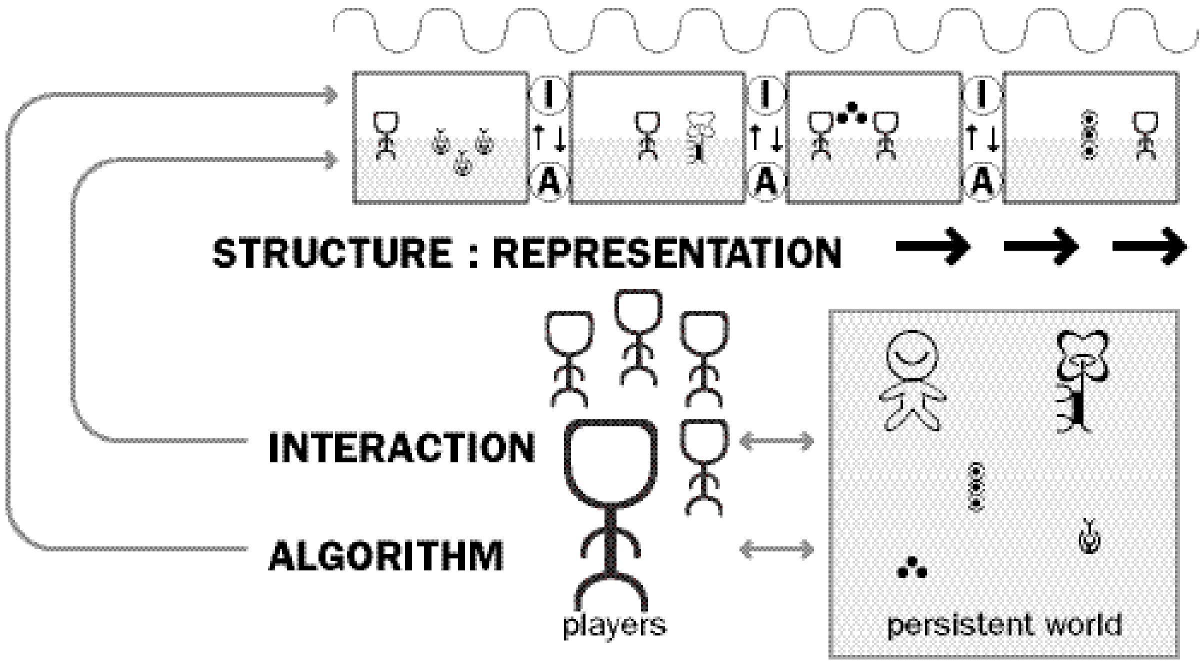


Figure 107. *Simulation lifespan*: the expression of structure over time in *Eidosand*

Simulation lifespan describes the various ways in which structure unfolds over time, whether that is staged, generated, evolved or through some combination of these. There are two main ways in which this happens: through the cumulative experience of the players, and in the world itself. This knowledge may be transient in that it exists only during a single game, or it may accumulate, either in a database that records the state of the world or in the collective experience of a group of players. The latter amounts to a culture or style of play that can be identified over a series of games played by the same group. *Literacies of Speed* allows this kind of culture to form in the use of its language and development of team-based strategies. Modifications to the game world, such as labelling locations, only persist for that single game session. In *Eidosand* a formal model for persistence in the game world is established. *Eidosand* uses this strategy, as relationships, modifications and interventions in the world persist over several days or weeks. The world evolves and changes to reflect the ongoing activities of the players.

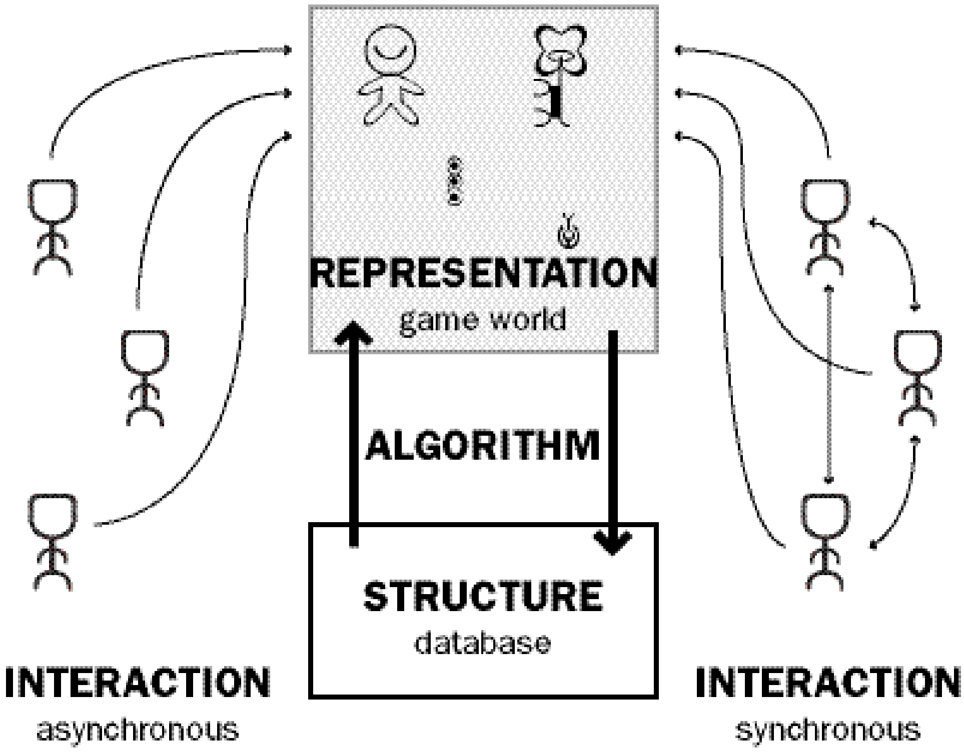


Figure 108. *Simulation time*: Asychronous and realtime interaction feeding into the timeline of a simulated world

Simulation time relates to the various timeframes that represent change over time within digital media. In these works properties and processes of the world work alongside player interaction to create a representation with a coherent and consistent sense of time. The world appears to have an immediate existence in realtime, but also persists over an extended period of time so as to become identified as a destination or place. The cumulative actions of players contribute to this sense of place as they build, play and converse in the world. The milestones set for the player by the game are a formal progression of events that mark time in the space. In many games these may be levels or items that are acquired by fulfilling game goals, in *Eidosand* these events are the taming of entities, location of language and building structures. These structures have their own life in the players' use of time over the lifetime of the world. They have two differing timelines: the realtime performance of them as musical-visual form, and the history of manipulation and building they have accumulated through player interaction over days, weeks or months.

9.3.9 Overview of case studies

Via this collection of case studies the entire model can be seen in practice. Each of the works examined has contributed to an iteration of the digital media poetics. Different levels of the system for human-computer expression are active in the play, development and analysis of each work. Media creatures with specific codes of interaction proliferate within the virtual worlds of *Semiomorph* and *Ludea*. Audio-visual syntax is explored through experiments with interactive sound environments, and the synaesthetic computer graphics of the *SWM* and *PsyVision*.

Both *Iconica* and *Field of Play* express a world as language: *Iconica* as a virtual world literally made of language, and *Field of Play* as the expression of an artificial language in an urban environment. Process as communication occurs in the generative meaning systems embodied in *lifeSigns* and the play with nonverbal communication in *Eidosand.*

The poetics of digital media is expressed through the systems of interaction, representation, structure, and algorithm that are embodied in these works. They demonstrate its language in practice through specific examples of *experience flow, emergent meaning, ontological complexity, play mechanics,* and other properties. More importantly, the works are analysed as systems identifying relationships between player, entity, virtual and actual worlds. It is in identifying these couplings and connections that a systemic understanding of the works can be articulated. This reflects the nature of digital media and its particular codes and modes of operation.

9.4 Summary

The model for a digital media poetics has been summarised, building on the previous four chapters that describe its features in detail. Using the table of sixteen properties and characteristics that has resulted from this process, a methodology for applying the model to the development and analysis of digital media works has been proposed.

This has been explored in detail, via the following case studies:

1. *Shaolin Wooden Men* (SWM) in *PsyVision*
2. *Iconica: an artificial world made of language*
3. *Artefact: Semiomorph* and *Mixed Reality*
4. *lifeSigns: eco-system of signs & symbols*
5. Interactive sound environments
6. *Ludea* featuring *neome*
7. *Field of Play*
8. *Eidosand.*

Via this process, the model has been demonstrated in action as an integral part of a digital media art and design practice.

10 Conclusion

This investigation began with the intuition that digital media is significantly different from previous generations of media, and that to understand this significance requires insight into its endemic properties and unique characteristics. What has emerged is a system of human-computer expression articulated as a digital media poetics.

10.1 Results and findings

At the beginning of this thesis, a definition for digital media was outlined. To allow a broad scope for this research, it was as general and inclusive as practically possible. The aim was to reach a fundamental understanding of both its core and the systems by which it creates meaning. The model constructed through this thesis articulates digital media in terms of this understanding. Let us look at each level of this in turn.

10.1.1 Unique characteristics and endemic properties

This approach to the poetics of digital media articulates its unique characteristics and endemic properties within a consistent framework. The nature of this 'language of computers' is articulated via a system of styles, conventions, systems and logic rather than a more formal language. This system is modelled as a poetics of digital media for human-computer expression. This poetics is broken down into the areas of actions, alphabet, grammar and logic that correspond to major domains of representation, interaction, structure and algorithm.

In summary, new methods of communication and expression are identified in this form as it captures many of the unique characteristics and endemic properties of digital media. In identifying these methods the process of meaning construction has been explored, along with its particular mechanisms and logic. Digital media poetics are typically embodied within an interactive environment (such as a virtual world) and expressed through the space of that environment, typically via a fusion of audio-visual signs that are nonverbal in nature. The player is intrinsic to this process through their input and participation, experience of the process and complex, multi-level relationship to the world.

These ideas will now be explored in further detail via examples, threads and themes that have emerged during the study and research.

10.1.2 A ‘language of computers’

This investigation began with the proposal that by articulating a ‘language of computers’ we may get new insight and understanding into the unique characteristics and endemic properties of digital media. However, it was quickly established that identifying the model as a language is too formal and does not reflect the post-symbolic nature of the system articulated in this text. The proposed model describes its terms, tools and functions of expression within digital media, and is therefore more accurately described as the poetics of digital media. We will now look at the mapping of the model to the form outlined above – the world as medium.

Interaction describes the *actions* possible within this system of digital media expression. This includes what the player may do and how the world reacts to this. In practice interaction is much more complex and four terms describing different characteristics for interaction are defined that serve as tools for formulating and evaluating expression. This concept extends to describe interactions between elements of the world itself.

Representation describes the *alphabet* from which digital media expression is constructed. Essentially this is the range of possible forms that expression may take across media. The nature of this system is broken down into four terms that articulate its various characteristics and provide tools for its construction and analysis. The system is dominated by expressions that are iconic in nature. This occurs either literally, in that expressions use computer icons and other audio-visual language, or through their iconicity, in that they simultaneously represent and are the function they represent.

Structure describes the *grammar* for the construction of digital media expression. This articulates the system of connections and relationships between actions of entities and an alphabet of icons. The ways in which this occurs are identified through the four terms that provide tools for building and decoding digital media structure. These are concerned with unstable and dynamic structures—although often defined by relatively simple rules, the latter quickly generate spaces of great complexity. This process is described as a media ecology, consisting of a complex web of relationships between the entities and icons.

Algorithm describes the *logic* of digital media expression. This includes rules, behaviours and the nature of connection and relationships within the world. Tools for understanding digital media logic are defined via four terms that describe different aspects of its operation. Although entity, icon and world all contribute to the process of meaning construction in digital media, it is within the logic that these connections are clearly defined. The ways in which this logic can be defined can be very direct (connect A to B to get C) or can be general properties of a world defined to govern how things work in a particular environment—thereby allowing the emergence of new connections through play.

10.1.3 A model of actions, forms, grammar and logic

Following this summary of the model, we may now look at it in the context of practice by exploring the model in use by the audience, developer and critic. It articulates a system of digital media poetics that extends the terms of actions, alphabet, grammar and logic into a set of tools and functions that describe nature of interaction, representation, structure and algorithm. Subsequently, these are used to articulate an understanding of digital media that accentuates these aspects as unique characteristics and endemic properties, giving rise to new forms of expression. As illustrated in the previous chapter, the major forms identified are entity, icon, world and code, each of which provides a particular insight into digital media works.

This system may be related to different levels of practice. On one level, the audience for digital media benefit in two main ways. First of all, the model provides a means of understanding the basic literacy required to engage with digital media on its own terms; and secondly, this understanding of digital media leads to the development of works that take advantage of these particular aspects of its form. On another level, the system provides a framework for developers to design and construct works that utilise the opportunities enabled by new forms of expression. It also provides a useful tool for the analysis of works in the prototyping and testing stages of development. Finally, the system is used as an analytical tool for the deconstruction of digital media works by critics. It provides a set of terms and tools for the articulation of qualitative analysis and critical understanding in relation to identifiable forms such as entity, icon, world and code.

10.1.4 New methods of communication and expression

New methods of communication and expression are demonstrated by this system in the forms that arise through the analysis and development of digital media. Interaction as communication enables expression through the behaviour of a virtual world and its inhabitants. New modes of representation allow the formation of an audio-visual syntax for expression via musical-visual form, new iconographies and crossmedia environments. The structure generated by combinations of network, database and world-building give rise to novel forms of digital media. The aspects of algorithm outlined range from artificial lifeforms to rules of play through to levels of engagement with simulation—each of which allow methods for either mapping or embodying meaning in code. Throughout the text, several examples demonstrate these individual aspects of digital media, as well as many working in concert, to create novel modes of expression.

Imagine a virtual world that is simultaneously evolving on three levels: one, autonomously via a digital ecosystem; two, through customisation and interpretation by the players; and three, via ongoing management and manipulation by the developers. This is a dynamic form that is best understood as a system of relations between entity, icon, world and code. There is not a fixed artefact but a living system that is generated by both the players and the designers in collaboration with the indigenous life of the world itself – artificial lifeforms. The world may not be a typical game world that aspires to the conventions of realworld physics and photorealistic representation. It may not employ familiar modes of communication such as narrative via backstory and cut-scenes, and dialogue via chat and conversation trees. The communication may occur through action in the gameworld itself, enacting the idea of post-symbolic language. The world is made of language and acting in the world is an act of communication.

10.1.5 How meaning is constructed within digital media

Coming to this understanding of how meaning is generated within digital media has required a transdisciplinary approach. While the model outlines characteristics and properties that are unique to digital media, it has evolved from preceding theories on defining worlds, building ecosystems, modelling reality and sign systems. These concepts provide alternative frames of reference in contrast to the preceding theatrical, elemental, cinematic models and so on.

Ontology, the study of being, provides a model for defining worlds and digital existence. This is not an investigation of the metaphysics of digital media, but a way to describe its participatory nature and how engagement with process creates ways of being in virtual worlds. Often this interaction involves feedback loops and cybernetic systems between player and world, player and player, and within the world itself. Interactive processes integrated within the world may use an ecosystem to allow it to construct itself autonomously through autopoesis. This is particularly relevant to game worlds where the rules of play define the reality for the players. Semiotics has been used to explore communication in a wide domain; and more recently, the discipline of computational semiotics has applied semiotic theory to areas such as interface design and digital games. This thesis explores the ways in which meaning (that is, clouds of association around specific icons and entities) is generated through these systems of human-computer expression.

10.2 Human-computer expression in discourse

This model has developed and evolved in synergy with my digital media arts practice. Undertaking practice-led research has provided me with valuable insight into my own processes in formulating, developing and testing digital media works. This has evolved into a reflexive approach in which the model outlined in this thesis has become embedded in the cycle of analysis and development of project work. The approach has translated an intuitive knowledge of the 'language of computers' embodied in practice into the system of digital media poetics that is articulated in this thesis.

At this stage, this is a model with one main user or proponent—myself. It has evolved in response to ten major and eleven minor works, including computer animation, virtual worlds, public artworks, and interactive sound toys. It has evolved through a decade of reflexive practice that has shifted to accommodate the mutation and growth of digital media. The present study constitutes an operations manual for a digital media poetics based on this practice. It is applicable at three levels, those of consumer, creator, and critic. These levels apply to different activities in relation to digital media: a basic literacy for play, tools for design and development, and a language for analysis and critique.

The system of human-machine expression may be applied at or across any of these levels. An artist may employ the strategies for defining artificial worlds in creating their own work. A designer may adopt particular aspects of the model suited to their particular practice: for example web designers may find different uses for the principles outlined than game designers. A deeper understanding of a digital game becomes available to the player, who can articulate levels of the space they are immersed in using the language articulated here. Writers and critics may be interested in the hybridised theory that emerges from practice-led research and choose to expand on some of the ideas proposed by this thesis.

As noted earlier, in its entirety the model is relatively complex. However due to its modular nature it may be applied in part to specific situations or contexts. One or more aspects may be drawn out and adapted to a particular work, as it is not necessary to apply the entire model to every application.

At the level of consumer, for example, a vernacular use of the concepts and terminology may emerge. The works themselves encourage this style of language use and become vehicles for its adoption. The digital game *Semiomorph* takes its name from the *semiotic morphism.* During the game, the player may 'perform a semiomorph', that is to cause an instance of *semiotic morphism* to take place. A shorthand version of the term is used in conjunction with the event itself and as a result the term is learnt through practical experience of the event itself. Likewise, the title of the work *Iconica* describes, quite literally, the idea of a world made of language – an idea that is central to the concept of human-computer expression. The model is open to adaptations of its concepts and terminology into contexts that are exclusively focussed on the play of digital media.

Another example of this style of casual use can be found in a journalistic context, with analysis of digital media in terms that are relevant to the player. This style of writing may adopt the casual use of language outlined above in addition to introducing its own hybrid style. Some ideas may be adapted to a public discourse within the wider context of new media arts criticism. Through this discourse the specialised language of the model may be translated across fields and disciplines. It may be interbred with other models or applied to specific applications of digital media and mutated through adaptation to the needs of these new forms. It is not didactic or prescriptive but rather an open system that is flexible and adaptive.

Although this translation is not a prerequisite for the practical use of the model it does provide a broader context. However its specialised and very specific language is also suitable for the critical analysis of digital media. Aspects of structure and representation may be identified, analysed and tested using an approach based in digital media poetics. This will produce a kind of criticism that draws out those aspects of digital media expressed in the model, for example viewing works as systems of human-computer expression rather than fixed media artefacts. The focus is on understanding defining characteristics such as interaction and algorithm and to use these to focus the analysis of digital media. In short, criticism expressed via digital media poetics needs to embody its core ideas via analysis that is strongly based in experience and practice.

At this stage, this model is well suited to application within a digital art or design practice, as it has evolved within this context. As a modular system it may be adapted in part to specific works or contexts (as mentioned), or taken as a general framework in which to operate a practice. The diverse range of works explored in this thesis is not inclusive of all forms of digital media, which is becoming increasingly atomised into categories and sub-categories distributed across a huge range of different locations and contexts. Each instance of new practice presents an opportunity for adaptation and further development of the ideas presented in this model, continuing its evolution as a diachronic, heuristic approach to digital media.

10.3 Exploring a digital media poetics

This particular moment presents a unique opportunity for digital media, which has a rich past, an exciting and active present, and a vast field of unexplored territory awaiting discovery. This model for digital media poetics presents a new way of looking at past, present and future forms in that it provides terms, tools and functions for the experience, development and analysis of these forms. Acquiring an appreciation of new understandings across generations of digital media is essential to develop a broader understanding of its history and potential for future generations.

The model has articulated a new way of looking at digital media and understanding its fundamental nature. The model and methodology are a means to this end. The reasons for this approach were twofold: firstly, constructing a new model was necessary as existing theories were unsuitable; and secondly, taking a new approach highlighted aspects of digital media important to the central goal and original intuition. In summary, the model has articulated properties and characteristics that are unique to digital media, and in doing so contributed to our understanding of its experience, development and analysis. What follows outlines how this has been achieved through the articulation and application of the model in this study.

First of all, the thesis has explored the various aspects of the representational context of digital media and how it is constructed:

- New forms of iconography have emerged in digital media, augmented by aspects such as interaction, dimensionality, code, animation, sound, and mutability. Within the worlds presented, various schema for these types of systems are presented that allow interaction with a high degree of *hyper modality*, that may alter their appearance through *semiotic morphism* and *adaptive expression*, and that are situated within systems rich *ontological complexity*.

  Each of the examples may be broken down into elements of a language of computers through the key elements of interaction, representation, structure and algorithm. In each case, a subset of the digital media poetics may be used to express its particular features, including relationships between player, entity, real and virtual worlds.

  Nonverbal language features heavily in the chapter on representation and is implied in other areas through their focus on process and experience as communication rather than high-level symbolic representation. The world structure itself lends itself to this type of communication as it is open to many different modes of interaction and representation.

Issues related largely to the player experience, and the related processes of interaction and feedback have then been analysed:

- The construction of meaning occurs in digital media in very different ways. First of all, much of it is expressed through interaction via aspects such as *experience flow* and *system behaviour*. Meaning can emerge through play or its potential may be generated in a virtual world via *evolutionary code*. The process of crossing over different worlds and media can also contribute to this, particularly in worlds built from *recombinant space*.

  Engagement of the player with algorithm and simulation allows communication via process and play. This may occur by embedding them in the *system process* or through them learning and adapting to *play mechanics*. It may also occur when interaction is reinterpreted by a world via *transmedia mapping*.

While almost all of these concepts are situated within virtual worlds, some aspects are directly related to the virtual aspect of their nature as simulated worlds:

- Complex multi-level relationships and structures may be identified and analysed by looking at them in terms of *ontological complexity*, *meta design* and *recombinant space*. Algorithmic issues also come into play through *system process* and *evolutionary code*, in which these processes may be used as a form of expression using the world as medium.

  New media ecologies may express the alien intelligence of artificial worlds and relate it to our own embodied human experience. These worlds are particularly dependent on *adaptive expression* and *evolutionary code*. The nature of these worlds is defined by aspects such as *simulation time* and *simulation lifespan*, *system behaviour* and *multi-processing*.

  Taking a broader view, we can see the impact of many aspects working together in generative meaning systems. This concept looks at the connections between player and world, and the ways in which *transmedia mapping, adaptive expression, emergent meaning* and *evolutionary code* create a space in which a digital ecosystem may be coupled with a network of players—generating a coherent language through an ongoing process, rather than explicitly by design.

Then there are the specific ways in which artificial spaces, entities and codes relate back to the real world:

- Identity and perception are changed through the multiple ways of being demonstrated in the various worlds referred to in the thesis. This occurs through the engagement with artificial lifeforms driven by *evolutionary code*, the *ontological complexity* of many virtual worlds, and the feedback between virtual and real worlds facilitated by *transmedia mapping*. Other experiential aspects also contribute to this, such as *experience flow* and *simulation time*.

Post-digital possibilities are situated in the relationship between virtual and real worlds, allowing players and entities many spaces in which to be. The many ways that these can cross over are demonstrated via aspects such as *transmedia mapping* and *recombinant space*.

At this point in time, the model is situated in a moment rich with new forms and applications of digital media. This is preceded by an equally rich formative period, in which aspects such as interaction and computation have developed via its major forms. Within this context the model is well placed to explore further the concepts relating to entity, icon, world and code discussed above.

10.4 Game studies, semiotics, ontology, and cybernetics

Starting with the model articulated earlier, we are able to identify sixteen significant aspects of digital media that deal with interaction, representation, structure and algorithm mapped across time, multiplicity, adaptation and transmutation. This provides insight into the nature of these new methods of communication and expression. The significance of these aspects is demonstrated via a range of examples, including experimental projects and artworks, popular games, website, etc. In the previous chapter major forms of digital media have been explored to demonstrate that some forms are better suited to illustrating the novel aspects of digital media than others.

10.4.1 Major themes

During its emergence and growth, digital media has had significant impact on our social, business and recreation activities. Research from a range of disciplines has contributed to the development of both the technology and its application, including by many artists and designers inspired by its unique creative potential. This exploration has covered a wide territory, but has been centred on one major theme – the exchange between human players and computational systems, and the ways in which meaning is constructed in this exchange.

The player's identity has been shaped by new kinds of social space such as virtual worlds and MMOGs. Blogs, minihompys[15], flickr accounts, podcasts and myspace pages are all characteristic of these extended social networks that permeate reality as a kind of distributed

15 'minihompy' is the name for the small personal web pages typically accessed via a mobile phone on South Korea's Cyworld network.

third place. Many different types of play have emerged within the realm of digital games. A virtual world may offer free play within the range of activities afforded by its rules—but not make participation in those activities a condition of interaction; while a condition of playing many games is the achievement of set goals governed by rules.

The site of digital media has undergone a number of transformations. Online publishing via the Internet brought multimedia to a wider audience and established a wider web of connections and interactions between media. More recently consoles have introduced novel modes of interaction that further expand the audience for gaming. Digital media is now located everywhere. With each successive generation of media, the rules of the game change in terms of audience literacy, expectation and location. In response to the shifting nature of digital media, its language has evolved significantly in a relatively short period. Initially, this involved previous media such as print and cinema mapping their language onto the space of digital media; more recently there has begun to be an acknowledgement of some of its particular properties, such as interaction and computation.

Of major impact on all of these developments is the evolution of digital media technology itself. Technologies enable new forms that in turn react to other forms to create hybrids. Theoretical possibilities become practical as technology expands in raw capacity: for example, the concept and technology used in the Sony Eyetoy have been around for decades, first introduced as the main mode of interaction in Krueger's artificial reality (Krueger 1991). One of the most significant aspects of digital media over the past decade has in fact been its apparent disappearance. This has occurred as it has become naturalised, more familiar, widely adopted and accepted. As a result, we may say that there has been a shift to a post-digital era, characterised by ubiquitous media that embed the digital in anything and everything.

In the context of these developments in digital media art and design, technology and application, the model articulated in this thesis provides a set of fundamental principles for development and analysis. It may be applied equally in all instances; in many cases it bridges understanding between what appear to be disparate forms—such as mobile phone networks and virtual worlds—or it may be used to show connections and relationships, such as the many ways in which electronic spaces are integrated with real spaces. Furthermore, it provides this understanding on three levels: those of player, developer and critic.

10.4.2 Overview of methods and model

This thesis articulates a model for human-computer expression. It explains how modes of communication and acts of expression that were shaped by generations of digital media (with once unusual attributes and structures) became familiar and commonplace. It is not so much that our relationship to these media was defined by this, but rather our reaction to them and understanding of them led to conventions and codes in their use.

The focus of the model is on how the simple act of adding computation and interaction to these earlier generations of media caused mutation and transformation into something entirely different and unfamiliar. Previous conventions and codes became of little use; however once a familiarity with these new forms emerged through use, an entire world of alternative modes of communication and expression became possible.

The model is a new set of relations in which couplings of player, entity, virtual and real worlds via digital processes generate novel forms of communication and expression.

Apart from the more obvious ways in which this new set of relations differs from those in earlier generations of media, there exists a whole range of more subtle differences that also shape our understanding of this relationship. These have been explored in detail though examples of contemporary digital media and case studies that draw upon my own digital media practice.

Thus this thesis presents a suitable framework for understanding the relationship between human and computer (human-computer expression) on equal terms—both from the point of view of the player situated in the real world and of the systems that define the relationship of the player with entities situated within the virtual world.

Human-computer expression is articulated as a digital media poetics. In the previous chapter, the various properties and characteristics of this were reviewed in detail citing a series of major works developed to explore and test these ideas. I will undertake a more general summary here that encompasses key concepts and ideas.

Digital media has structuralist tendencies—however, this is not to say that there is an inherent or universal structure within digital media. Rather that to make it meaningful to both player and computer requires tangible entities, categories and other objects to be defined within the processes of symbol manipulation that mediate communication between the two. As such, it explores the idea of digital media structure via ontology—to define these entities, and their properties and relations. Once again, this needs to include equal representation of both points-of-view so that they may operate on equal terms.

There is a preoccupation with semiotics, in order to understand how these entities are represented to the player, and how that representation shapes both their perception and the process of the construction of meaning. By embedding the player within the process of media generation, meaning construction becomes more fluid and dynamic. The player is not only able to interpret the meaning in a particular representation but in many cases can influence the relationship between signifier and signified, through feedback or other interaction. Digital media may adapt and change in response to the player, or the player may directly shape or build digital media as part of their engagement.

Digital media is largely procedural: the representation is typically generated in response to interaction. This can be extremely simple, such as producing a list of results in response to a search request, or vastly complex, such as the simulation of a virtual world that responds to a player on a multitude of levels. The best example of this kind of engagement can be seen within digital games. Here, rules of play govern engagement with media on many levels: reactivity, feedback loops, changes in behaviour, modifications to the environment, creation and manipulation of objects, conversations with agents, and so on. To understand the communication between player, entity, virtual and real worlds we can draw upon the rules of play within digital games. They provide a formal set of operations for this exchange so that it may be understood in terms that make sense on both sides of the conversation between player and system.

Furthermore digital media may be partly or entirely autonomous—operating independent of player interaction altogether. Artificial lifeforms may evolve within ecosystems within software, and media may be created automatically by generative systems. Even without an active ecosystem, the complexity of relations within virtual worlds and digital games suggests metaphors of life and worlds driven by process. Our understanding of the nature of these relationships and how they are expressed through computation draws upon concepts from cybernetics, alife, autopoesis and generative systems. Alife can be very different from real life.

Most of all, this study is about practical example. All of these ideas have been modelled, tested and analysed in digital media artworks through a reflective practice focussed on electronic media art, digital games, interactive installation, computer animation and sound design.

10.5 Human-machine expression in practice

Throughout this thesis, the codes and modes of operation of digital media poetics have been articulated via examples of media art, digital games and computer software that is largely screen-based. Over the past decade, digital media has become increasingly distributed. Developments such as ubiquitous computing, locative media, and crossmedia communication have shifted the site of digital media away from a single screen or computing device to networks of connected devices and experiences. The PC and games console have not become obsolete, but rather established as mainstream delivery platforms. While the present model did not evolve in this new context, its nature as a flexible and adaptive system allows it to be applied to these new forms for play, development or analysis.

As it originates in practice-based research, the system is reflexive and fluid—it has evolved in response to experimentation and play with digital media's potential. Adapting to new forms of practice involves another iteration in the same process used to develop the model in the first place. As a system of human-computer expression its focus is not on specific delivery platforms of technologies but on the underlying concept of exploring the idea itself as it manifests in digital media and all its forms. Like all languages, digital media poetics is inclined to development and interpretation through its use in identifying and forming new expressions. It has been developed as a living, adaptive system rather than a definitive model.

It is partly because of its design for adaptation and its fluid nature that the system is complex. As a model, it is inherently structural. This provides a coherent and consistent structure within its complexity. Its complex nature is necessary – simple models are no longer robust enough to address the current diversity of digital media forms. This thesis defines a system and structure for constructing and decoding these forms, but is not prescriptive in terms of its operation. There is room left for interpretation and space for the evolution of the next iteration; this is a system that is best deployed and understood in action.

Viewing the system as a framework for operation allows the play, development or analysis of each work to occur within its own context. There are many cultural and practical issues that need to be considered in each instance, as well as the complex shifts in terminology that occur in use. Each system of human-computer expression is effectively a unique interpretation that may contribute to its further development. Essentially, the model is not a didactic structure with strict rules and conditions for its application but an open-ended framework for the exploration of digital media. The three works described below provide examples of its adaptation.

10.5.1 I like Frank in Adelaide

The availability of mobile phones with media capacity and the accessibility of networks in urban areas present another opportunity for the experience of digital media. Mobile phone art typically responds to the portable and networked nature of the device by allowing multiplayer interaction and works that respond to their physical location as context. The limitations of the mobile phone, such as small screen size and relatively low bandwidth, also present aesthetic and technical challenges. In 2004, Blast Theory developed a mixed reality game using 3G phones as the main interface for play. *I like Frank in Adelaide* (Blast Theory 2004) connected street players with online players in a search for a fictional character named Frank.

Online players logged into a website to explore a simulation of the streetscape in which the game takes place. From this vantage point, they are able to see locations and game objects. They are also able to see the location of street players and send messages to guide them (or lead them away from) towards the locations that will help them to solve the game. Only the street players are able to act in the game world (by collecting postcards) and so play requires the collaboration of players within each environment.

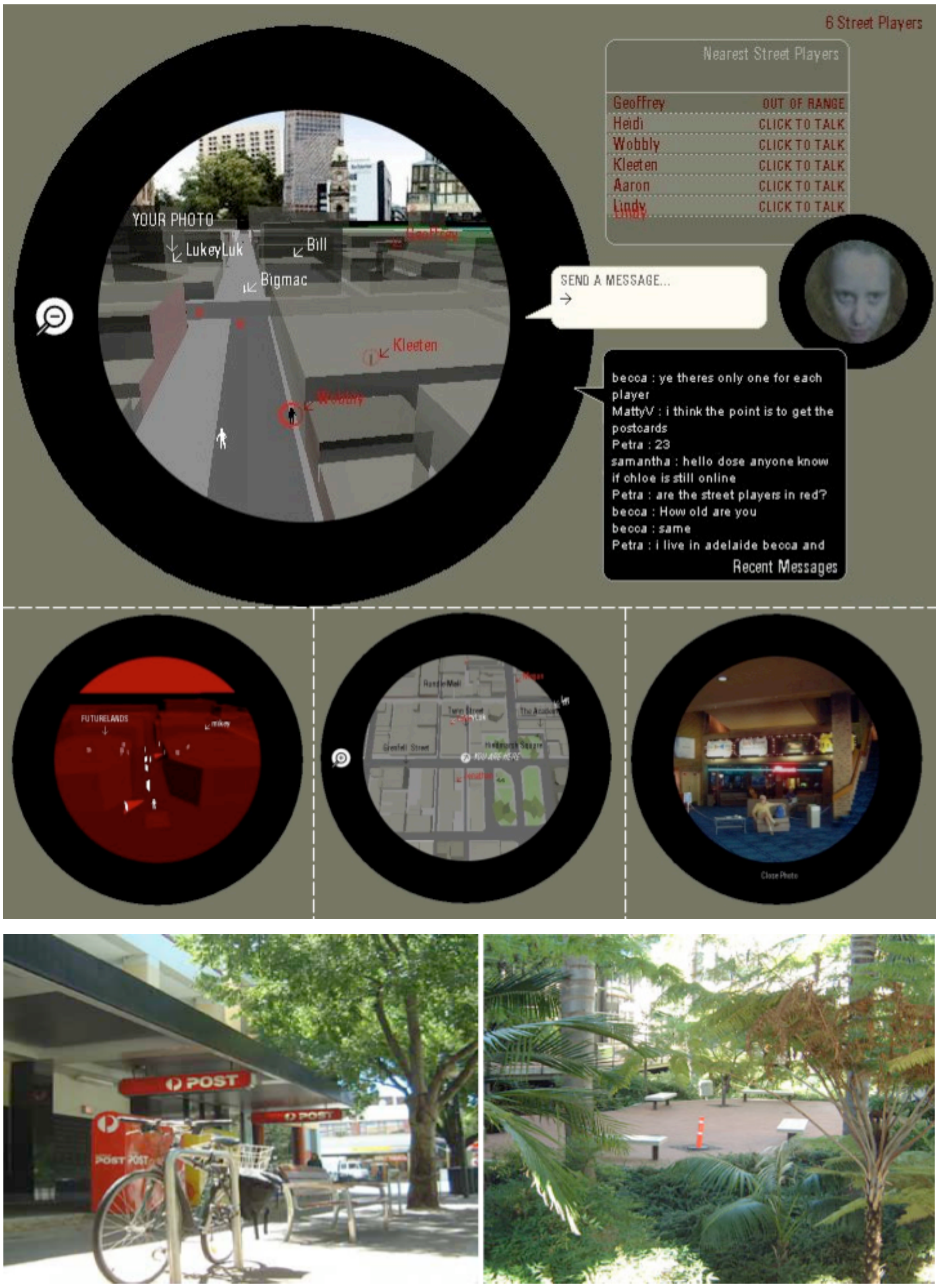


Figure 109. Blast Theory, *I like Frank in Adelaide* (2004)

In terms of interaction, *I like Frank* demonstrates a high degree of *hyper modality*. By their nature, all mixed reality projects are likely to feature heavily in this area. However, this game has both several modes of interaction and a sizeable number of players operating simultaneously, both in groups and individually. There are at least four major modes of interaction: the online players' navigation of the virtual streetscape, the street players' navigation of their real environment, the online players' communication with the street players, and their interaction with the mobile phone interface. The interaction between street players may also be considered as a fifth mode, mediated by the shared reality created by the game rules.

Via these modes of interaction, the system is rich in *emergent meaning.* In fact despite the elaborate technological infrastructure, the game is relatively simple. It is essentially a treasure hunt. It is a system that generates many possible game events for interpretation by the players. These may come from player-to-player interaction; situating media in a real world location; or by seeing the city in a new way. Often, the work provoked this third response, as the game rules led players into a way of looking and experiencing the game world in an altered or heightened state of awareness.

Due to its live nature, the game ran for fixed periods of time. The start and end points of these periods clearly defined the game's *simulation lifespan*. When online, it is clearly an event with an open but finite timeline and time limits imposed by the ephemeral nature of the real world game objects. This is also a limitation. Although I played as an online player when the work was live, now the only way to experience *I like Frank* is through documentation and texts as it is not currently being played. However, this transient aspect of the work generates an intense sense of urgency in playing the game. Unlike a digital game world that may be recalled at any time, its existence was finite and specific to a particular moment.

Due to its transient nature, *I like Frank* is somewhat like an MMO in terms of *system process*. Like the game rules, this is relatively simple. It is essentially a cycle that keeps the flow of communication between all of the players moving. However, there is also the task of synchronising the two expressions of the game world – tracking the street players so as to represent them online, checking the state of game objects and so on. Once again, the decision-making processes in the game are relatively simple; it is the real world context and collaboration between players that generates complexity in the work.

10.5.2 World Without Oil

The ubiquity of the Internet and its widespread adoption as a mainstream medium of communication has led it to become a natural part of everyday life much like other popular media such as newsprint and television. In fact, to a certain extent it overlaps with these other media—augmenting, extending or replacing certain aspects of them. In its central role as an integral part of the contemporary mediasphere, it provides the vehicle for a new genre of game design that is situated in the real world rather than being the simulation of a virtual world. Although many alternate reality games (ARGs) use familiar models of game design such as the treasure hunt, the ways in which they are played, developed and analysed follow different patterns than those situated exclusively in a virtual world.

An ARG involves players as participants in an interactive narrative situated in the real world. The story typically traverses many different media, both to provide multiple points of engagement for the participants, and to feed the illusion that the game is happening now, in the real world; and it has real effect on the player. Players' collective and individual actions shape the course of the narrative—as the game designers work behind the scenes while the game is 'live' to control characters, manage the release of information, and monitor the player population. *World Without Oil* (WWO) (Eklund 2007) is a recently completed ARG that ran for 32 weeks in 2007 with 1,850 registered players[16]. Players were drawn into a simulation of global oil crisis and invited to respond to this situation as if it were real by creating blogs, images, video, podcasts and so on.

Figure 110. ***World Without Oil*** **(Eklund 2007)**

16 Data collected from Christy Dena's ARG stats compilation at http://www.christydena.com/online-essays/arg-stats/ (accessed January 30th, 2008)

In WWO, players had a multitude of options for interaction with its fictional world. Via this high degree of *transmedia mapping*, the distinction between reality and fiction becomes blurred, as players appear to a have real effect on the events that occur in game's narrative. They may comment or link to content posted by characters or other players, make their own posts to contribute to puzzle-solving, or respond to the discussion of issues presented by the work. However, it is via their participation as collaborators in the development of the content of the work that players were able to really make a difference. Other threads in the narrative emerged as the game unfolded: players formed their own chronicles that interacted with the official narrative (written by the game designers) and the narrative developed by the player community.

We can view this crossmedia, participatory representation of a fictional world as an example of *adaptive expression*. The content of the work is constantly in flux as the participation of the players influences the course of the narrative. However, AI or alife does not generate this adaptation. Behind the scenes the gamemasters have an overall plan for the story, outcomes and goals of the game. The system is not used to autonomously generate behaviour and responses from entities, but to manage and track the player community. Ongoing feedback between players and gamemasters is processed and filtered via the fictional world itself that evolves in response to this collective activity.

Meta design is clear feature of WWO. It has been designed as a system for participation; in fact its structure relies on players to contribute to the content of the work within the parameters put in place by the gamemasters. These parameters for recombination and modular construction of the fictional world are critical for a successful ARG. The rules of participation need to be clear, the mechanisms simple and easy to use, and players need a strong motivation. The intense sense of engagement that comes from having real effect on what appears to be part of the real world and working with other players provides this. Getting the balance of the system right is crucial.

This is where *play mechanics* are important in the design and experience of an ARG. Playing out a game in the real world with real people can be risky and unpredictable. This is very different to a simulated world, in which the game can strictly enforce its own rules of engagement. Underneath all the character development and storytelling that go into creating a believable alternate reality are some really fundamental, basic game rules. Solve a puzzle. Be the first to locate a key object (perhaps at a real world location). Find a link. These simple mechanisms hold the entire experience together by providing clear goals and outcomes for players.

10.5.3 Autoinducer_Ph-1 (cross cultural chemistry)

Although digital media is dominated by the moving image, systems may be expressed in many other forms. These may use the screen as output device amongst other outputs, or dispense with screen-based representation altogether. Different media and genres may be combined using hybrid and transdisciplinary approaches to media. Strictly speaking, hybrid art works fall outside the scope of our definition of digital media—although digital systems often play a key role in either the development or experience of the work, and sometimes both. These works may include robotics, locative media, performance, biotechnology or genetic engineering.

The practice of BioArt is typical of this approach. It uses cloning and living systems in works that are usually produced in laboratories via collaborations between artists and scientists. It may be compared to alife practice in its exploration of systems art and life sciences. In 2007, Ars Electronica introduced a Hybrid Art category to its International Competition of CyberArts. *Autoinducer_Ph-1 (cross cultural chemistry)* (Gracie & Rowe 2006) was included in this category. The work combines various systems interacting with one another in a gallery installation. At one end of the room, an alife simulation of synthetic bacteria is coupled with living *Anabeana* bacteria cultures. These synthetic and organic micro worlds have a symbiotic relationship, as they influence each other's growth via the system assembled in the work. The living bacteria then feed *Azolla* growing in a pool located in the centre of the space. Robotic arms feed these water ferns into a moat-like rice paddy that circumnavigates the room. All of these various systems are interconnected to create a single 'bio-artificial ecosystem for growing rice'.

Figure 111. Andrew Gracie & Brian Lee Yung Rowe, *Autoinducer_Ph-1 (cross cultural chemistry)* (2006)

Although it is not exclusively an artificial simulation, the work may be analysed in terms of its *system behaviour*. The four systems (artificial bacteria, living bacteria, water ferns, and rice paddy) are connected via artificial mechanisms with rules, parameters, thresholds and triggers. The interaction is autonomous – the player has no influence on the outcome of the system—and is governed by the configuration of the overall system. Thus it is not player input that is being reacted to but the behaviour of the various living systems in the work. Due to their symbiotic nature, these interactions need to be adaptive and flexible for the overall installation to survive its time in the gallery space.

This introduces the idea of *simulation time*. It is a live work that is unpredictable and needs maintenance. The timeframe of its 'simulation' extends into days or weeks—changes in the systems occur slowly. Although the work uses living systems, it is still an artificial simulation, as the conditions and environment in which these live are, by necessity, strictly controlled and regulated. So the timeframe is driven by the systems themselves—their growth and decay rates, and the dynamics of their collective interaction to trigger thresholds, and so on.

As four different micro worlds are connected by the work, it has a high degree of *ontological complexity* when considering its intercellular communication and the mapping between living systems and the laboratory environment. The artificial bacteria model the physical interactions and signalling system of the living bacteria within a virtual environment. The construction of the environment also clearly identifies entities and their relationships with one another: the installation reads like a schematic of the system. This overall design is expressed as an ecosystem—a hybrid world that integrates biological and artificial systems.

It is via this hybridised ecosystem that the work's *evolutionary code* is expressed. The development of the entire system involved the evolution of the system that connects the living systems. Although these organisms themselves were not modified or evolved as part of the process, their environment was constructed for the purpose of supporting the 'bio-artificial ecosystem'. Of course, the virtual environment and its synthetic bacteria were evolved in code to accurately model the behaviour of the biological bacteria that they simulate. All of these processes are made explicit to the player via video projections of the two environments populated with artificial and biological bacteria, and through the installation itself.

As the model presented in this thesis is centred on human-computer expression, it can be adapted to new forms of digital media such as mobile phone art, alternate reality gaming, and hybrid media arts practice. Using the characteristics and properties identified in the thesis the analysis of these works can generate new understandings or perspectives on the experience of the works. This same approach may also be applied to development, such as in *Field of Play*, a location-based game, and *neome*, a micro ARG, reviewed in the previous chapter.

10.6 Concluding remarks

This iteration of the poetics of digital media, as articulated here, has consolidated into a mature, coherent and practical system. However, it will continue to evolve. As a poetic language it will be shaped by patterns of use, new contexts, forms of expression, and modes of operation. Its significance is as a system for human-computer expression. This captures the essential nature of digital media: its endemic properties and unique characteristics such as interaction, representation, structure, and algorithm. These have now been articulated and defined in terms of *how* they enable new forms of communication and expression. The system demonstrates how meaning is formed in digital media.

Increasingly, the space of digital media is becoming a hybrid construct characterised by ubiquitous media, crossmedia, locative media, and transmedia. The proliferation of new names and terminology continues as novel forms emerge. Naming conventions aside, these new spaces offer territory ripe for exploration via digital media poetics. They present new environments for media creatures and artificial lifeforms; novel structures and expressions in the audio-visual syntax. The diversity of new terms is a symptom of the increasing atomisation of media; there is a need for clearly articulated but flexible models to provide a common methodology across this diversity of forms. The principles of human-computer expression may apply in all these instances and, as demonstrated, may be adapted to these new forms.

Digital games have become mainstream media. Virtual worlds have become a significant place in many people's lives and their communities form an extended social network. Artificial lifeforms make their homes in virtual worlds hosted by computers everywhere. Now that the virtual is seamlessly integrated with the real, the distinction between virtual and real is losing its meaning. It's all real. It is all part of our lived experience. Understanding the actions, vocabulary, grammar and logic of the systems embedded in our world has never been more important – for consumers, creators and critics. The framework articulated in this poetic language enables that understanding.

With this poetics we have a clearer understanding of how meaning is formed in digital media. This system of human-computer expression is situated within and draws upon computational semiotics. In turn, it contributes to these understandings by articulating a systemic view of digital media—inspired by its unique processes of meaning production. By way of example, digital ontologies may in themselves be vehicles of communication. Their entities and relationships, rules and systems are integral to the formation of meaning. Each artificial world represents a specific model of reality. This is a relatively new concept but suggests further, largely unexplored, potential for digital media.

What will the next generation of media creatures evolve into? In what forms will the new expressions of digital media's audio-visual syntax materialise? How will we interact with and live within future worlds made of this language? When will process as communication become a mainstream vehicle of expression? Another decade of digital media is unfolding, and likely further developments beyond that well into the remainder of this century. What will readers of this text do with this model to develop, define and articulate the future of digital media?

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