UNIVERSITY OF CALIFORNIA

Santa Barbara

Nonlinear Media as Interactive Narrative

A dissertation submitted in partial satisfaction of the requirements for the individual, interdisciplinary degree Doctor of Philosophy in Media Arts and Technology.

by

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June 2008

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June 2008

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ISBN:1-59593-447-2

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ACM Multimedia Interactive Arts Program, art exhibition. October 2006, Santa Barbara, California.

Morning Song (2001, rev. 2002) Soprano, 2 Marimbas, Piano And Vibraphone

Ensemble of Contemporary Music, Department of Music, University of California, Santa Barbara, March 11, 2003, Santa Barbara, California.

Only This (2001) Live electronic processed voice and video.

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California Computer Music Exchange Concert, California Institute for the Arts, April 7th, 2002, Valencia, California.

CoreDump, electronic media concert, JoJo's Café, December 14th, 2002, Santa Barbara, California.

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2nd Prize, Large Ensemble for the composition, "Phantast" (May 2002)
2nd Prize, Electronic Music Division for the composition, "What You Are" (May 1998)
3rd Prize, Vocal Division for the composition, "Sprechstimme Danse Musik" (May 1998)

Las Positas Faculty Senate Scholarship (May 1996)
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Spring Literary Arts Awards: Long Form Poetry (May 1996)
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ABSTRACT

Nonlinear Media as Interactive Narrative

by

Mark-David Hosale

As an interdisciplinary artist and composer I have found that, beyond the common language of new media, the connecting tissue between various art practices and music can be found in narrative. In particular, the kind of narrative that is structured using nonlinear representations of information, time, and space. Nonlinear narrative is an inherent aspect of new media that provides a common baseline whereby media artworks can be evaluated and understood.

The discussion of nonlinear narrative as interactive media is an exploration of the question, "*what is the form of nonlinear interactive narrative?*" providing the impetus for a theoretical discussion, and a formal approach to the understanding of my past works, while providing a basis for the creation of new works that have a dynamic nonlinear structure and reflect on our modern understanding of knowledge and nature.

The domain of this document falls within the field of media art and is motivated by a transmodal aesthetic that developed and matured in tandem with my participation in a series of seminars led by Marcos Novak on the subject of *transvergence*. The terms and ideas presented in support of the concepts put forth in this document are derived from a variety of sources, including the histories of art, music, and literature; concepts in philosophy (in particular Deleuzeian philosophy); and pattern language as found in the field of software engineering. The result of this discussion is the definition, evaluation, and exploration of a transmodal, generalized description of nonlinear narratives in an abstract formal model called the *Universe*.

It is important to clarify that the term *Universe* is not intended to describe what can be understood as a "universal model." The *Universe* is a reference to the concept of *worlds* borrowed from Virtual Reality terminology in order to describe the qualities of immersive interactive artworks as immersive environments. Thus the *Universe Model* is a description of the formalized approach taken in the realization of my own work and, although not strictly about music, this document follows a long line of documents in music whereby composers formally define the techniques and theory used in their work.

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I. What is the form of Nonlinear Interactive Media?

The influence of technology in the arts is significant and profound. In an age where it is not beyond the imagination to paint music or to sculpt light, a new species of works has emerged that defy categorization. Technologically influenced artworks are hybrids, encapsulating aspects of several art practices into a single work. Although the combining of different art practices to create a single work is not entirely new[1], what is unique in history is the common language of new media, based in the electronic and the digital domains, used to create these new works. This common language is the basis whereby music and the varying disciplines of the arts dynamically connect at a deeper structural level than was ever possible before. Because of this connection new media artworks go beyond a simple mixing of various art practices to form a new species of art practice, spliced at the signal level, which is analogous to gene-splicing in biology.

Through the context of technology the creation, performance, and presentation of art and music have been redefined. The speciation of art practice implies a need for

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[1] In fact many examples of multi disciplinary art that predate the digital age can be found. One interesting early example of an interdisciplinary artwork is the 14th century novel called, *Le Roman de Fauvel.* Besides text, the novel is filled with images to be viewed, and song scores to be sung as the story progresses. Scholars have proposed various interpretations of Le Roman de Fauvel. This is because, while the combination of text and images implies that the novel was intended just for reading, the combination of scores in the text implies that intention of the novel was to be used as a guide for performance. While the possibility exists that both interpretations are correct, the likely explanation is that the novel was read aloud by a small group of readers, who would view the images, and sing the text as appropriate. In other words, *Le Roman de Fauvel* is a participatory multimedia interactive work. (Gagnepain 1996)

new formal constructs for the organization and interpretation of new media works. As an interdisciplinary artist and composer I have found that, beyond the common language of new media, the connecting tissue between various art practices and music can be found in narrative. In particular, the kind of narrative that is structured using nonlinear representations of information, time, and space. Nonlinear narrative is an inherent aspect of new media that provides a common baseline whereby media artworks can be evaluated and understood.

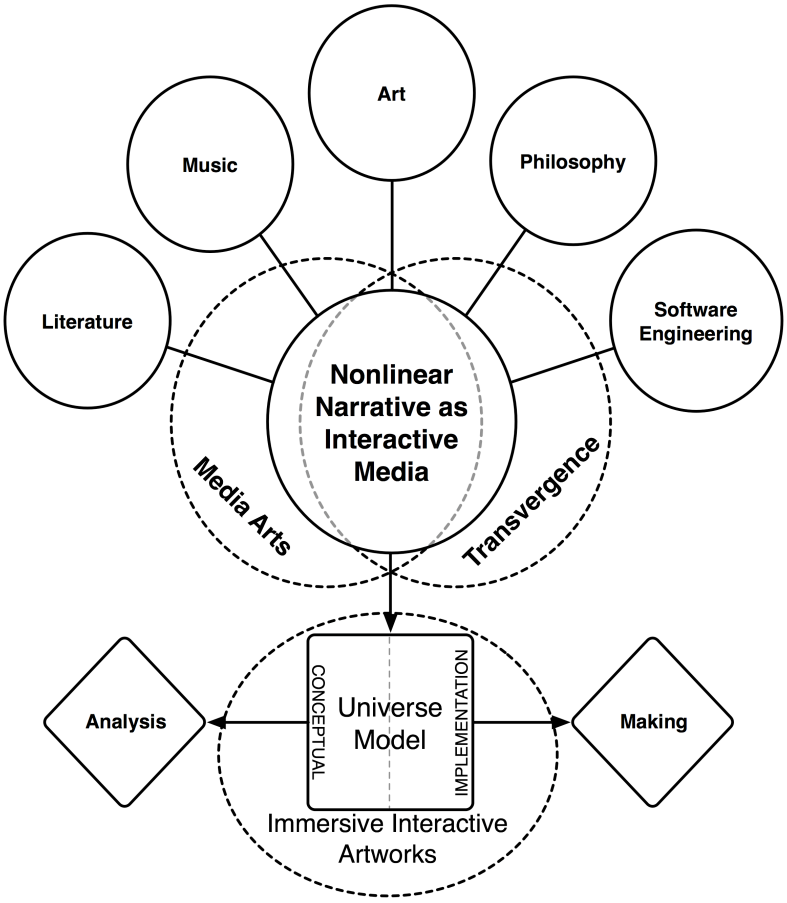

Figure 1. Domain of the Document

The exploration in this document of the question, "*what is the form of nonlinear interactive narrative?*" provides the impetus for a theoretical discussion, and a

formal approach to the understanding of my past works, and more significantly, the creation of new works that have a dynamic nonlinear structure and reflect, to one degree or another, on our modern understanding of knowledge and nature.

As implied above and as diagramed in Figure 1, the domain of this document falls within the emerging field of media art and is motivated by a transmodal aesthetic that developed and matured in tandem with my participation in a series of seminars led by Marcos Novak on the subject of *transvergence*. Transvergence is a conceptual approach to new modes of making and thinking about the creation of new forms of artworks, disciplines, and knowledge through a process of derailment, hybridization, and speciation. According to Novak, transvergence can be understood in contradistinction to the concepts of convergence and divergence:

> While convergence and divergence are simple linear extrapolations that proceed by strategies of alignment, transvergence advances translinearly, by tactics of derailment. While convergence and divergence are allied to epistemologies of continuity and consistency such as those of David Hilbert, Bertrand Russell and Alfred North Whitehead, transvergence is epistemologically closer to Kurt Gödel's incompleteness theorem– which states that for any well-formed theory there will be valid propositions that are not derivable within the theory – and to complexity, chaos and catastrophe theories, dynamical systems, emergence and artificial life. While convergence and divergence contain the hidden assumption that the true, in either a cultural or an objective sense, is a continuous landmass, transvergence recognizes true statements to be islands in an alien archipelago, sometimes only accessible by leaps, flights, and voyages on vessels of artifice.
>
> -from *Speciation, Transverence, Allogenesis: Notes on the Production of the Alien* (Novak 2002).

Transvergence goes beyond the simple mixing of genres and forms that result in new combinations of existing ideas. Transvergence seeks out new species that are

the offspring of existing and future forms characterized by the emergence and growth of ideas that are alien to what is currently known and understood.

The terms and ideas that are presented in support of the concepts and assertions put forth in this document are derived from a variety of sources, including the histories of art, music, and literature; concepts in philosophy (in particular Deleuzeian philosophy); and pattern language as found in the field of software engineering. The result of the discussion that unfolds in this document will be a transmodal, generalized description of nonlinear narratives in an abstract formal model called the *Universe*.

As a description of a model, the term *Universe* is derived from the concept of *worlds* as it is used in virtual reality (VR) terminology. The concept of *worlds* is borrowed from VR terminology in order to describe the qualities of immersive interactive artworks as immersive environments. As term the *world* in VR terminology is used to describe the qualities of immersive environments, the *Universe* is used to describe the organization of immersive environments. Therefore it is important to clarify that the term *Universe* is not intended to describe what can be understood as a "universal model." The purpose of the *Universe* is to provide a description of the formalized approach taken in the realization of my own work, which is based on a generalized definition of nonlinear narrativity in the context of art, music, and literature. From this perspective this document, although not strictly

about music, follows a long line of documents in music where composers formally define the techniques and theory used in their work[2].

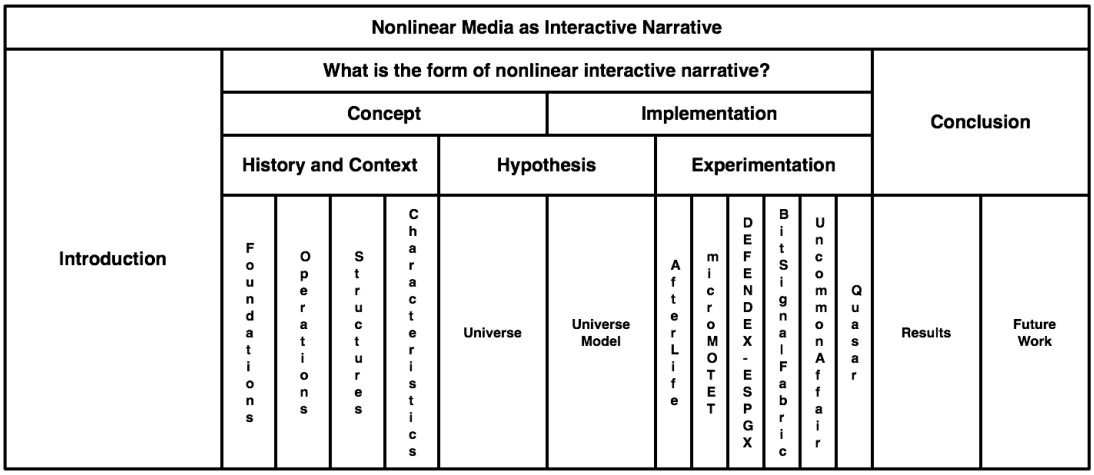

Figure 2. Document Overview

Conceptually this document can be divided in two ways that reflect two perspectives on the argument being proposed. One aspect is the exploration of the question, "*what is the form of nonlinear interactive narrative?*" and the other aspect provides a description of the formal model of the *Universe* (see Figure 2). Based on the format of a standard thesis (introduction, context, hypothesis, experiments, and conclusion), the first division of the document is a five-part discussion addressing the question *what is the form of nonlinear interactive narrative?* Using sources drawn from computer science, philosophy, literature, art, and music, the discussion in this document lays down the foundations needed for the analysis and evaluation of

[2] Examples of this tradition include Paul Hindemith's *The Craft Of Musical Composition* (Hindemith, Mendel, and Ortmann 1941), Olivier Messiaen's *The Technique Of My Musical Language* (Messiaen and Satterfield 1956), Iannis Xenakis' *Formalized Music* (Xenakis 1992), and Harry Partch's *Genesis Of A Music* (Partch 1973).

nonlinear narratives based on their operations, structures, and characteristics. The foundations of nonlinear narratives provide the background needed for the description of the *Universe* hypothesis, which is defined both in terms of theory (in relation to Deleuzeian philosophy) and praxis (in relation to the design patterns of software engineering). The experiments chapter of the document provides a description of the evolution and testing of the *Universe* hypothesis through the realization of several works[3]. The conclusion of the argument provides an evaluation of the results, as well as the future directions of the *Universe* hypothesis.

The second division of the document is in two-parts, with the first half relating to the conceptual model of the *Universe* (theory), and the second half relating to the implementation of the *Universe* (praxis). As shown in Figure 2, the two-part division of this document occurs in the third chapter of the five-part discussion, demarcating the change in the discussion from theory to implementation. While the first division (based on the 5-part thesis form) is most closely related to the question, the second division of the discussion (between theory and praxis) is most closely related to the hypothesis. The interleaving of the two formats is representative of how the question and the problem, from conception to implementation, are intertwined.

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[3] *After-Life on the Bardo Plane of Existence* (1997), *microMOTET: There Is Only Emptiness In The Eyes Of A Lonely God/Alle Menschen Müssen Sterben* (1999), *DEFNEDEX-ESPGX* (2004), *BitSignalFabric* (2005), *An Uncommon Affair At Tooting Bec Common* (2007), and *Quasar* (2008)

II. The Context of Nonlinear Interactive Media

The establishment of the context of nonlinear interactive media is based in the history and practice of media art. An interdisciplinary practice, the field of media art has a varied history that is based in a myriad of disciplines, styles, and structures, with a variety of practices that can be seemingly conflicting and/or unrelated. Works categorized under media arts share a common basis in technology and the new media resulting from new technologies. If it is true that, as Marshall McLuhan states 'the medium is the message' (McLuhan 1964), then media art works 'say it' with media.

Because of the interdisciplinary nature of media arts practice, the field of media art is not based on one history or practice, and therefore should be discussed from the perspective of several histories and practices. The multiplicity of the histories and practices in media arts is inherent because, as McLuhan states, "the content of a medium is another medium" (McLuhan 1964). Thus the history of media art is a history of histories and the context of new media lies in other media.

In media arts, the commonality of having a basis in new technology and the commonality of having a context of multiple histories is not enough to provide a unifying connection between the seemingly conflicting and/or unrelated practices of media arts. If media art works do 'say it' with media, then perhaps the best place to find a unifying connection between media arts practices lies in how 'it' is said. After all, when 'the medium is the message' the practices of media become the conduits of knowledge and information; this is because "it is the medium that shapes and

controls the scale and form of human association and action" (McLuhan 1964). As new media emerges, the way we experience and interact with knowledge and information changes through new media. Therefore, media arts practice is a narrative practice that shapes our connection with knowledge and information.

The unifying feature between the seemingly conflicting and/or unrelated practices of media art can be found in narrative. Thus, the unifying form of media art is a narrative form. In particular, it is a narrative form that is structured using nonlinear representations of information, time, and space. Nonlinear narrative form is pervasive in the structure of the narratives of art and culture, which is a reflection of the experience of knowledge and information in contemporary society. The nonlinear organization and dissemination of knowledge is pervasive in contemporary arts practice as well as in new media. Nonlinear narrativity in contemporary art practice anticipates new media by expressing the conditions that have affected our understanding of knowledge and nature in the context of modern science and technology.

Therefore it is through the history of various arts practices that the context of nonlinear interactive media will be established. The discussion in this chapter will briefly define the foundations, operations, structures, and characteristics of nonlinear narrativity from the perspective of art, music, and literature under the influence of technology. Doing so will not only establish a context of nonlinear interactive media,

it will also provide a basis upon which a discussion of the form of nonlinear interactive media can unfold.

A. Foundations

As a review of the foundations and origins of nonlinear narrative this section will define the concept of linear narrative, the use of narrative as a description of form in non-literary contexts, the origins of nonlinear narrativity as a historical break from the traditional form of linear narratives, and the correlation of the break from linear narratives to the rise technology. The concepts described in this section will provide a context for a discussion of nonlinear narrativity in terms of its operations, structures, and characteristics in the sections that immediately follow.

1. Linear Narrative

By conventional definition a narrative is the detailed telling of a story composed of the sequential unfolding of significant events (Merriam-Webster Inc 2007). Beyond this definition, history provides a clearly defined and well-established generalized structure for the basis of linear narratives. Originally defined in Aristotle's thesis on *Poetics,* linear narrative is traditionally understood as a unified action composed of three parts, a beginning, middle, and an end[4] (Aristotle and Heath 1996). Although often debated and criticized throughout history, Aristotle's three-part narrative structure was widely accepted as convention in Western

[4] For Aristotle, the most important aspect of drama is the *plot*. As is commonly done in discourses on narrative theory, the term narrative is used here interchangeably with the term plot. Aristotle defined the best plots as those plots that result in either a *reversal* or a *recognition.* Reversal plots result in the exact opposite state of affairs as presented in the beginning of a story, while

dramaturgy practice until Gustav Freytag expanded upon the form in his seminal text, *Technique of the Drama*[5] (Freytag and MacEwan 1895).

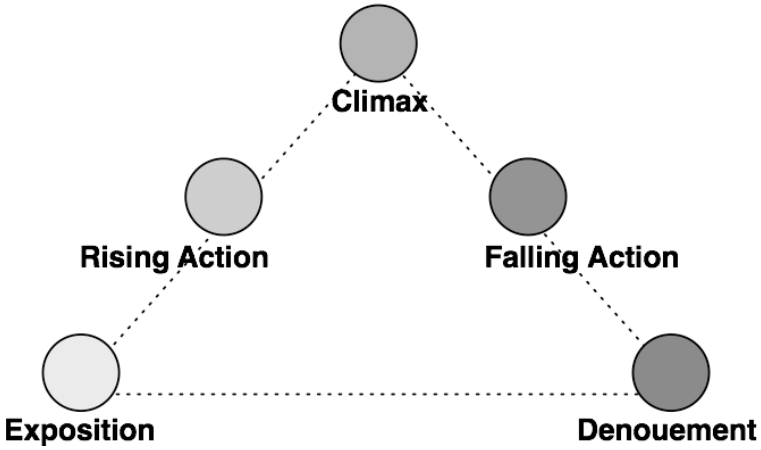

Figure 3. Freytag's Triangle

Freytag's *Technique of the Drama* is an extension of Aristotle's thesis on poetics, which expands Aristotle's three-part structure into a five-part structure, known as *Freytag's Triangle* (*or Freytag's Pyramid*). As shown in Figure 3, the five-part structure of Freytag's Triangle consists of an exposition, rising action, climax, falling action, and denouement. The exposition represents the beginning of the narrative; this is where the characters and/or themes are introduced and the setting is set. During the rising action a conflict between the principle players is introduced. The climax occurs when the conflict comes to a head. The fallout of the climax is represented by the falling action. And, the denouement (which means *unknotting* in

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recognition plots result in a change from ignorance to understanding. The ideal plot combines the result of reversal and recognition. (Aristotle and Heath 1996)

[5] Specifically Aristotle's thesis on *Poetics* concentrated on *tragedy*. According to Aristotle tragedy, as apposed to comedy, was the highest form of drama; and the most important aspect of drama was the plot. Freytag's text was an extension of Aristotle's thesis, but by the time of Freytag's

French) represents the resolution of the conflict. Commonly referred to as the *narrative arc*[6], Freytag's Triangle is a widely accepted basis for the description of linear narrative structure.

2. Non-literary Narratives

Although originating in literary and dramatic contexts, the term *narrative* is often used to describe form in non-literary contexts, as in the case of music and art[7]. The unfolding of narrative in music is often structurally similar to forms found in literature, such as poetry and prose. A quintessential example of a literary form in music is the *Sonata-Allegro* form.

The *Sonata-Allegro* form is a three-part structure consisting of an exposition, development, and recapitulation. Although generally abstract in nature, the Sonata-Allegro form follows the familiar narrative unfolding of the narrative arc as it is described in literary form. During the exposition of a Sonata-Allegro two themes are presented individually, like characters in a story or play. Within the development

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text the interpretation of Aristotle's thesis had changed and Aristotle's criticism of tragedy was commonly applied to all forms of drama. (Clark 1918)

[6] Although there is no clear definition of the term *narrative arc,* it is often assumed to mean a structure close to, if not the same as *Freytag's Triangle.* For clarity, in this context *narrative arc* will refer to the rise and fall of a narrative as described by *Freytag's Triangle.*

[7] The use of narrative in the context of this discussion is intended to describe the unfolding of information within a work from a particular art practice, and should not be confused with the programmatic use of narrative in certain genres of art practice. In genres of programmatic art practice there is either an implied, or supplied literary program, which tells the story being represented by the work. For example, when attending a performance of the *Tone Poem*, *Symphonie Fantastique* by Hector Berlioz (1803-1869) (which is the musical telling of an opiated nightmare) the audience is presented with a programmatic text that details the unfolding of events within the work. Likewise Michelangelo's *Genesis* (from the Sistine Chapel) is an example of *Narrative Painting* that depicts the *Genesis* story from the Old Testament. But rather than relying on a provided text as in the case of *Symphonie Fantastique, Genesis* relies on its title to provide the programmatic reference.

section themes are compared and contrasted, mutated and transformed, as if the characters were having a struggle with each other. Finally, in the recapitulation, the themes are presented again, but this time they are different from before (in a different mode, tempo, and/or key). It is as if the themes (as characters) changed through the process of the development; in other words, the characters were transformed by the unfolding of the story.

In painting and other visual arts the unfolding of narrative is connected to visual perception. Through the interplay of color and form a painter directs the path of a viewers attention through the visio-spatial narrative path of the painting. For example, in one interpretation of Wassily Kandinsky's (1866-1944) *On White II* (1923; see Figure 4), the consolidation of color and shape initially draws the viewer's attention to the center of the canvas. The viewer's attention is then drawn from the center to the edges guided by the transition of color from dark to light, and the trajectory of shape, which changes from thick to thin and dense to sparse. The form of the painting therefore implies a visio-spatial unfolding of sequential events as a perceptual path through the work.

Figure 4. Wassily Kandinsky. *On White II*, 1923.
Centre Georges Pompidou, Paris.

In addition to the formal description of works in various art practices, non-literary use of narrativity is used to describe concepts in philosophy, especially in *epistemology* (the study of knowledge). One reason for the connection between narrative and knowledge is that the origin of the words *narrative* and *knowledge* is from the same linguistic root. According to Merriam Webster's dictionary the etymology of narrative is 'from the Latin *narratus*, which is the past participle of *narrare*, which is in turn derived from *gnarus*, meaning knowing; and akin to the Latin *gnoscere*, or *noscere,* meaning to know.' Therefore it can be derived that narrative is the structure of knowledge and the unfolding of knowledge as a sequence of information.

The significance of the connection between narrative and knowledge is recognized in the work of philosopher Jean-François Lyotard (1924-1998). As shown in his seminal text, *The Postmodern Condition: A Report on Knowledge*, Lyotard states:

> It is fair to say that there is one point on which all of the investigations [of knowledge] agree, regardless of which scenario they propose to dramatize and understand the distance separating the customary state of knowledge from its state in the scientific age: the preeminence of the narrative form in the formulation of traditional knowledge (Lyotard 1984).

In *The Postmodern Condition* Lyotard uses the definition of the narrative form in the formulation of traditional knowledge to describe the concept of *grand narrative*. G*rand narrative* is a term used by Lyotard to describe and criticize oppressive social archetypes (such as the "nuclear family" and the "American Way") that are used to define and organize our society. According to Lyotard, these grand narratives are being rejected by contemporary society because of their inability to reflect individual, and diverse experience. Because of this rejection Lyotard predicts that grand narratives will eventually disappear, leaving in the aftermath an interconnected web of smaller narratives, each equal in value, and none more legitimate than the other.

3. The Decline of Linear Narratives

A basic understanding of the origins and definition of linear narrative provides a useful contrast for understanding the origins and definition of nonlinear narratives. Like linear narrative, nonlinear narratives have a rich history that extends across

many disciplines and art practices. However, unlike linear narrative, nonlinear narratives do not have a clearly defined and well-established generalized structure upon which all nonlinear narrative artworks can be understood. The reason for this lack of definition is that the term nonlinear narrative is used to describe a disparate category of works that are only similar because they commonly represent a break from the definition of traditional linear narratives and their contexts.

In art and music history the break from the grand narratives of past traditions is a phenomenon demarcated by a series of movements that took place between the late 19th and early 20th Centuries. Many of these movements were the result of a crisis, which necessitated a rethinking of art practices during the turn of the 20th century. The crisis of tradition during the turn of the 20th century is exemplified in a movement in music known as the *Emancipation of the Dissonance*.

A term coined by composer Arnold Schoenberg (1874-1951), the *Emancipation of the Dissonance* refers to an all out rejection of traditional tonal systems, which emphasized consonant harmonies and tonal centers, in favor of a music known as *atonality* that favored dissonant harmonies and the de-emphasis of tonal centers. The culmination of the *Emancipation of the Dissonance* resulted in the 12-tone composition system (also known as serialism), which provided a systematic method of organizing melodies and harmonies to fit the criteria of the atonal aesthetic (Simms 2000).

Rather than being a rebellion against the tradition of Western concert hall music, the experiments of the *Emancipation of the Dissonance* were considered by Arnold Schoenberg and his followers of the Second Viennese School to be a continuation of the tradition of Western concert hall music. Consequently, the *Emancipation of the Dissonance* is considered by its progenitors and many scholars to be the denouement of the decline of tonality in late 19th century Western concert hall music (Simms 2000). The development of a movement as the denouement of a past narrative is the affirmation that the past is coming, or already has come to an end, and thereby begging the question, 'if the past is over, then what is next?' Ironically, the *Emancipation of the Dissonance* as a solution to a crisis introduces a new crisis of its own.

While movements such as the *Emancipation of the Dissonance* represent an affirmation of past narratives, other movements took a skeptical view by challenging the grand narrative archetypes of past narratives. Among the movements in the skeptic camp were the Dadaists. Started in Switzerland by a group of artists whose figurehead was Tristan Tzara (1896-1963), Dadaism actively sought a break with traditional art practices by using absurdity, humor, and other anti-rational means to draw into question the validity of the narrative of traditional Western art practices.

One of the most famous Dadaist works is Marcel Duchamp's (1887-1968) *Fountain* (1917; see Figure 5). *Fountain* was a urinal on a plinth signed "R. Mutt," which Duchamp submitted to an open exhibition of contemporary artists held by the

Society of Independent Artists in 1917. Although Duchamp was a member of the board of the Society of Independent Artists, the submission caused a big uproar in the Society, inspiring a heated debate about the validity of the work (Cros 2006). The nature of the debate is characterized in this article from a magazine called *The Blind Man,* which was edited by Beatrice Wood, H.P. Roche, and Marcel Duchamp (printed subsequently to the exhibition):

> The Richard Mutt Case
>
> They say any artist paying six dollars may exhibit. Mr. Richard Mutt sent in a fountain. Without discussion this article disappeared and was never exhibited. What were the grounds for refusing Mr. Mutt's fountain:
>
> 1. Some contended it was immoral, vulgar.
> 2. Others, it was plagiarism, a plain sheet of plumbing.
>
> Now Mr. Mutt's fountain is not immoral, that is absurd, no more than a bath tub is immoral. It is a fixture that you see everyday in plumbers' show windows.
>
> Whether Mr. Mutt with his own hands made the fountain or not has no importance. He CHOSE it. He took an ordinary article of life, placed it so that its useful significance disappeared under a new title and point of view – created a new thought for that object.
>
> As for plumbing, that is absurd. The only works of art America has given are her plumbing and her bridges. (Duchamp, Roche, and Wood 1917)

As can be derived from the statement above, after much debate, the work was censored on 'non-artistic grounds.' Outraged by the outcome of the exhibition Duchamp resigned from the Society of Independent Artists Exhibit in protest.

Figure 5. Marcel Duchamp, *Fountain*, 1917, photograph by Alfred Stieglitz

Despite Duchamp's apparent outrage the work most likely had achieved the intended result (Cros 2006). By submitting a found object (what Duchamp called a *readymade*) to the exhibit Duchamp forced the Society to question the meaning of art and the role of art, particularly in a gallery context. Therefore, what is provoking about *Fountain* is not that Duchamp wanted to put a urinal in a gallery under a

pseudonym, it is that Duchamp is suggesting that art is about intellectual ideas, which lies in direct opposition to the traditional view of art as a physical craft (Duchamp, Roche, and Wood 1917).

The Second Viennese School and Dadaism represent just two examples of the multitudes of art movements, occurring and continuing throughout the 20th and 21st century, that break from the traditional narratives of the past. In one form or another all of the art movements of the 20th and 21st century represent either a skeptical or an affirmative break from the traditional Grand Narrative of art and art making. Whether affirmative or skeptical, there is a common dialog that the forms of the past can no longer adequately contribute to the contemporary dialog of the arts and therefore new approaches must be taken in art making.

4. Narrative And Technology

At the turn of the 20th century new technologies, such as cinema, radio, and recorded media, were emerging that allowed people to experience the world in ways that were never possible before. The stop motion photography of Eadweard Muybridge (1830-1904), known as chronographs, is an early example of this new technology (see Figure 6). Originally published in the 1880's for the benefit of 'artists, doctors, and researchers,' the photo collections of Eadweard Muybridge quickly became an object of curiosity in late 19th century culture. Of the first of its kind, the collections consisted of a number of plates with a series of photos on each plate showing men, women, and animals in motion taken by an array of cameras at

short regular intervals at a speed close to a low frame rate movie camera (Muybridge 1955).

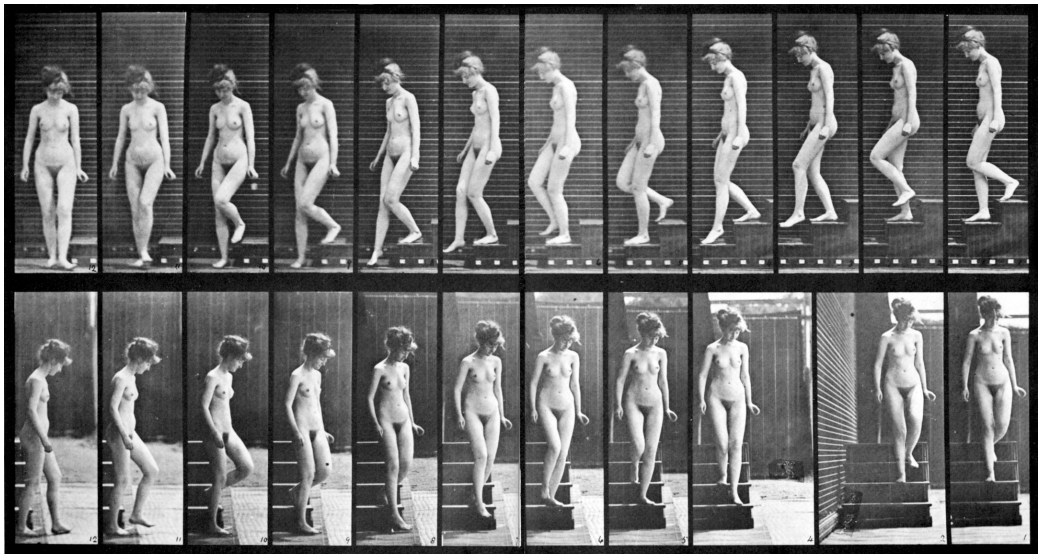

Figure 6. Eadweard Muybridge. *Woman walking downstairs*, late 19th century. The photos in the series are ordered from right to left.

The similarity between Eadweard Muybridge's *Woman walking downstairs* (Figure 6) and Marcel Duchamp's *Nude Descending A Staircase, No. 2.* (1912, Figure 7) underscores the connection between technology and art making during the period at the turn of the 20th century[8]. Like Muybridge's photography, Duchamp's painting expresses a new understanding of time and space by providing a multi-perspective gesture of a woman walking down stairs.

[8] Although the connection is remarkable, Duchamp claimed at a later date he did not recall seeing Muybridge's *Woman walking downstairs* before painting *Nude Descending a Staircase* (either *No. 1* or *No. 2*). Rather he cites having been influenced by the chronophotographs of French photographer Etienne-Jules Marey (1830-1904), which were first published in *La Nature* and *L'Illustration* (c. 1893). Either way the example of Muybeard's work is provided here to help emphasize the influence of new technology and art making during this period. (Tomkins 1996)

Figure 7. Marcel Duchamp. *Nude Descending a Staircase, No. 2,* 1912. Oil on canvas. 57 7/8" x 35 1/8". Philadelphia Museum of Art.

However, unlike Muybridge's photographs, the movement of the woman through time in Duchamp's painting is unified into a single object. Duchamp's use of hard edges and solid planes seem to suggest that time is no longer transient and intangible, but has become physical and that new technology has transformed time into something that can be recorded in a fixed medium, manipulated, shaped, and sculpted just like any other object. The transformation of time in to a solid malleable object is significant and profound because it shows that as our understanding of time changes, so does our understanding of narrative. Consequently the breaking of the

frame of narrativity is not only tied to movements and ideals, but to the manner of art making as well.

B. Operations

The operations presented in this section (which can be summarized as operations of montage, indeterminacy, and formalization) are techniques that are ubiquitous throughout the various disciplines of the arts. These techniques represent a new way of thinking about art making and the meaning of authorship, which results in art works that are the expression of new narrative structures. The categories mentioned are not intended to be ridged categories, but provide a basis for describing the operations that are used to make nonlinear narratives. Although these operations can often result in traditional linear narrative structures (i.e. the narrative arc), the operations themselves provide an implied commentary on our understanding of the structure of knowledge as a product of nonlinear processes.

1. Montage

a. Montage and Collage

The influence of the chronographs of Eadweard Muybridge and Ettienne-Jules Marey on the work of Duchamp pales in comparison to the influence of cinema on art and culture in the 20th Century. Unlike cinema, which shows time in motion, the chronograph presented a frozen view of time unfolding as a series of images arranged in sequential order across a page. Through the motion of cinema time becomes fluid again and the transient reality of time returns, but altered. As an object in motion, time in cinema is something that can be played back, rewound, repeated,

cut-up, and reassembled to make new forms using the common cinematic technique of *montage*.

One of the strongest influences on narrativity in the twentieth century is the montage. As described by film theorist Sergei Eisenstein (1900-1965), Montage is:

> …the juxtaposition of two separate shots [whereby] splicing them together reassembles not so much a simple sum of one shot plus another shot – as it does *creation*… [and] in every such juxtaposition *the result is qualitatively* distinguishable from each component element viewed separately. (Eisenstein and Leyda 1975)

Figure 8. Max Ernst. *Le Rire Du Coq,* from *Jeudi,* the last section of the novel: *Une Semaine De Bonté, Ou Les Sept Éléments Capitaux,* 1934.

The concept of montage may be, as Eisenstein states, "most pronounced in cinema" (Eisenstein and Leyda 1977), but the narrative form of montage can be found in other art practices in many guises. A striking example of the montage in art

can be found in the *collages* of surrealist artist Max Ernst (1891-1976), who was considered the inventor of the collage. Max Ernst's first published collection of collages was in a novel called, *Les Malheurs des Immortelles* (1919), which featured twenty-one collages accompanied by the text of writer Paul Eluard (1895-1952).

Ernst's most famous novel called, *Une Semaine De Bonté Ou Les Sept Éléments Capitaux* (1934), was composed of seven parts with each section relating to a different day of the week. Images in Max Ernst's collages were taken from sources that had a similar quality, facilitating Ernst to blend the collection of juxtaposed elements of his collages into a seamless dream-like whole (see Figure 8) (Brotchie, Gooding, and Lamantia 1995).

b. Cut-ups

The technique of collage and montage is analogous to the technique in literature called *cut-ups*. Author William S. Burroughs (1914-1997) wrote several novels using the cut-up technique. Inspired by the poetry of Dada founder Tristan Tzara[9], Burroughs based his first experiments on the procedure described in the following poem:

> To Make A Dadist Poem
>
> Take a newspaper.
> Take a pair of scissors.
> Choose an article as long as you are planning to make your poem.

[9] The poet and painter Brion Gysin first introduced the technique of writing Dadaist poetry to Burroughs while Burroughs was living in the Beat Motel in Paris in the late 1950's. (Geyh, Leebron, and Levy 1998)

> Cut out the article.
> Then cut out each of the words that make up this article and put them in a bag.
> Shake it gently.
> The take out the scraps one after the other in the order in which they left the bag.
> Copy conscientiously.
> The poem will be like you.
> And here you are a writer, infinitely original and endowed with a sensibility that is charming though beyond the understanding of the vulgar.
> (Tzara 1920)

The chief difference between Tristan Tzara's approach to Dadaist poetry and William S. Burroughs' approach to writing cut-ups was that Burroughs used his own writing as the source material when writing a cut-up, rather than using an *objet trouvé* (i.e. 'found object') as suggested in Tzara's poem. Also, Burroughs tried several variants of the cut-up technique, achieving various results. For example, in later works Burroughs used a variant of the cut-up technique (a more deliberate technique known as *folding*), which involved taking paragraphs, cutting them in half, and splicing then together out of sequence.

Burroughs used cut-up techniques to create the paranoid schizophrenic nightmare worlds of his novels that existed between the metaphysical and science fiction. The delusional mind set of the juxtaposed imagery found in Burroughs' novels were an expression of his life struggles that stemmed from his heroine addiction and the inner torment he experienced as he struggled with his identity as a homosexual in the mid-twentieth century. For examples of Burroughs' cut-up novels see *The Soft Machine*

(1961), *Dead Fingers Talk* (1963), and *Nova Express* (1964) (Geyh, Leebron, and Levy 1998).

c. Quotations

As exemplified in the third movement of *Sinfonia*, *In ruhig fliessender Bewegung* (1968) by Luciano Berio (1925-2003), the use of montage in music is a technique known as quotation. In the third movement of *Sinfonia* Berio musically blended fragments from the works of several symphonic composers, including Bach, Brahams, Debussy, Webern, Mahler, and his own previous works. Berio himself referred to the technique of quotation as an *objet trouvé* approach (Osmond-Smith 1991), which blended musical fragments in a manner analogous to the technique Max Ernst described above.

In *Sinfonia*, the montage of musical quotations was orchestrated to provide accompaniment for the vocal parts, which were sung by a jazz octet. Composed of text fragments juxtaposed together from various sources the lyrics were organized in a manner similar to the cut-up technique of Tristan Tzara mentioned above. Text sources included play write Samuel Beckett's *The Innameable*, anthropologist Claude Lévi-Strauss' *Le cru et le cuit*, and score markings taken from the various musical sources that were used in composing the work.

Through the use of sources from throughout history and across several disciplines, *Sinfonia* creates a montage of text and music that swirls and spins in a

schizophrenic circus of history and knowledge. A self-reflexive work, the choice of sources in *Sinfonia* and their relation to each other places Berio's music in the same context as the works of the great composers. In addition, the self-reflexive nature of *Sinfonia's* third movement is reflected in the lyrics of the work, which provide commentary about the work as the work is playing. It is at once self aware and unsure as it announces the unfolding of the work in a dream-like cyclone of sound and text.

As shown in the examples provided above, the use of montage is pervasive through the arts. The forming a narrative out the juxtaposition of elements that otherwise have no connection to each other is a reflection of the form of the dissemination knowledge in new media, which transmits information in slices, quips, and bits. Therefore the montage is a juxtaposition of information that breaks with the ordered teleological narratives of the past by expressing new assemblages of knowledge that form a nonlinear whole.

2. Indeterminacy

> In its advocacy of structures that demand a particular involvement on the part of the audience, contemporary poetics merely reflects our culture's attraction for the "indeterminate," for all those processes which, instead of relying on a univocal, necessary sequence of events, prefer to disclose a field of possibilities, to create "ambiguous" situations open to all sorts of operative choices and interpretations. -- Umberto Eco, *The Open Work* (Eco 1989)

In addition to being an example of the cut-up technique, the mixing of lines of text described in Tristan Tzara's *To Make A Dadist Poem* provides an example of an indeterminate process known as a *chance operation*[10]. Chance operations in art practice are any process that allows an artist to remove themselves from the decision making process by leaving the outcome of the work to the unexpected or the unknown. The intent of using chance operations is to open a work up to, what composer John Cage (1912-1992) describes as, "the totality of possibilities" (Pritchett 1993).

a. Chance and Indeterminacy

Chance operations often involve the use of coin tossing, dice rolling, or other indeterminate methods for making decisions in the composition of a work. Chance operations such as the ones described were significant to the work of John Cage. Cage's interest in chance operations stemmed from his interest in the philosophy of Zen. In the Zen view nature is a force that acts without thought, therefore to act with out thought is to be part of nature, a state that Zen Buddhists call 'no mindedness.' The use of chance operations facilitated Cage to remove himself from the decision-making in his work, act without knowing, and thereby express in his music a Zen understanding of nature (Pritchett 1993; Nicholls 2007).

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[10] As can be seen in the examples above, the processes of montage and indeterminacy are often combined. Besides Tzara's description of the Dadaist poem, further examples can be found in William S. Burroughs' cut-ups, and the Lyrics to Luciano Berio's *Sinfonia.* However it should not be assumed that montage and indeterminate operations are dependent upon each other either. More often

An example of a work by John Cage that uses chance operations is *Music of Changes* (for piano, 1951). One of his most important works, *Music of Changes* was named after *The Book of Changes* (also known as the *I Ching*), an ancient Chinese book of symbols that describes a system used to identify order in chance events (Pritchett 1993; Nicholls 2007).

The process of composing *Music of Changes* involved the use of three charts containing musical gestures that were mapped to the symbols of the *I Ching*. The three charts were used to determine the sonority, duration, and dynamics of the composition respectively. During the composition process *I Ching* symbols were selected based on a roll of dice. Each roll of the dice mapped to an *I Ching* symbol that would then be used to determine which element to use next in the score (Pritchett 1993; Nicholls 2007). Although Cage was the author of the gestures and the process of selection, through the use of chance operations Cage was able to remove himself from the decision making process of the work.

In the repertoire of John Cage chance operations were not exclusively employed for the purpose of creating fixed compositions. In other indeterminate works Cage also used chance operations to make decisions about the structure of a work during a performance. The use of these 'real-time' chance operations guaranteed that a

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than not montages are made with intent, and frequently indeterminate works are made out of related materials.

composition would be unpredictably different from one performance to the next (Pritchett 1993; Nicholls 2007).

Over his lifetime John Cage made a number of works that involved chance operations. Besides *Music of Changes*, examples of the use of chance operations in Cage's work can be found in works such as, *Water Music* (for pianist, using also a radio, whistles, water containers, a deck of cards, a wooden stick, and objects for preparing piano; 1952), and *William's Mix* (for magnetic tape, 1952) (Pritchett 1993; Nicholls 2007).

b. Happenings

In addition to the discovery of chance operations, John Cage's desire to express the 'no-minded' intent of Zen nature eventually lead him to other experiments in indeterminacy. These other experiments incorporated the use of non-traditional elements, such as the use of everyday objects (as in the case of *Water Music*, above), and audience participation in his works. John Cage's new approaches to composition, which blurred the lines between music, performance, and art, became the basis for the ideas that he taught in a course at the new School for Social Research (Stokstad, Collins, and Addiss 1999). Billed as a composition course, Cage's students included painters, sculptors, dancers, writers as well as composers. Among this cross-disciplinary group of students was artist Allen Kaprow (1927-2006).

Inspired by Cage's teaching, Allen Kaprow desired to create works that transcended the barriers between art and life, a desire that lead him to the creation of the *Happening*. Happenings, which were primarily a phenomenon of the 1950's and 1960's, were event based performance artworks that could 'happen' anywhere, under almost any circumstance. Happenings attempted to blur the line between audience and observer by breaking the fourth wall and making the audience part of the performance themselves. Obsessed with breaking the frame and the definition of art, the philosophical approach to Happenings made the works difficult to define because each performance not only broke down barriers between art, performance, and music, Happenings broke down barriers between the audience and the artist as well (Stokstad, Collins, and Addiss 1999; Nelson 1965; Kaprow 1965).

In 1965 Allen Kaprow wrote an article called, *Untitled Guidelines for Happenings*, which, in addition to being a compelling description of an operation for the development of Happenings, provides a compelling description of an operation for the development of participatory indeterminate works in general. Kaprow's guidelines can be summarized as follows:

> (A) The line between art and life should be kept as fluid, and perhaps indistinct, as possible.
>
> (B) Therefore, the source of themes, materials, actions, and the relationships between them are to be derived from any place or period *except* from the arts, their derivatives, and their milieu.
>
> (C) The performance of a Happening should take place over several widely spaced, sometimes moving and changing locales.

(D) Time, which follows closely on space considerations, should be variable and discontinuous.

(E) Happenings should be performed once only.

(F) It follows that the audiences should be eliminated entirely.
(Kaprow 1965)

c. Hypertexts

While the indeterminate processes above focus on the use of random chance and participation, another approach to indeterminacy focuses on opening the possibilities of user choice through an operation of navigation. Navigability is a prominent feature found in *hypertexts*. Often associated with modern computing and the internet, the term hypertext was originally coined in 1965 in the article *A File Structure for the Complex, the Changing, and the Indeterminate* by Theodore H. Nelson (Nelson 1965).

In the Nelson's article he describes the form and operation of structuring data in what he calls the *evolutionary file structure* (ELF) as a way of structuring information that in many ways anticipates the querying, ordering, display, and linking common in databasing applications today. The intent of this structure is to facilitate the implementation of *hypertext*, *hyperfilm*, and, more generally, *hypermedia* works. The content of *hypermedia* is a nonlinear navigable structure that uses related data elements to link information together in the knowledge space of the work (Nelson 1965).

Like the chance operations and the participatory operations described above, hypermedia works draw into question the nature of authorship by releasing the responsibility of determination to elements beyond the author's control. The navigable narratives of hypermedia are focused on selection and choice. Through selection the user creates their own narative path, which is only one of many potential narrative paths.

One of the most highly acclaimed hypertext novels is *afternoon, a story* (1990) by Michael Joyce (b. 1945). The perspective of *afternoon, a story* is taken from the viewpoint of a fictional writer named Peter who (depending on the reading of the story) is coming to terms with a loved one's death. While reading the story the user navigates through a psychological terrain of Peter's consciousness that, depending on the user's choices, lead to different outcomes (Geyh, Leebron, and Levy 1998). As the user navigates the story they discover new aspects to the story that change the story's perspective and alter the user's understanding of the meaning behind the work. The openness of possibilities in the hypertext novel format means that a novel could be read over and over with the potential of having numerous outcomes that can be revisited again and again. Assuming a user takes a unique path on each visit, the novel would continue to change, providing a new story on each read.

In assessment indeterminate narratives represent a radical shift from the traditional narrative structures of the past. Although it is often the case,

indeterminate narratives are not simply a rebellion against traditional narrative. Like montage, indeterminate narrativity reflects on an aspect of our experience of knowledge and information that is characteristic of our contemporary perception of knowledge and nature, which is indeterminate, unexpected, and open to possibility.

3. Formalization

Ranging in character from controlled chaos to total organization, operations discussed in this section systematize information with the use of stochastic algorithms, deterministic rule-sets, and game theory. Borrowing a term from the book *Formalized Music* by composer Iannis Xenakis (1922 - 2001), these operations will be referred to as *formalized* operations. Formalized operations are used to organize, generate, and shape complex data for the creation of works.

Generally speaking, formalized operations and indeterminate operations are like two sides of the same coin. Both operations are motivated by a desire to express a modern understanding of knowledge and nature, however each operation takes a different approach. While indeterminate operations tend to be an expression of knowledge and nature as the unexplainable and the sublime, formalized operations are an expression of knowledge and nature based on scientific models, social structures, and/or mathematical principles. In this way formalized operations are often used to make the connection between art and science.

a. Formalized Music

The use of formalized operations has been ubiquitous in music composition since the end of World War II and provides an excellent basis for a discussion on formalized operations in the arts. While the use of formalized operations for the generation of musical material has a long history dating centuries into the past, the formalization of music since the end of World War II is unique in history because of its more rigorous connection to science and mathematics. The range of formalized operations used in the creation of art is extremely varied. Some examples of the formalized operations that have been used to create art include cellular automata, stochastic processes, fractals, chaos generators, grammars, artificial intelligence and more recently genetic algorithms (Roads 1996; Griffiths and Griffiths 1995; Stokstad, Collins, and Addiss 1999).

As mentioned above, Iannis Xenakis, who was in the vanguard of the use of formalized operations in music, coined the term *formalized* to refer to mathematical processes in art practice in his seminal book *Formalized Music*[11]. Xenakis' book provides an in depth description of the aesthetic and technical approaches that Xenakis took in the creation of music. For Xenakis the use of formalized operations, such as game theory and stochastic mathematics, provided a way for him to draw connections between the worlds of science, architecture, and music (Xenakis 1992).

An early example of the use of stochastic operations in Xenakis' music can be found in the work *Pithoprakta* for orchestra (1955-1956). Operations borrowed from probability statistics related to the kinetic theory of gases were used in *Pithoprakta* to generate large data sets for the content of his work (Xenakis 1992). Unlike Cage's use of chance, which determined the content and the structure of a work, Xenakis' use of stochastic operations were generally used solely for the generation of the content for a predetermined consciously composed structure. To this end, the stochastic operations in *Pithoprakta* were used to generate the content of clouds of sound that represented the way molecules moved in a body of air (Xenakis 1992). Through this operation Xenakis was able to create varying textures and shapes that ranged from dense short varying glissandi at small intervals to sparse pizzicato textures at larger intervals. The use of irregular meter and the continuity between the sections of the work gives the work a feeling of stasis. The narrative of *Pithoprakta* was more like the form of an object morphing in space, rather than an arc-like sequence of unfolding events through time.

[11] Although a *Formalized Music* is book about the aesthetics and techniques in music, Xenakis stated that 'for everything said here on the subject [of Formalized Music] is also valid for all forms of art (painting, sculpture, architecture, films, etc.). (Xenakis 1992)

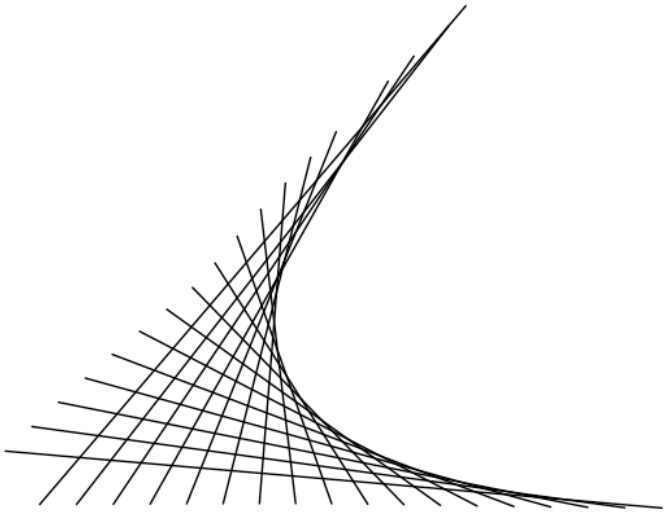

Figure 9. A parabola formed from the envelope of the sum of line segments.

Interest in the interplay of time and space also inspired Xenakis' first large-scale work, *Metastaseis* for orchestra (1953-1954). *Metastaseis* was composed using a mathematical process that resulted in a series of lines that, when summed together, formed the envelope of curves, much like the parabola shown in Figure 9. The initial composition of *Metastaseis* was realized in a similar manner to drafting an architectural blueprint. A series of lines created the shape of the time-based morphology of the structure of the piece with the *y*-axis relating to pitch and the *x*-axis relating to time. The lines in the blueprint were interpreted as long and interlaced glissandi to form what Xenakis called, 'sonic spaces of continuous evolution' (Xenakis 1992). Xenakis orchestrated the lines with each of the instruments in the 61-piece orchestra having their own part.

Figure 10. The Philips Pavilion from the 1958 World's Fair in Brussels. Source: Philips Technical Review, Vol. 20, No. 1 (1958/59), page 35. Photo by Hans de Boer.

As *Pithoprakta* made a connection from science to music, *Metastaseis* made a connection from music to architecture. While working under *Le Corbusier* (1887-1965) Xenakis was consulted on the design of the Philips Pavilion for the 1958 World's Fair. Developed a few years after the composing of *Metastaseis,* Xenakis' design drew inspiration directly from the score of *Metastaseis* (Xenakis 1992). This connection becomes apparent when comparing the diagram in Figure 9 with the structure in Figure 10.

The techniques of stochastic processes described in *Formalized Music* facilitated Xenakis aesthetic impetus of bringing together science and man in his music. For Xenakis, music was not only a reflection of our understanding of the universe; it was a way of transforming the universe as well. Xenakis describes the connection between formalized processes and the transformative quality of music in this passage from *Formalized Music*:

> Music is but a path among others for man, for his species, first to imagine and then, after many, many generations, to entail this existing universe into another one, one fully created by man. Indeed, if man, his species, is the image of his universe, then man, by virtue of the principle of creation from nothingness and disappearances into nothingness (which we are forced to set), could refine his universe in harmony with his creative essence, such as an environment he could bestow upon himself. (Xenakis 1992)

b. Potential Literature

Much in the same way that Xenakis proposed to formalize music, the members of Oulipo (short for *Ouvroir de Littérature Potentielle*, or *Potential Literature Workshop*, *trans*.) propose to formalize literature. François Le Lionnaise (1901-1984) and Raymond Queneau (1903-1976) co-founded the Oulipo in 1960 "to propose new structures to writers, mathematical in nature, or to invent new artificial or mechanical procedures that will contribute to literary activity: props for inspiration as it were, or rather, in a way, aids for creativity" (Queneau 1998).

Oulipo carries out the pursuit of new structures and new procedures through the techniques of analysis and synthesis. Through analysis Oulipo looks for techniques in past works and find possibilities for making new literature, and even, in some

cases exceed those possibilities. Through synthesis Oulipo searches for unexplored possibilities for making new literature (Lionnaise 1998). To this end the members of Oulipo pursue a formalized investigation, using mathematical procedures and modern mechanical tools, such as the computer, to carry out their work.

Combinatorial techniques are one of the many techniques used by the members of the Oulipo in the creation of potential literary works. One such example of a combinatorial work is *Cent Mille Milliards de poèmes* by Raymond Queneau. *Cent Mille Milliards de poèmes* is a book composed of ten sonnets. Each of the fourteen lines of the sonnets can be turned individually. As each line is turned a new poem is created, hence the combinatorial effect of this construction. The potential number of poems from this small collection is enormous, 10^{14} (i.e. 100,000,000,000,000), or one hundred thousand million possible poems[12] (Motte 1998).

The various transforms, procedures, and analyses that members of the Oulipo have experimented with produce a number of interesting results. There are combinatorial systems that create new works, transform existing works into other kinds of works (for example changing a sonnet into a haiku), and rule-based systems that place selection constraints on larger sets of data to control the results[13].

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[12] For a web based version of *Cent Mille Milliards de poèmes* please visit, http://www.bevrowe.info/Poems/QueneauRandom.html

[13] Italo Calvino proposed one such system based on the scenario of a detective novel where there are 4 characters, each with the potential of 12 crimes they could have committed. By categorizing the crimes into types implausible outcomes could be eliminated from the selection pool. For example, it

When considering the case of Oulipo the question arises of how the procedures of the Oulipo differ from the previously described methods of cut-ups/Dadaist poems and hypertext. While all three methods are concerned, in one way or another, with potential, the Oulipo approach is the only one that is formalized. In the case of the cut-ups/Dadaist poems this difference is conceptually similar to the difference between Cage's chance operations and Xenakis' stochastics. For example, in comparison of Tristan Tzara's *To Make A Dadist Poem,* and Raymond Queneau's *Cent Mille Milliards de poèmes*: Tzara's technique determines both the content and the structure of a work, while Queneau's techniques results in the generation of the content for a predetermined consciously composed structure.

While the methods of the Oulipo could potentially result in a hypertext, the underlying motivations are different. Based on the database model, hypertexts are concerned with the free interconnection of information through linking and navigation, whereas the formalized methods of the Oulipo are concerned with constraints. In this way Oulipo texts are more structurally and formally controlled than a text that was following the pure guidelines of the hypertext.

c. Games

Game narratives are ubiquitous in contemporary culture. As narratives, games can be considered formalized operations because of their use of constraints and rule

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didn't make much sense for someone to have hung someone then stabbed, thus these two crimes were

sets. Most electronic and computer-based devices either are literally games, or use the experience of games, by reference, to shape our interactions. Stereotypical game narratives rely on some form of a frustrated quest. During the quest a certain number of tasks (i.e. kill or collect) must be completed before a user is advanced to the next level. Once on the next level a new, but similar, set of tasks is presented, and the cycle continues. If the user fails the set of tasks given they are returned to the beginning of the level and must try again. Once all of the levels are completed the game ends, but the cycle is broken, leaving the construct unresolved. The pervasiveness of the cycle structure in games is so great that it creates a continuum that connects games together. While the characters and contexts change, the overall narrative does not; it is a process that can be sustained indefinitely, but never satisfied. Therefore the continuous game narrative is the context of our typical day-to-day interaction with technology, which is focused on play and playing, and a frustrated futility guised as gaining and winning. It is tied to a consumerist grand narrative, where the winner takes all, but no one ever wins.

Game-based artworks are often based on conventional games. Such is the case of *Meme-X Engine or Lara Croft Stripped Bare by Her Bachelors, Even* (Lafia et al. 1998), http://www.memexengine.net (see Figure 11). The *Meme-X Engine* is a sophisticated work that represents the convergence of historical and cultural ideas surrounding media arts practice.

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placed in the same category so that if one was picked the other was excluded. (Calvino 1981)

Figure 11. Marc Lafia, et. al. *Meme-X Engine or Lara Croft Stripped Bare by Her Bachelors, Even*. Two screenshots from the web-based work located at: http://www.memexengine.net
Used by permission ©1998-2008 ArtandCultureLLC (http://www.artandculture.com)

The title, *Meme-X Engine,* is an unsubtle reference to the well-known article by pioneer computer scientist Vannevar Bush, called *As We May Think* (1945). *As We May Think* is a future looking article that imagines what technology will be like in a future distant to 1945. In the article Bush proposes a machine used to 'extend our memory' called the *Memex*. The speculative design of the Memex was a kind of hypermedia machine that facilitated the navigation of tagged media stored on microfiche. The intent of the machine was to be a kind of memory bank and encyclopedia that could cross-reference any subject at the click of a button, a design that anticipates the modern computer equipped with a web browser (Bush 1945).

The transformation of the term *Memex* to *Meme-X* is also a reference to the fields of memetics. Memetics is the theory that ideas (a.k.a. *memes*) spread in a manner

analogous to the spread of viruses within populations. Thus memes experience the same selection processes that determine viability as the evolutionary processes of life. In this sense the *Meme-X Engine* is literally a meme engine where memes are processed, assessed, and converged.

The *Meme-X Engine* uses familiar elements to provide user navigation based on the context and language of the internet. To use the *Meme-X Engine* a user must login, navigate and explore. As the user explores the *Memex Engine* they are guided by an unknown narrator that evaluates the user's actions by providing commentary and instructions about the user's progress through the story. Infused with elements of cyber sexuality, encryption, and voyeurism, the *Memex Engine* is an enigmatic nonlinear hyper-narrative written in a paranoid, science fiction style reminiscent of the writings of William S. Burroughs. In order to solve the mystery of the *Meme-X* engine users must surveil, decode, scan, and create an identity using a set of engines that reveal themselves sequentially when the user has completed a new set of tasks. As the user explores the *Meme-X Engine* they are being profiled, as well. The story is finished when the user completes the final task and hacks into the d7va computer system. The story ends with the *Meme-X Engine* profiling the user and exiting.

Although the *Meme-X Engine* is structured in a manner analogous to the cut-ups of Burroughs and Tzara's Dadist poems, the work also (intentionally) is structured like a game. As the user explores the *Meme-X Engine*, the user achieves new levels, and ultimately reaches the final goal and finishes the story/game. The convergence

of the various themes of the *Meme-X Engine* on the game provides an effective basis for a commentary on the history, current state, and consequences of modern computing technology from the context of media arts.

Art can be a game, but a game isn't necessarily art. By drawing upon game-like narratives in art, there is the unavoidable connection to games and game culture. Obviously there isn't a problem when the connection between an artwork and gaming culture is intentional. But what approaches can be made when trying to make a game narrative work that does not wish to draw on gaming culture as a reference? If the goal of an interactive artwork is to communicate some meaning beyond the context of games, then a balance must be made between the user's past experiences and contexts and the language of a work. To escape the context of games the artist must negotiate a new language with the user regarding the nature of interaction with the work.

In art making it is important to look outside of conventional gaming structures when it is desirable to use the logic games without referencing the culture of gaming. Therefore the following discussion will explore some of the alternative models of game narratives that are worth considering because of their greater capacity to describe nonlinear operations and produce nonlinear constructs.

One source for alternative game models can be found in Alastair Brotchie's *A book of Surrealist Games* (Brotchie, Gooding, and Lamantia 1995). *A book of*

Surrealist Games is a collection of games that were used by members of the Surrealist movement of the 1920's and 1930's for the experimental exploration of ideas. Artists, such as Andre Breton, Marcel Duchamp, and Max Ernst, were among the creators of the games included in the book.

The function of games in the Surrealist movement was to provide amusement and stimulate original thought. The goal of playing Surrealist games was not about winning, but rather about arriving at an interesting outcome. In that sense, Surrealist games could be thought of as more than a game, but a form of exercise, training, and an operation for the development of nonlinear works (Brotchie, Gooding, and Lamantia 1995). To provide a clearer understanding of the nature of Surrealist games, two examples are provided here from Brotchie's book.

The first example is a game called *The Exquisite Corpse Shall Drink The New Wine*, or *The Exquisite Corpse* for short. Probably the most well known Surrealist game, *The Exquisite Corpse* can be played in two ways, by using language, or by using images (Brotchie, Gooding, and Lamantia 1995):

> The Exquisite Corpse (version 1: language)
> For a minimum of three players.
> The Players sit around a table and each writes on a sheet of paper a definite or indefinite article and an adjective, making sure their neighbors cannot see them. The sheets are folded so as to conceal the words, and passed round to the next player. Each player then writes a noun, conceals it, and the process is repeated with a verb, another definite or indefinite article and adjective, and finally another noun. The paper is folded and the sentences read out. Players may agree to small changes to ensure grammatical consistency. The game acquired its name from the first sentence obtained in this way: *The exquisite corpse shall drink the new wine*. (Brotchie, Gooding, and Lamantia 1995) page 25.

The Exquisite Corpse (version 2: image)

For three or more players.

…based on the same principle of the written 'exquisite corpse'. Its parlor game equivalent is *Heads, Bodies, and Legs* in English and *Petits Papiers* in France.

Each player receives a sheet of paper and folds it into equal sections, as many as there are players, and usually with the lines horizontal to the proposed picture. The sheets are smoothed out and each player draws what ever he will in the top section allowing the lines to cross the crease by a few millimeters. The sheet is then refolded back onto this crease to conceal the drawing and passed to the next player who begins the next section from these lines. And so on, until the last section, when it is unfolded and the result revealed. (Brotchie, Gooding, and Lamantia 1995) page 73.

The second example of a surrealist game, called *One Into Another,* is a language game that uses an operation similar to the game of *Charades*:

One Into Another

For a minimum of three players, although a larger number is preferable.

One player withdraws from the room, and chooses for himself an object (or a person, and idea, etc.). While he is absent the rest of the players choose and object [as well]. When the first player returns he is told what object [the other players have chosen]. He must now describe his own object in terms of the properties of the object chosen by the others, making the comparison more and more obvious as he proceeds, until they are able to guess its identity.

[When commencing the description] the first player should begin with a sentence such as ' I am an (object) …' (Brotchie, Gooding, and Lamantia 1995) page 31.

Brotchie provides the following example to illustrate a typical result of playing *One Into Another*; the answer is *coffee-mill* and the given word was *sunbeam*:

I am a hardened SUNBEAM that revolves around the sun so as to release a dark fragrant rainfall each morning, a little after midday, and even once night has fallen. (Brotchie, Gooding, and Lamantia 1995) page 31.

Another example of alternative game narrativity is the *infinite game*, a term borrowed from James P. Carse's novel *Finite and Infinite Games*. According to Carse games can be categorized as two types, finite and infinite, 'finite games are played for the purpose of winning and infinite games are played for the purpose of continuing to play' (Carse 1987). In his book, Carse goes on to say that, while finite games must end once someone has lost, infinite games are continuous because as players leave new players join the game. Also the infinite game has infinite boundaries, there are rules and limitations, but the rules and limitations may change at any moment. The infinite game is about openness and possibility. Therefore the ultimate infinite game is life.

Since the introduction of Multi User Dungeons[14] (MUD's) in the late 1970's, there has been a whole genre of games that could be considered closer to the aesthetics of the infinite game than the finite game. These games feature continuous play, multi-users, and, to one degree or another, less boundaries than the traditional game. One of the most recent examples of a game using finite game narrative is a game called, *Second Life* (http://secondlife.com/). *Second Life* is a web-based multi-user virtual reality environment.

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[14] Multi User Dungeons (MUD's) are multiplayer text-based games, the most famous being *Zork*. Often based on *Dungeons and Dragons*, MUD's used narration to tell a story with a path that was determined by user decisions. Because of the narration, MUD's are similar to hypertext novels, with the exception that they have causality. When a decision is made (i.e. turning on a lamp) it is recorded and remains that way until changed back, if possible. The fact that MUD's were multi-user spaces meant that one user's decisions could affect another user's experience. Also when one user left the game another could continue to play, others could join, and the game could continue indefinitely. Although fairly limited in possibilities, and ultimately ending, the continuity of the game across users made the game closer to an infinite game than a finite game. For more on MUD's see: (Murray 1997)

The content of *Second Life* is user designed using a toolkit that is integrated into the *Second Life* software environment. With the exception of certain physical characteristics, *Second Life* is designed to be a reflection of the real world. Users create avatars (which are, for the most part, human-like) that they use to represent their presence as the users navigate the world of *Second Life.* There are no points given but in order to buy land, upgrade an avatar, or participate in certain activities users must use a virtual currency called Linden dollars. Linden dollars can be bought with real money (there is an exchange rate) or earned by performing services, selling real estate, or selling personal effects in the form of upgrades to a user's avatar (such as hair, clothes, etc.) [15].

Therefore the narrative of *Second Life* is shaped by commerce. Real estate and currency values are controlled by supply and demand. As new servers are added, new land becomes available, land values drop, and the Linden dollar devalues. Likewise, if a server were to go offline then land values would increase and the Linden dollar would get stronger. Although it is possible to create spaces within the *Second Life* environment that are non-commercial and open, all users are still beholden to the Linden dollar in some form or another. While it is true that *Second Life* presents a mirror to our society, it presents a distorted view that focuses on

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[15] There have been a quite a few cases where the virtual reality of *Second Life* has crossed over into the reality of the physical world. One such case was a woman named, Anshe Chung, from Frankfurt, Germany who created a trendy apartment complex in *Second Life* and then sold the units of

consumerism and a laissez faire lifestyle. A more interesting proposition for future virtual infinite games would be to create worlds that present the option of an alternate life. For example a life with alien physics, alien customs, and alien conditions that move beyond the mundane realities of our everyday world, and thereby present the user with situations that would otherwise only be theoretically possible.

C. Structures

In the same spirit that Freytag's triangle provides a general description of the flow of linear narratives, the structures presented here (loops, maps, mazes and labyrinths, branches, webs) are intended to provide a general description of the flow of nonlinear narratives. Nonlinear narrative structures are characterized by their openness to possibilities by providing avenues for choice and/or mutability to the unfolding of a sequence of events. Rather than being generators of content, the narratives structures presented here are scaffolds for building content and therefore should be considered independent of the operations described above. Presented abstractly, these narrative structures should be considered generalized forms that can be expanded, combined, and reduced as needed.

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the complex, yielding millions of Linden dollars. She then sold the Linden dollars for real currency, making her the first reality crossover real estate mogul. (Hof)

It should be taken for granted that nonlinear stories can be told within a linear scaffold based on the narrative arc of Freytag's triangle[16]. Nonlinear narratives that have a traditional arc form are grounded in the generation of content via one or more of the operations described above. Likewise the structures presented here should not be considered a dismissal of the narrative arc of Freytag's triangle, rather they are additions to the traditional palate of narrative developed out of a consequence of the influence of a contemporary understanding of knowledge and nature as a nonlinear construct.

[16] There are many examples found in all media of nonlinear stories told in a linear fashion. In these stories the sequential unfolding of events is presented in a different order than when they happened in the story reality, however the resulting narrative arc still fits the Freytag form. Nonlinear narratives structured on traditional narrative arcs are especially common in cinema, for example the film *Memento* (2000) by director Christopher Nolan featured a storyline about a man with short-term memory loss. The events of *Memento* were told in reverse order of when they happened in the fictional history of the film, even though the plot still followed the structure of Freytag's five-point structure. Other examples in cinema of linear scaffolds with nonlinear narratives can be found in Quentin Tarantino's *Pulp Fiction* (1994), George Roy Hill's *Slaughterhouse-Five* (1972, based on a novel of the same name by Kurt Vonnegut), and nearly the entire film catalog of director David Lynch.

1. Loops

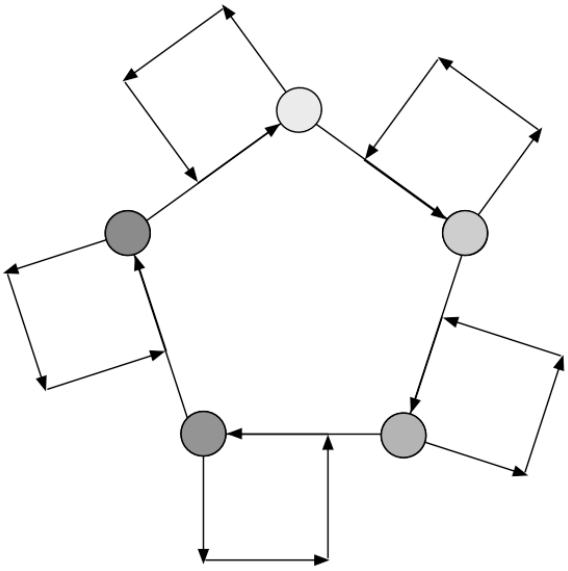

Figure 12. A looping plot structure.

Looping plot structures are cyclic, and therefore, ideally, have no beginning or end. The plot diagram shown in Figure 12 shows a cyclical plot structure that contains loops at every major development in the story. The looping plot structure is common in game narratives. In the game narrative each plot point is equivalent to a level. If the player succeeds in the level they move on to the next point in the cycle, otherwise they are moved back to the beginning of the level.

What happens when the plot points of the grand cycle are exhausted depends on the design of the game. In some cases when the larger narrative cycle has completed the game 'flips' and the cycle continues, usually with a greater difficulty level. In such cases the points could be designed to unfold in a similar manner as the Freytag structure described in the section on foundations described above, however the story

must be robust to repetition. In other games when the larger narrative cycle has completed the game ends. In these less ideal cyclical models the narrative tends to follow a more traditional linear structure, and the loops at the plot points simply disrupt the continuity of the narrative flow. However, that being said, looping narrative structures are noteworthy because of their break with traditional narrative flow and their ubiquitousness in 20th and 21st narrativity.

2. Maps

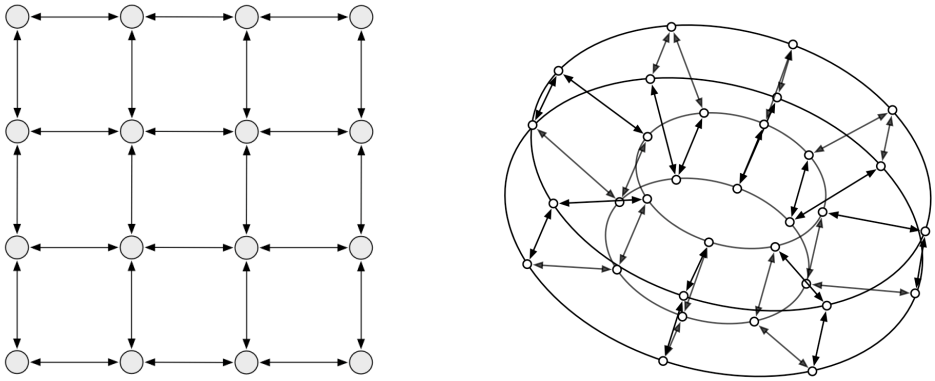

Figure 13. A map-like plot structure.

By expanding loop narratives into larger structures it is possible to form maps. As shown in Figure 13 map narratives are narrative structures that have plot points laid out in a grid pattern. Narrative navigation happens by traversing the map. When traversing the map only stepwise movement is possible, but it is possible to move in any direction. In order to get to a point that is more than one point away it is necessary to go through any connecting points in between.

The grid shape on the left side of Figure 13 provides a very literal interpretation of the map narrative layout. It is a 2-Dimensional structure with an edge boundary that, when reached, will not allow the navigator to continue any further.

The toroidal map structure on the right presents a more common implementation of the map narrative structure. The toroidal map structure is arrived at when removing the boundaries of the map structure described above and allowing for the navigation to loop between the edges. Like the loops described in the previous section, toroidal map narratives are common to games as well, but often tend to result in deeper nonlinear structures than the simple loop. The game *Second Life,* described above, provides an example of a game environment that is laid out as a toroidal map narrative. However, in a break from the strict definition of a map where the avatar is fixed to the grid of the map, users in *Second Life* can fly over parts of the map, or teleport directly to areas that they wish to visit.

The challenge of developing content for map narratives is maintaining dramatic interest throughout the navigation of the narrative space. This difficulty arises from the loss of a narrative arc due to the opening of possibilities in the narrative structure. One approach to resolving this issue is to ensure that each plot point is internally structured as a linear narrative arc with an outcome that logically flows to any of the adjacent points. Another approach is to define two points that either create dramatic conflict or provide dramatic resolution, then intersperses them on the map.

Finally, it is possible to combine the two methods and create interspersed points of conflicts and resolutions, each with their own internal dramatic arc.

3. Mazes and Labyrinths

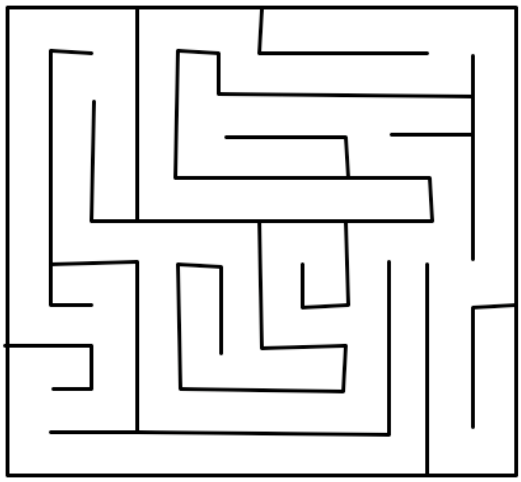

Figure 14. A maze-like plot structure.

Although similar in structure, mazes and labyrinths have different goals. The intention of a maze is to solve the maze by traversing the maze from an entry point to an exit point, whereas in a labyrinth the goal is a quest to retrieve a treasure at some point in the center and return to the point of entry.

Conceptually the narrative structure of mazes and labyrinths are characteristically similar to the map narratives described above. Like maps mazes and labyrinths can be explored openly, but unlike maps, mazes and labyrinths have boundaries that restrict a users movement. If a user runs into a dead end they must turn around and return from where they came, presumably through the same narrative points that were explored to reach the dead end. Because of this narrative

repetition having a recorded causality is extremely important for maintaining narrative continuity for the user.

Another similarity between mazes and maps is the challenge of maintaining dramatic interest throughout the navigation of the narrative space. Like maps, mazes and labyrinths can be infused with dramatic qualities by either creating mini narrative arcs at every plot point, interspersing the plot points with conflict resolution characteristics, or with a combination of the two methods.

Because of the restricted navigation of the structure mazes and labyrinths often have the affect of a creating a sense of exploration or mystery for the users. This mysterious quality is exemplified in quest games and MUD's like *Zork,* described above. While exploring a narrative space of a game like *Zork* the user never knows what is around the next corner, or what is behind the next door, etc.

4. Branches

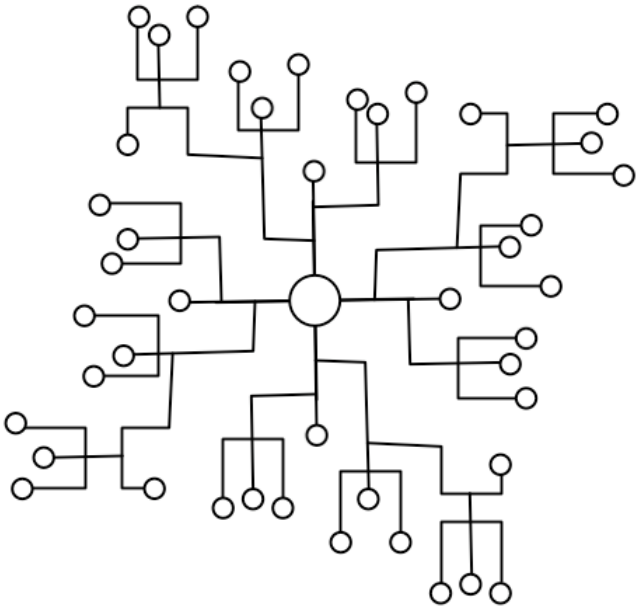

Figure 15. A branching plot structure.

Branching narratives usually have a single starting point, as represented by the large circle in the middle of Figure 15. As the narrative progresses it branches based on decisions made by either a viewer or an algorithm. Branches can bifurcate and converge at any point; therefore it is possible to build loops into branching narratives and for branching narratives to fold back on themselves. The branching narrative structure can potentially have one or many possible endings.

The main difference between the branching structure and the maze and map structures described above is that, although the branching narrative can fold back and loop, the branches cannot be explored in any direction. Branches have a set trajectory that flows from the beginning to an end, as represented by the movement

from the center to the edges in Figure 15. In summation, mazes and maps can be explored openly, but branches are dead ends.

Branching is a common structure found in hypertext novels like *afternoon, a story* (1990) by Michael Joyce, described above. As long as the reader of a hypertext takes a new path every time they explore the work, they will experience a new story. If they take the same path, the story will not change. In this sense the branching structure is invariant. Because of this predictability embedding a traditional sense of a dramatic arch in the branching structure becomes much easier, because the branches of the structure can be organized hierarchically according to the flow of a narrative arc. In this case, no matter which path the reader follows, the narrative will continue along the logic of a narrative arc.

5. Webs

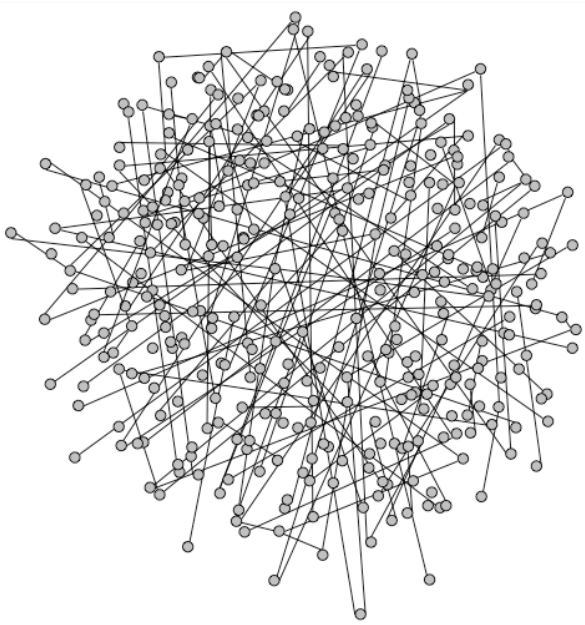

Figure 16. A web-like plot structure.

Ideal web narratives are non-hierarchical free associations of information tied together through common elements. In reality, the narrative structures often referred to as web-like are often closer to branches, mazes, or maps than a web. The internet, for example, is a hierarchical structure organized by commercial control, social movements, and, on a fundamental level, the very structure of its physical backbone.

The ideal web structure contains aspects of all the narrative structures described above. A web is a looping structure in that navigation through the narrative space can result in oscillations. A web is a map because in order to get to one point of information it is necessary to go through another. A web is a maze or labyrinth because it is bound by limitations of the interconnectedness of its content, causing

twists and turns in the narrative path, and leading to dead ends. And finally, a web is a branching narrative because it bifurcates, folds over, and converges. Therefore a web narrative is a structure built on layers of structures, which are superimposed in such a way that nearly any narrative path could be taken.

Because of the fluidity, the web structure can be indeterminate or organized. A web structure can be indeterminate in that its connections are mutable and can change on the fly. The open constructs and user editable content of the web means that, much in the spirit of the Happening as described by Allen Kaprow's *Untitled Guidelines for Happenings* (1965), the lines between information become 'fluid and indistinct'; information is 'derived from any place or period'; information is placed 'over several widely spaced, and sometimes moving and changing locales'; time is 'variable and discontinuous'; and the line between creators and 'the audience is eliminated entirely' (Kaprow 1965).

As an organized structure the web narrative is related to the stochastic structures described in Iannis Xenakis *Formalized Music.* However, rather than being used to form clouds of notes that result in masses of sound, the stochastic processes in a web narrative could be clouds of any kind of information to form clouds of knowledge that result in the amassing of ideas.

D. Characteristics

The characteristics of immersion, agency, and interactivity are unique to nonlinear narrative structures and are rooted in a fundamental shift in the role of the audience (i.e. the observer) in relation to the work (i.e. the subject), from that of a passive observer to that of an interactive participant. The rise in user participation in artworks is a reflection of our changing understanding of our relationship to our universe. This changing understanding is ubiquitous, equally evident in the dissemination of media and information, as it is evident in new approaches to research in the humanities and the sciences[17].

The changing role of the audience has created a demand for interactive immersive artworks where the audience participates in the direction of the narrative unfolding of the work. As a result, the role of the author in a work becomes degraded, because the final form of the work is left open to interpretation until experienced by the user. Therefore the unique experience of the user draws into question the validity of authoritative interpretation. In an open interactive work there

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[17] Issues surrounding the changing role of the observer-subject in the various fields of research are described using different terms. For example, there is the *Hawthorne Effect* in psychology, the *Anthropic Principle* in theoretical physics, and the *Westinghouse effect* in sociology.

The changing role of the observer-subject in particle physics is a well-known paradox called the *observer effect.* The observer effect states that it is impossible to observe a particle without changing it, because in order to observe a particle it is necessary to interact with it, and thereby change the particle's state.

A parallel phenomenon to the observer effect is described in social science research called, the *observer's paradox*. The *observer's paradox* recognizes that when a researcher is conducting an interview the subject will not behave as if they are in a natural setting. Because of the abnormal conditions, such as the formality of the interview setting and the status of the observer as a scholar, the subject will often unconsciously take on a more formal manner of interaction than normal.

For more about the Observer Effect and its relationship to various disciplines see: Wikipedia, "Observer Effect" http://en.wikipedia.org/wiki/Observer_effect

is no authentic experience, only testimonial. This lack of authority also means that there is a loss of hierarchy because the individual experience of a work is just as valid as any other experience of a work; all interpretations become equal, including the artist's interpretation.

1. Immersion

The term immersion is a widely used metaphor to describe the experience of being saturated in a subject or situation. For example, one can be immersed in a book, a language, a culture, or an artwork. One of the most compelling immersive experiences can be found in sound and music[18]. The experience of immersion in music is connected to the saturation of the aural senses. By saturating the aural senses it is possible to perceptually mask the acoustic space of the listener and replace it with an acoustic that is constructed. The construction of space through sound and music suggests a landscape. Through aural saturation it is possible communicate nearly any landscape to the listener, from the literal, to the conceptual, to the most alien. Therefore the construction of a landscape through sound and music places the listener in the center of an artificial reality.

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[18] Testimonial accounts have been recorded of the immersive quality of music throughout history. In the 4th century A.D. St. Augustine describes an immersive musical experience that causes him to question if he is placing the love of music before the love of God: "But yet for all this, that those airs may together with these words … gain full admission with me, do they aspire to be entertained into a place of no mean honor in this heart of mine, nor can I scarce afford a room befitting for them. For sometimes forsooth, do I seem to myself to attribute more respect unto them than is seemly…" (St. Augustine 1998)

a. Contexts

Saturation occurs in contexts whereby artificial realities can be constructed. For music these constructions occur when acoustics can be carefully controlled, such as concert halls, through loudspeaker systems, etc. Likewise it is important to create contexts for other mediums that isolate conditions to achieve ideal immersive experiences through saturation. Part of the process of isolating these conditions is controlling unwanted sensations by either eliminating their possibility (such as in the use of acoustic treatment) or by negating them (such as in the case of sound masking). The isolation and control of sensual conditions is the baseline purpose of the theater.

Although the term theater is used to describe venues for either cinema or the performing arts, any space that is used to control sensual experiences can be considered a theatrical space. From this point of view the gallery, library, museum, cathedral, courthouse, rollercoaster, and the concert hall are all theatrical spaces in their own right, for in all of these cases the observer's experiences are shaped by a saturation of information that results in a constructed reality.

In order for a constructed reality to be truly immersive it must be believable as well as controlled. Believability is a subjective experience that takes place solely in the observer's mind. Thus the success of an immersive artwork can be judged by how convincingly the work is able to assist in creating an immersive environment in the imagination of the observer. In other words, an immersive artwork can be judged

by how well it helps the observer *create belief*, a concept described in the following passage from Janet Murray's, *Hamlet on the Holodeck*:

> The pleasurable surrender of the mind to an imaginative world is often described, in Coleridge's phrase, as "the willing suspension of disbelief." But this is too passive a formulation even for traditional media. When we enter a fictional world, we do not merely "suspend" a critical faculty; we also exercise a critical faculty. We do not suspend disbelief so much as we actively *create belief*. Because of our desire to experience immersion, we focus our attention on the enveloping world and use our intelligence to reinforce rather than to question the reality of experience. (Murray 1997)

In the end immersive environments cannot create artificial reality, they can only provide the tools and context whereby the immersive experience of the world can be created in the mind of the observer.

2. Agency

In a believable constructed reality an observer often assumes certain roles based on past experiences and familiar cues that are taken from their understanding of the contexts being presented. Take for instance the cathedral, courtroom, or the library, which are intended to be quiet spaces. Although intended to be quiet, these spaces are often designed to be loud spaces that are built with large open ceilings and hard floors that carry sound readily. Making the space loud is seemingly counterproductive to the intent of the space, however the loud space has an opposite affect on the observer by forcing the observer to make careful movements and avoid speaking in order to maintain the quiet state of the space. In other words, the loudness of the space subjugates the observer to a role of a conscientious listener who must consciously contribute to the silence of the constructed reality.

Whether consciously or unconsciously, the observer chooses to assume the implied role through their behavior. The assumption of a role by the observer has a recursive affect on the constructed reality as well. Through role-play the actions of the observer increase believability by attributing meaning to the constructed reality, which in turn is potentially communicated to other observers. Having a choice also means that the possibility exists for the observer to not accept the role being communicated to them. However, in doing so the observer has the potential of disrupting the recursive affect of the constructed reality, with the potential of destroying the structure of the constructed reality altogether.

In contexts that encourage a more active range of participation the observer is given greater latitude over choice and action within the constructed reality. The greater the interaction the more the observer can contribute to meaning in the context. Through active choice the observer's decisions have a greater influence over the narrative unfolding of the context.

Active choice on the part of the observer is demonstrated in the case of the Happening as described in the Operations section above. In the case of the Happening the majority of the decisions that determine the outcome of the work are made by the participants (i.e. the observers) and the artist only provides the most general context for the activity of the work to unfold. In the Happening the content of the work is comprised of the collective subjective experiences of the participants.

Thus the recursive relationship between the observer and the work becomes extremely important, because without this recursive relationship there would be no work at all.

Unlike the restricted range of interpretation and choices appropriate to the quiet spaces described above, the Happening provides an extreme example of a context open to observer interpretation and choice. The comparison of these examples implies that there is a correlation between interpretation and choice: the more active choice there is in a work, the greater the latitude for interpretation, and therefore the greater the subjectivity.

The conditions described here of observer role-play empowered by choice provide classic examples of the concept of *agency.* Agency, as defined by Janet Murray, "is the satisfying power to take meaningful action and see the results of our decisions and choices" (Murray 1997). Although not a requirement of immersive contexts, agency facilitates a closer connection between the observer and the context. Therefore, by engaging the observer in the context through agency there is a greater facility for the observer to create belief.

3. Interactivity

The issue of agency underscores the need for interactivity in the construction of immersive contexts: the more active the observer, the greater the sense of agency, and the greater the sense of agency, the greater facility for the observer to create

belief. The experience of the active observer is what Brenda Laurel refers to as a '*first-person* experience' in her book, *Computers as Theater*:

> *Agency* is a key component of first-person experience. Although we may describe in which we are not an agent in the first-person pronouns (I saw this, I smelled that), the ability to *do* something sooner or later emerges as a criterion (Laurel 1993).

According to Laurel the first-person experience arises from the observer's ability to engage in the narrative unfolding of the context through interaction, which ties the sense of first-person agency to the level of interactive control. Therefore as the sense of empowerment increases through interaction, so does the sense of agency.

However, input control is only part of the equation of interaction. In order to provide a convincing sense of empowerment to the process of interaction a causal relationship must be established whereby user input is reciprocated with a systemic response that provides feedback to the user. The reciprocal relationship between the system (i.e. the subject) and the observer through interaction, as described in Mark Meadows' *Pause & Effect, The Art of Interactive Narrative*, is a process that unfolds over four steps:

> Interaction can be broken down into four steps which, if the interaction is done well, generates an increased interest in further interaction. The steps go like this:
>
> 1. Observation: The reader makes an assessment.
> 2. Exploration: The reader does something.
> 3. Modification: The reader changes the system.
> 4. Reciprocal Change: The system tries to change the reader.
>
> (1. Repeat: The reader makes another assessment.)
>
> … [Interactivity is] a bidirectional conduit. It's a response. Interaction is a relationship. It's mutually executed change. (Meadows 2003)

Meadows' analysis suggests that the reciprocal relationship between the subject and observer is a complex system through the process of reciprocal change. While it is important that the observer experience a direct response to their input, the systemic response must be deeper and more complex in order to affect reciprocal change in the observer[19].

A metaphor in support for the need of complexity in the reciprocal relationship between the subject and observer can be found in the action of throwing a pebble into a lake. When an observer throws a pebble into a lake there is a direct response to the action in the form of a splash, followed by an indirect response in the form of disturbances in the lake. Most obviously, the splash causes ripples to form on the surface of the lake. The ripples in turn interfere with the other wave patterns moving through the lake, a condition perceivable by the observer, which exhibits causality in the system of the lake.

Imperceptible to the observer, but constructed in the observer's imagination, are the systems under the surface of the lake that were disturbed by the pebble as well. As the pebble enters the lake, the impact of the pebble startles the animals of the lake, causing them to move away from the pebble's point of entry. The resulting movement of the animals, and disruptions to the underwater currents affect other relationships and processes unfolding in the lake. The action of the pebble thus

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[19] This reciprocal effect is what Marcos Novak would refer to as a *transactive* exchange between

causes a stratified system of reactions that ripple throughout the layered systems of the lake. Therefore, in some small way, the act of throwing the pebble in the lake has changed the composition of the lake as a whole. Whether perceived or not, it is the complex interaction of these systems, both real and in the observer's imagination, that helps the observer create belief in the pond and its relationship to the surrounding world.

While interaction needs to be direct in order to communicate clear causality of action to the observer, the feeling of agency is more convincing when the users actions stimulate a complex system. Therefore layers of activity could be added to create complex systems of interactivity, which exhibit characteristics closer to real world experiences.

E. Summary

While not exhaustive by any means, this section on context of nonlinear interactive narratives provided a brief overview of the qualities of nonlinear narrative and how they can be understood, according to their foundations, operations, structures, and characteristics from the perspective of art, music, and literature under the influence of technology. This description provides a basis upon which the definition of nonlinear narrative can be evaluated and understood.

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the subject and observer (Ludovico April, 2001).

Starting with the discussion of the foundations of nonlinear narrative, this section described the decline of linear narratives was the result of a crisis that coincided with the rise of new technologies emerging at the end of the 20th century. The discussion then moved on to describe how nonlinear narratives can be understood in terms of its operations (montage, indeterminacy, formalization), structures (loops, maps, mazes and labyrinths, branches, webs), and characteristics (immersion, agency, interactivity).

The foundations, operations, structures, and characteristics described in this chapter provide a basis upon which a discussion of the form of nonlinear interactive media can unfold. It is in the context of nonlinear narratives as described in this chapter that the *Universe* hypothesis will be proposed. Although it is beyond the scope of this document, the generalized categories for describing nonlinear narrative provides a baseline for the analysis of nonlinear narrative works by outlining the general characteristics of nonlinear narrative form.

III. The Universe: Concept and Implementation

The *Universe*[20] is a hypothesis that attempts to address the question, "*What is the form of nonlinear interactive media?"* by describing an abstract conceptual model that provides a formal approach to the high-level organization and implementation of nonlinear narratives in immersive interactive artworks. In this chapter, the *Universe* is described in two parts, first as a theoretical model based on the discussion of nonlinear narratives in Chapter II, and secondly in terms of a software model that was developed during the implementation of several works as described in Chapter IV. Thus this chapter provides a bridge between the theory and praxis of the *Universe* hypothesis.

A. Concept: The Universe

When considering the form of nonlinear narrative it is important to keep in mind the difficulty in defining a single formal construct for the description of nonlinear narrative, as in the case of Freytag's triangle for linear narratives. The reason for this difficulty is that nonlinear narrative is a class of narrative that includes a multitude of disparate forms and practices. The only common thread between these forms and practices is that they each represent a break from traditional narrative form. Therefore, what is required is a model that isn't tied to one particular operation or structure, but a generalized model for the organization of the potential operations and structures found in nonlinear works. This generalized model needs to be scalable

[20] For the purposes of this document the term *Universe* will always be italicized when referring to art-works in order to differentiate it from the actual Universe.

and dynamic, allowing for the implementation of many operations using various structures. Such a model would allow for a multitude of operations and structures to work in tandem so that structures and operations could be joined, interchanged, and separated as needed.

From the strict viewpoint of a model such as Freytag's triangle, the *Universe* is not a formal definition of a nonlinear narrative; rather, it is a context whereby nonlinear narratives can be readily defined. Driven by an aesthetic of creating nonlinear immersive artworks, the term *Universe* is derived from the concept of the *world*[21] as used in virtual reality (VR) terminology. Larger than a *world,* the *Universe* is an abstract construct capable of modeling multiple *worlds* individually or in combination. In that sense the *Universe* can be thought of as a *world* of *worlds*, a construct independent of any particular nonlinear structure or operation that defines a *world*, the *Universe* is a container for *worlds.*

1. Worlds

A stereotypical VR hardware set-up includes a stereoscopic head mounted display, headphones, positioning sensors, and haptic feedback. Alternatives to this stereotypical set-up include immersive rooms, which don't require head mounted displays, such as the Cave at the University of Illinois at Urbana-Champaign and the

[21] For the purposes of this discussion the term *world* will always be used in italics when referring to immersive *world* spaces, like those found in immersive art installations and virtual reality environments. When the term world is not italicized it is in reference to the world at large (i.e. the world of physical reality).

AlloSphere at the University of California, Santa Barbara (Wakefield et al. 2008). Regardless of the variants in the set-up, VR systems are designed with the intent of total immersion for the purpose of creating believable artificial realities.

The concept of the *world* is a significant concept in VR theory that goes beyond a particular technology, or set of technologies. For example, the conceptual goal of creating immersive *world* spaces is common in the arts and can be readily applied to many forms of works. A *world* not only encompasses the space of the constructed immersive reality of a work, it encompasses the imagined constructed immersive reality that exists in the observer's imagination as well. In this sense the *world* is more than the work itself; it is a set of operations, structures and semiotics that form the processes, which are beyond the format of the presentation of the work.

As established thus far, the construction of an immersive reality, assisted by a sense of agency through complex layered interactions, takes place in two modalities: first through the saturation of perception, and second through the saturation of the imagination. Based on this assessment, it can be said that a successful construction of an immersive reality results in a believable *world*, a *world* with it's own logic and systems that resolve in a convincing way.

The content of a work is a viewpoint that provides a portal into a greater *world*, leaving it up to the observer to construct the imperceptible aspects of the *world* in their imagination. The content of a work as a viewpoint of a *world* is the definition

of what is described in this document as a *view*. While the *world* represents the structure of a constructed immersive reality, a *view* is an expression of some part of the constructed reality, which manifests as a perceivable aspect of the work. Thus the content of a work can consist of many *views* (as in the case of transmedia works), with each *view* manifesting in a unique aspect of the same *world* system.

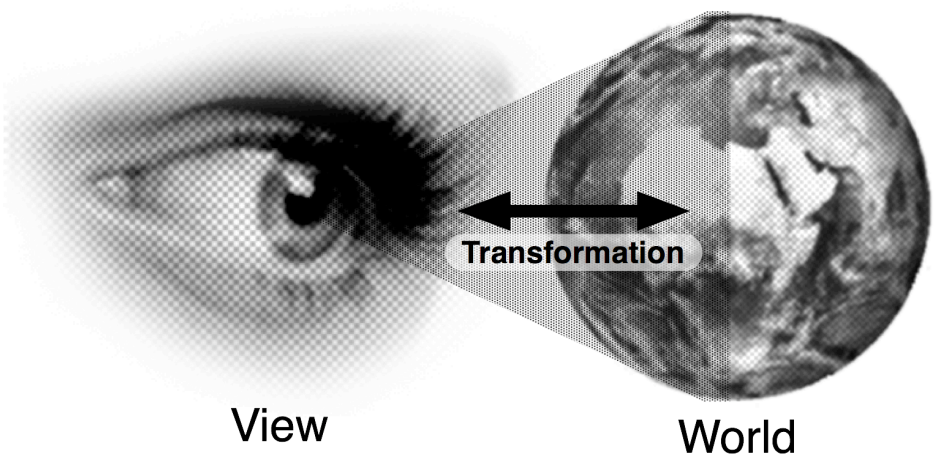

Figure 17. Conceptual diagram of the *world, view,* and *transformation* components.

The distinction between *world* and *view* becomes apparent upon comparison with the real world. As human beings, our understanding of our world is limited by what can be perceived by our senses. But the information gathered by our senses represents only a fraction of the information that exists in our world. This is in part because our senses (in tandem with our mind) filter out more information than is taken in, and our senses (before cognition) take in far less information than the world has to offer. Therefore the totality of our world is not what is perceivable by our mind and senses, but a complex layering of systems. Our perception (mind and

senses) is a filter of the world that *transforms* the information of the world system into a form that expresses something meaningful to us about our world.

The process of the *transformation* of *world* information by our senses and perception is similar to the transformation of world information that is performed by scientific instruments. Through the processes of data mapping, interpretation, and filter/transform scientific instruments visualize and sonify the world that exists outside of our normal range of perception so that it can be perceived. While our perception (and the extension of our perception through scientific instrumentation) provides a view into the systems of the world, perception is not the actual systems themselves, but an interpretation of these systems.

Our understanding of the world around us is derived from the results of our interactions with the world. Interactions, as described above, are a reciprocal relationship between the observer (action and perception) and subject (the world system). As we interact with the world we can perceive certain changes in the world via a series of scaling, filtering, and mapping *transformations* that give us a better understanding of our connection to the world.

The three components of *world*, *view*, and *transformation* are the components needed to describe the components of the *Universe* (see Figure 17). In other words, the *Universe* is a meta-structure designed to be a description of *worlds*, *views*, and *transformations* that comprise the actuality of a work.

2. The *Universe* as Rhizome

As described in *A Thousand Plateaus: Capitalism and Schizophrenia* by Gilles Deleuze and Felix Guattari (Deleuze and Guattari 1988) the rhizome provides a compelling construct for the description of the conceptual model *Universe*. Using the rhizome of *A Thousand Plateaus* as a metaphor will facilitate the description of the interconnection between the *worlds*, *views*, and *transformations* that are the building blocks of the *Universe*.

In botany, a rhizome is a horizontal stem of a plant that is usually found underground, often sending out roots and shoots from its nodes[22]. An example of a rhizome is grass. In *A Thousand Plateaus* the rhizome is the central metaphor for an ontological description of the patterns and structures that compose our world. According to Deleuze and Guattari the rhizome represents a non-hierarchical structure, with the nodes of the rhizome representing nodes of knowledge and information. The roots and shoots of the rhizome form interconnections between these nodes, which represent nodes of knowledge. The *connectivity* of the knowledge nodes of the rhizome form paths that are nonlinear, they join and twist and break apart making *assemblages* with any other point via branching and recursive lines. This is represented by the root mass of the rhizome

[22] http://en.wikipedia.org/wiki/Rhizome

The mass of the rhizome is a decentralized mass of information, which Deleuze and Guattari describe as a *body without organs.* Another metaphor that Deleuze and Guattari use to describe the structure of the rhizome is the amorphous *plane of consistency* upon which the rhizome takes shape. The body without organs and the plane of consistency present two perspectives on the same concept intended to illustrate the non-hierarchical and indeterminate structure of the rhizome:

> Does the plane of consistency constitute the body without organs, or does the body without organs compose the plane? Are the Body without Organs and the Plane the same thing? In any event, composer and composed have the same power: the line does not have a dimension superior to that of a point, nor the surface to that of the line, nor the volume to that of the surface, but always an exact, fractional number of dimensions that constantly increase or decrease with the number of its parts. The plane sections multiplicities of variable dimensions. (Deleuze and Guattari 1988)

The groupings of the nodes in the rhizome do not form classes or ordered relations, but instead form emergent *multiplicities* that are connected in a blurry mass of schizophrenic aggregates and *assemblages* that are *deterritorialized* in their growth, dying, and movements. According to Deleuze and Guattari deterritorialization is 'the movement by which "one" leaves a territory. It is the operation of the line of flight' (Deleuze and Guattari 1988), which occurs much in the way the blossoms of a budding rhizome 'are always taking the leave of the trees, inventing connections that jump from tree to tree and uproot them.' Therefore, as a deterritorialized assemblage, the rhizome is always moving, spreading, and consistently changing its shape and connections.

The assemblages of the rhizome are composed of *abstract machines*. Abstract machines are the phylum or the diagram of the operations that unfold within the concrete manifestations of the assemblages of the rhizome. In other words abstract machines define the unfolding of the processes that form concrete assemblages, but are not the assemblages themselves.

The space that the rhizome inhabits is a *stratified* space characterized by 'accumulations', 'coagulations', 'sedimentations', and 'foldings' (Deleuze and Guattari 1988), which represent the accumulation of processes within and between the assemblages of the rhizome, on both the molecular and the molar scale. It is the strata of *A Thousand Plateaus* that Manuel De Landa centers his illuminating discussion on Deleuzeian philosophy in his book, *A Thousand Years of Nonlinear History* (De Landa 1997). In *A Thousand Years of Nonlinear History*, De Landa presents Deleuzeian philosophy as a flat ontology whereby the entities that make-up our reality essentially function upon the same types of nonhierarchical, nonlinear, and indeterminate processes, which manifest in various forms and at various scales of time and size. De Landa uses geological processes, evolutionary processes, and the history of linguistics to illustrate how the systems of the world are a series of bifurcated, divergent, and convergent processes, which consistently accumulate, forming stratified layers from their results.

The stratified processes that De Landa describes in *A Thousand Years of Nonlinear History* provide a model for the *world* processes described in the section

on immersive *worlds* above. While De Landa describes the processes unfolding at the varying scales of the geological, the biological, and the cultural as being part of the same abstract machine, he also describes how, from our perspective, these processes can seem to function in a manner different than they actually do. In particular in the belief in progressivism, the permanency of mankind, the rigid teleological view of knowledge are all shown to be really a momentary expression of a larger morphological process that exists outside of the scale of our perception. To draw on the terminology used in the *worlds* section above, concepts such as progressivism, the permanency of mankind, and the rigid teleological view of knowledge are *views* that give a distorted view of the deterritorialized assemblages of rhizomatic processes that make-up the layered systems of our world.

In order to illustrate how the structure of the rhizome relates to the structure of the *Universe* the image in Figure 18 provides a graph that maps the characteristics of nonlinear narrative (*world*s, *views* and *transformations*) to the metaphor of the rhizome. As a structure for the *Universe* the rhizome provides an ecosystem in which the processes of nonlinear narrative can thrive. The rhizome is a scaffold for building a work, but it is not the work itself. A structure for the structures and an operation of operations the rhizome of the *Universe* is a formal model that provides a generalized methodology for the description of nonlinear interactive media works.

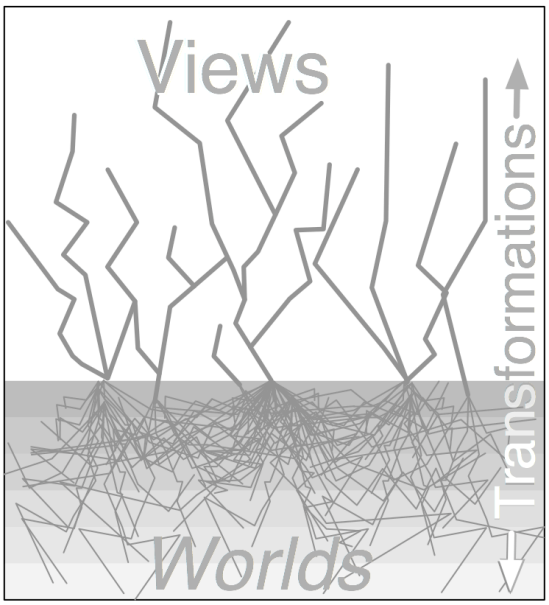

Figure 18. The *Universe* as rhizome.

At the base of the rhizome is the root mass of the rhizome, which represents the *worlds* of the *Universe.* In this diagram *worlds* are systems that are made of the nonlinear structures and operations described in Chapter II. Abstractly defined, the *worlds* of the *Universe* are organized into stratified, convergent, divergent, and bifurcating patterns, which can be swapped out, navigated, and combined to form complex *world* systems. In the root mass of the rhizome the possibility exists for the representation of one *world* (i.e. one structure and operation) or many *worlds* (i.e. many structures and operations), meaning that the root mass of the *Universe* is a scalable construct that is able to represent many types of systems from the simple to the complex.

The relationship between the shoots and the root mass of the rhizome in Figure 18 is representative of the relationship between the integrated mesh of imperceptible *world* systems of the *Universe*, and the perceivable *views* whereby an observer experiences the *Universe*. As *views*, the shoots of the rhizome are expressions of aspects of the structures and operations that make-up the *world.* As described above, *views* are interpretations of the nonlinear narrative unfolding of the processes of the *world* scaled to the parameters of perception. On the scale of perception *views* are the expressive modes of input and output of the *world* system; they are the perceptual connection that the user makes with the *world* systems of a work. In terms of media artworks, these modes of input and output are typically in the form of devices (such as joysticks, video monitors, and loudspeakers) that visualize and sonify some aspect of the structures and operations that make-up the *world* systems of a work.

The structure of the terranean shoots and stems of the rhizome *views* follows the same stratified, convergent, divergent, and bifurcating patterns that can be found in the operations and structures of the root mass of the subterranean rhizome. As the *views* express and interact with the subterranean systems of the rhizome, the *views* interact with each other as well. In this sense the *views* form another layer in the stratified system of the rhizome *Universe.*

Although *views* include input modes as part of their description, *views* are intended to describe *transformations*. This is because *transformations* do not

describe a manifestation of a system or view; they describe the transformative space between the system and view. Thus *transformations* filter and scale data for perception, and translate input actions into triggers that stimulate the processes of the subterranean structures and operations. To summarize, *transformations* are the bidirectional exchange and translation of information between the terranean *views* and the subterranean *worlds* of the *Universe*.

3. Conclusion

As a rhizome the *Universe* provides an abstract scalable model of the potential multiplicities of *worlds*, *views*, and *transformations* needed in the development of nonlinear immersive artworks. The conceptual model of the *Universe* also makes a compelling connection between the aesthetics of creating nonlinear immersive artworks and Deleuzeian philosophy, providing a point of departure for a cosmological understanding of the *Universe.* And finally, an understanding of the cosmology of the *Universe* provides a bridge between the theory and praxis of the *Universe* hypothesis by describing and providing a theoretical impetus for the components that need to be addressed when describing the software model of the *Universe*.

B. Implementation: The Universe Model

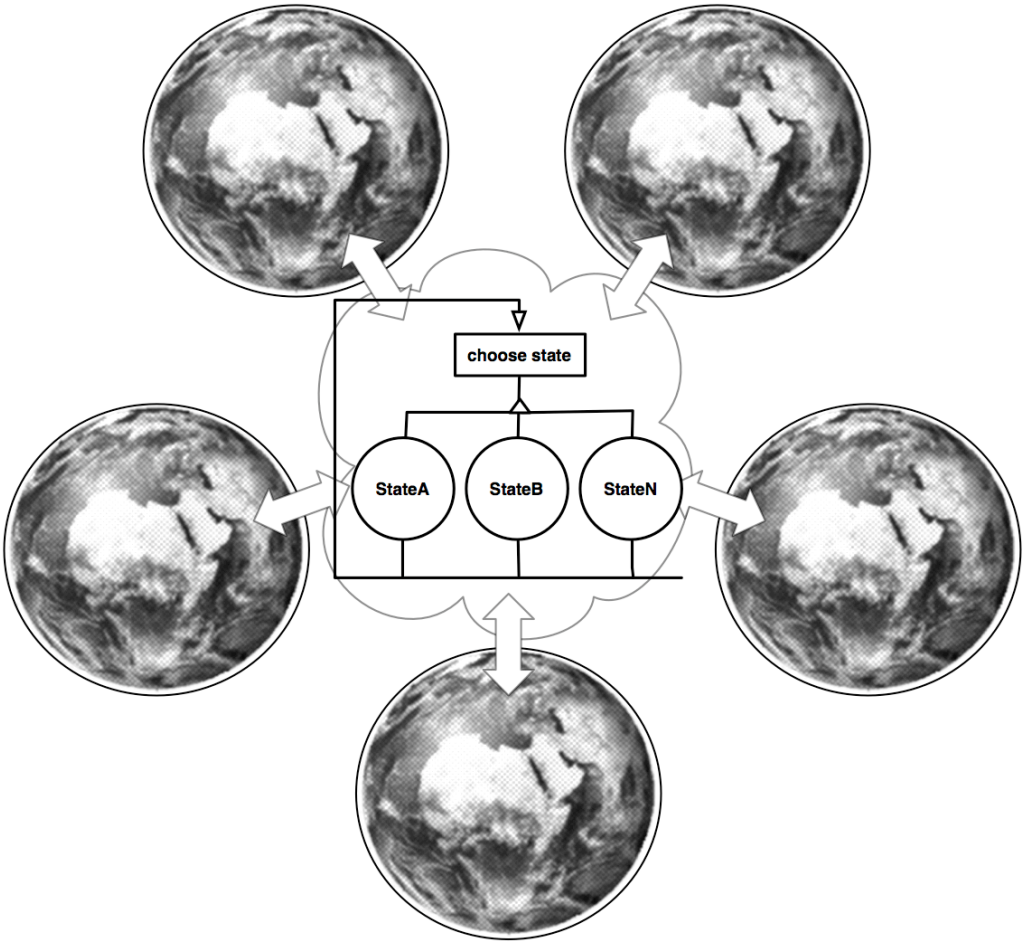

Figure 19. A Meta-View of the *Universe Model*

As a practical definition of nonlinear narratives in terms of the conceptual model of the *Universe* described above, the *Universe Model* abstractly defines the elements needed for the functionality of nonlinear immersive artworks from the standpoint of software design[23]. Having a predefined method for the implementation of common

[23] Because the context of this document is in the field of media arts, it is assumed that the implementation of the *Universe* will be ultimately realized in software. However, it is possible to use

use application tools in software can potentially facilitate the creation of more expressive and robust nonlinear immersive artworks. To this end, the *Universe Model* attempts to provide the artist with a software model whereby they can focus on what is really important in the creation of an immersive artwork, narrativity and meaning. Therefore, the *Universe Model* is intended to be a scalable solution that can be reused, distributed, extended, and augmented, and thus readily translatable to many projects.

The illustration in Figure 19 provides a meta-view of the *Universe Model.* The globes surrounding the cloud in the center represent a collection of unique immersive *world* spaces, each with its own set of possibilities and potentials. The number of *worlds* represented is arbitrary and, in actual implementation, could be any number of worlds. At the center of the cloud is the Logic Engine of the *Universe Model*. The Logic Engine is responsible for keeping track of each *world*, determining the relationship between *worlds*, and controlling the movement between *worlds*.

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the systems defined in the *Universe Model* as a guideline for various systems that do not use computers, such embedded systems, mechanical systems, etc. In such a case, some aspects of the *Universe Model* can be taken more literally than others, depending on the usage outside of the world of software design. For example, when using this model for systems that are decentralized, such as a group of autonomous agents, then the patterns are distributed across the systems, with the agents assuming all or part of the various components of the *Universe Model.*

1. Logic Engine of the *Universe Model*

The Logic Engine of the *Universe Model* as described in Figure 19 is similar to that of the State design pattern, as described in *Design Patterns: Elements of Reusable Object-Oriented Software* (Gamma et al. 1995). The intent of the State design pattern is to "allow an object to alter its behavior when its internal state changes, [as a result] the object will appear to change its class" (Gamma et al. 1995). By substituting the term *Universe* for *object*, and the term *world* for *state* in this definition, it follows (based on the description of Figure 19) that the *Universe* is *altering its behavior* when the *world* changes. Or, more precisely, the *Universe* is *altering its behavior* when the viewed *world,* or collection of *worlds* changes.

The connection between the Logic Engine of the *Universe Model* and the *State* design pattern makes a rudimentary, but profound connection between the conceptual model of the *Universe* to that of the world of software engineering. Software engineering provides the logic and terminology of object oriented programming practice (which emphasizes encapsulation and reusability) and design patterns (which are used for the organization of complex logic structures[24]) as tools for the description and organization of the *Universe Model*.

[24] Based on pattern language, design patterns in software engineering draw their inspiration from architecture. Besides architecture and software engineering, pattern languages have been used for the abstraction and encapsulation of anything having to do with form and design. For more on pattern languages see: (Alexander et al. 1977)

As shown above, the State pattern provides a foundation for understanding the Logic Engine of the *Universe Model.* However, it will be necessary to make several augmentations to the State pattern before the picture will be complete.

a. Transitions

The first problem to address in the *Universe Model* is the specification of the transition-logic for the movement between *worlds*. Making assumptions about the creation of inter-*world* transitions based on the observation of real-world scenarios can facilitate the creation of immersive *world* spaces that are more intuitive for the end user. For example, in real world scenarios spatial transitions occur through intermediate spaces, such as a corridor or a doorway, that provide not only a physical connection, but also a mental connection between the two world spaces.

The need for transitions may be tied to aesthetic and contextual choices that fall outside of the intuitiveness of real-world experiences as well. For example, in contrast to the intuitive approach of real-world transitions, there may be occasions where a counterintuitive transition may be used in order to usurp the end user's expectations. Also, there may be a case when, depending on the particular context, it is useful to dynamically change the manner of transitioning between *worlds*. Dynamically changing transitions could include switching between groupings of intuitive or counter-intuitive transitions, or transitions created by some other algorithmic means.

Whatever the means whereby transitions are implemented it is important to have some sort of transition logic embedded in the State of the *Universe Model* to handle all of these potential cases. Additionally, it is important that the transition algorithm avoid dependency with the State pattern so that the State and the transition algorithm can vary independently.

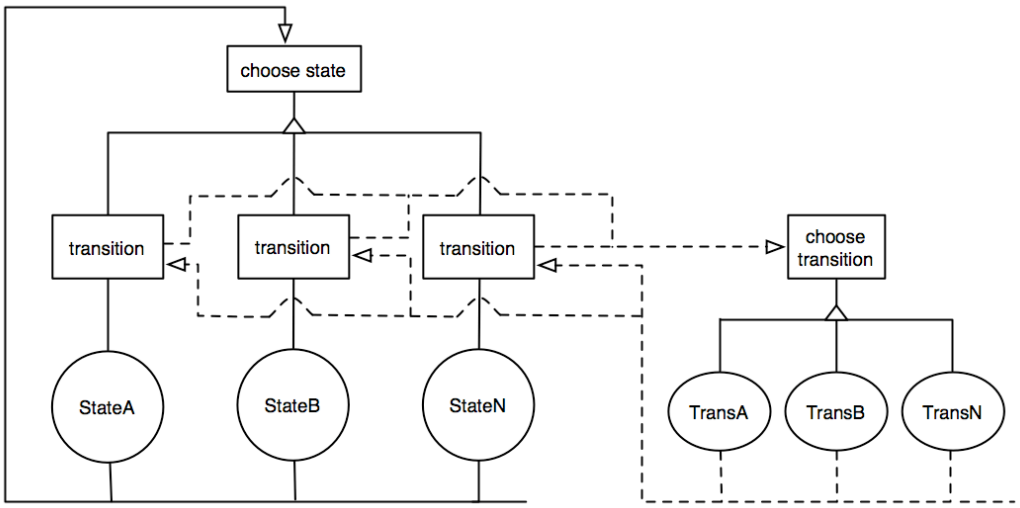

Figure 20. *Embedded Transition State* pattern

Figure 20 is a diagram of a variant of the typical State design pattern, called the *Embedded Transition State Pattern.* When a new state is chosen in the *Embedded Transition State Pattern*[25] the update is interrupted by a second State pattern embedded in the algorithm. The embedded State then chooses and executes a

[25] To clarify, in the context of the *Universe Model*, a state-change request is made when leaving the current *world* for a new *world.*

transition as appropriate. Once the transition has completed the *Embedded State* passes on the update handle, triggering the final state change[26].

b. Policy Of Narrative Control

Now that a transition model has been established, the next problem to address is how the narrative logic will be modeled within the definition of the *Universe Model.* The narrative logic determines the policy that controls the state and determines event handling. Policy controls happen mainly in the "choose state" and "choose transition" stages of the *Embedded Transition State Pattern* (see Figure 20).

The need for flexibility makes defining the narrative logic in the *Universe Model* challenging. The narrative logic needs to be defined in away that it remains flexible enough to handle the addition of both continuous and finite narrative forms, change structure on the fly, and be able to handle the logic of unknown potential narrative structures. The best approach to accomplishing this task is to provide a pattern with a simple structure and interface that allows the logic to vary independently of the *State* and *Embedded Transition* patterns described above. The pattern should be able to handle various logic systems, and various groupings of independent logic systems.

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[26] A question may arise here about the difference between the Finite State Machine (FSM) and the *Embedded Transition State* class. In principle, there is really no difference between FSM and the *Embedded Transition State*. However, careful use of terminology is used here to avoid confusion on two points: a) first of all FSM (often referred to interchangeably as a state machine) is commonly used in reference to the State design pattern, where, as shown in this discussion, transitions are implied but not explicitly modeled, b) secondly, there are several models of FSM. The two most common models are the Moore and the Mealy models. The State design pattern, with an implied transition state, most closely resembles the Moore model, while the Mealy model, with a specified transition state, most closely resembles the *Embedded Transition State*. for more information see: (Wagner et al. 2006)

Providing a structure for the defining of changing logics that can adapt to changing circumstances facilitates experimentation (i.e. swapping narratives for comparison), mutation, and variable narrative structures.

The design problem of narrative logic closely resembles the design problem encountered when handling the varied transition types of the *Embedded Transition State* described above. This comparison implies that an ideal solution for the design problem of narrative logic will be similar. However, there are some differences that need to be addressed, because the narrative logic will not behave in the exact same manner as the State pattern. For one, the narrative logic should be transparent from the *world*; it is not necessary for the *world* to know anything about the narrative logic in order to request a change. Also, it may be the case that the logic will seldom, if ever change, during the life of the *Universe*, and therefore will change independently of requests from the *world.* Therefore, a change in logic will most likely be connected to an internal mechanism, rather than an event or an update.

Again a solution to this problem can be found in *Design Patterns: Elements of Reusable Object-Oriented Software* (Gamma et al. 1995), this time with a design pattern known as Strategy. In the text the Strategy pattern is described as, "[Defining] a family of algorithms, encapsulating each one, and [making] them interchangeable. Strategy lets the algorithm vary independently from the clients that use it" (Gamma et al. 1995).

Other than by explicit reference in the Strategy pattern to algorithms, the distinction between the State and Strategy patterns is subtle and a common source of confusion in

discussions about the use of these patterns. Although, in the context of the *Universe Model,* many of the differences have been described, further clarification can be found in this passage from the text, *The Design Patterns Smalltalk Companion*:

> State is often confused with its close cousin Strategy, and it is sometimes difficult to determine which pattern to use, or if an implementation of one is actually the other. A good rule of thumb to follow to distinguish the two is that if the Context will contain only one (of several possible) "State" or "Strategy" objects during its lifetime, you are probably using the Strategy pattern. If, on the other hand, the Context changes during the normal course of an application so that, over time, it may contain many different "state" objects, then you may be referring to a State implementation, particularly if there are well-defined orders of transition between the different states. A subtler distinction can sometimes be found in the setting of an object's attributes. An object is usually put into a state by an external client, while it will choose a strategy on its own.
>
> Another distinction is that a Context seems to hide the Strategy it's using, but the State it's using is quite apparent to its Client. For example, when a Client tells a `Storage-Device` to store some text, the device may use one of several different techniques to compress the text before storing it, including no compression at all. However, the Client doesn't care how the device compresses the text, whether it does so at all, or whether it compresses the text the same way every time. It just wants the device to store and retrieve the text on command. Because of the way the compression is private to the device and hidden from the Client, the different compression objects are Strategies. On the other hand, once a Client opens a `TCPConnection`, it certainly expects the connection to behave like it's open. Once the Client closes the connection, it expected the connected to act like it's closed. Because the connection's status is readily apparent to the Client, the status objects are States. (Alpert, Brown, and Woolf 1998)

To summarize, the important differences between State and Strategy are found more in the motivation, than implementation of the pattern. However, these motivational differences are conceptually significant to the design of the *Universe Model.*

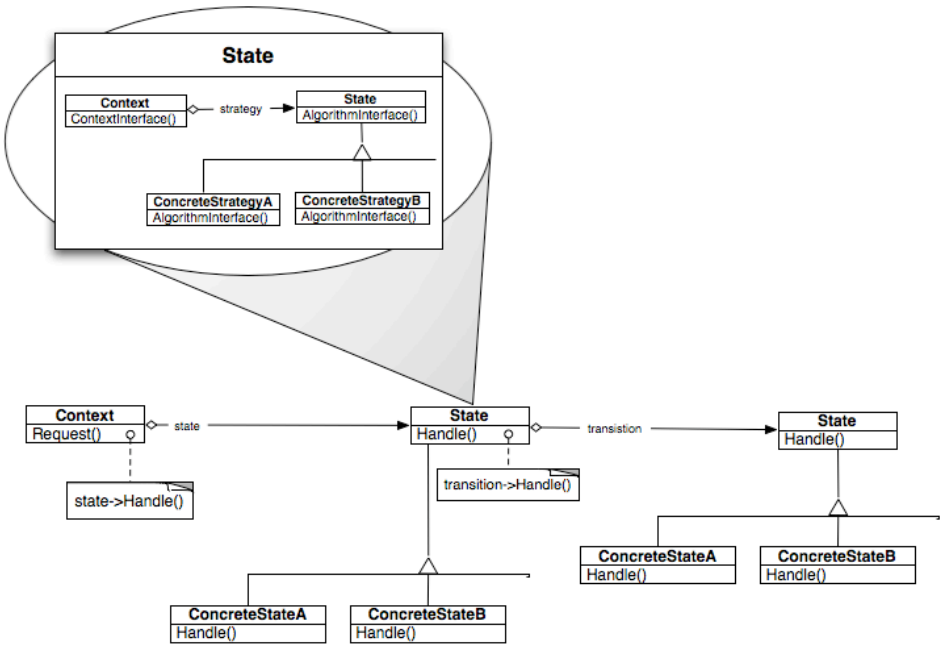

Figure 21. The Strategy Pattern as Control Logic Model

The diagram in Figure 21 shows an overview of the interrelationship between the *Embedded Transition State* pattern and the Strategy pattern of the Logic Engine. Much of the diagram is in essence a reiteration of the structure described in the previous section on transitions. In the diagram, a request from the context (i.e. *world*) triggers a State change. The State, via the Strategy, determines the next change in context and then passes on a separate request to the *Embedded Transition State*. Upon receiving the request, the *Embedded Transition State* executes a transition before relinquishing control back to the State, which ultimately completes the request.

As shown in the diagram, the logic for handling the request is kept hidden from the State, as well as from the requester. Since Strategy is a class on its own, it can vary independently of the State and *Embedded Transition State* logic.

2. *World*-View Classes and Views

As described above, users interact with the various worlds of the *Universe* by way of the *views*. In terms of the context of nonlinear immersive artworks *views* consist of anything that an end user makes contact with within the physical and virtual space of the work. Examples of *views* could include screens, computer mice, flashing lights, sensors, and so on. In software *views* are represented by *World*-View classes that provide a connection between the Logic Engine of the *Universe* Model and the perceptible space of the *Universe*.

World-View classes are structural models of the various *views* available in the *Universe*. *World*-View classes can be relatively simple or very complex. Simple *World*-View classes may only be responsible for keeping track of a current *world*'s state, while the most sophisticated *World*-View classes may be *Universes* in their own right.

World-View classes are intended to vary independently of the Logic Engine and, other than the naming scheme, have no fixed implementation requirements. Purposely defined vaguely, *World*-View classes are intended to be adaptable to any potential type of *view*.

Besides this ambiguity, there are several characteristics that *World*-View classes typically have in common. *World*-View classes should be named after the *view* they represent. A typical name for a *World*-View class would be *Mouse, Screen* or *Sound*. *World*-Views often have specialized data types associated with them. For example, a *Mouse* class could have a data type called *coordinate*, a *Screen* class could have a data type called *scene*, and a *Sound* class could have a data type called *soundfile.*

Data types are simple objects (similar to C-like structs) that act as containers for various types of information about a data element. For example a *soundfile* data type might contain information about the *soundfile*'s duration, frequency, loudness, timbre, or some other arbitrary criterion. This information is referred to as a tag, and can be used to sort, categorize, compare, or identify a particular data element. When needed, data types are stored in the *World*-View class in a collection of objects called a *map*.

A *World*-View class can be categorized as an input or output *view*, and will behave differently depending on their type. Input *World*-View classes are typically concerned with mapping logic and will either handle inputs as requests to their own *States,* or pass on requests to the Logic Engine as appropriate. Output *World*-Views tend to be more complex than input *World*-View classes. The reason for this complexity is that, while input *World*-Views are typically mapping and modeling transient actions, output *World*-View classes are often modeling continuous states. In order to maintain continuous states, output *World*-View classes usually have an

internal Logic Engine of their own. Output *World*-View classes are responsible for maintaining their *views* based on updates from the Logic Engine. These updates are potentially dependent on the previous past and future state of the *view*, and the current state of other *views*.

At this point it may be necessary to clarify the difference between the role of the Logic Engine and the role of the *World*-View classes. The Logic Engine of the *Universe Model* is responsible for keeping track of the state of the *worlds,* and handling update requests to the *world.* The *worlds* in the Logic Engine are represented as high-level abstractions that are used to communicate to the *World*-View classes when to update. When a *World*-View class receives an update it executes the update based on its internal logic and conditions. In other words, the Logic Engine knows when to change, and the *World*-View classes know how to change.

3. Control and Utilities

In the previous sections, the Logic Engine and the *World*-View classes of the *Universe Model* were defined. Now the focus of the discussion will turn toward the control and utility classes of the *Universe Model*. Control and utilities are a group of classes that provide the tools the *Universe Model* needs to function. Although closely tied to the Logic Engine and the *World*-View classes, control and utilities are defined separately because they are not directly responsible for the execution of decisions. In some cases controls and utilities facilitate the inter-workings of the Logic Engine

and *World*-View classes, while in other cases controls and utilities provide the glue between the Logic Engine and *World*-View classes.

a. Event Handling

In order to execute the requests of the Logic Engine there needs to be some method for event handling. The implementation of event handling can be simple or extremely complex. The simplest event handlers are basically message routers that may have some logic for time-delayed events, for example time-tags in the OpenSoundControl protocol[27]. On the other hand, event Handlers can become sophisticated applications in their own right, as in the case of the typical MIDI sequencer[28].

Sequencers are a classic example of a stand-alone event handler. Sequencers (also known as time-line editors) facilitate the defining of time-based events and gestures, and provide a convenient way to group events together. Often found in audio software, animation programs, and video editors, sequencers are commonplace in the media toolbox and a time proven method for dealing with pre-composed time-based events.

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[27] For more information on *OpenSoundControl*, and *time tags* visit: http://opensoundcontrol.org/
[28] For a history of hardware and software sequencers used in music see: (Roads 1996)

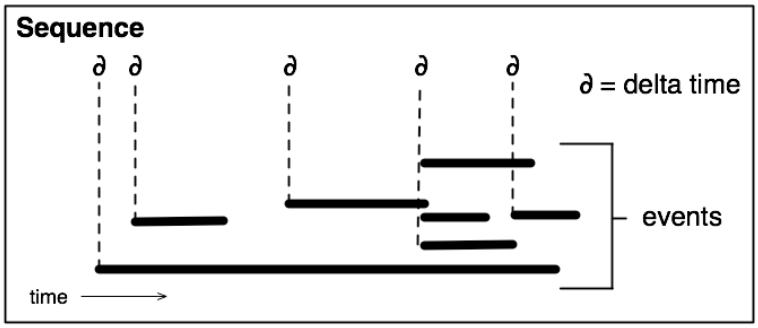

Figure 22. Sequence Graph

A basic sequencer, like the one depicted in Figure 22, is composed of a sequence of events that are executed in order, according to a predefined relative point in time. Events are defined by an onset and duration. The time between the onsets of events is referred to as the *delta time* (∂). Events occurring simultaneously will have the same delta time. Simultaneous events can have independent durations, and events can extend over the beginning of the next event's delta time allowing for overlaps.

The advantage of the sequencer is that it can be used to handle nearly any type of pre-composed or triggered event. As implied above, the sequencer is a familiar tool to users of time-based media applications. With careful consideration, the sequencer makes an ideal tool for the handling of events in the *Universe Model.* However, there are some disadvantages to the sequencer model as well. For example, most basic sequencers require an entry for every event that is to be played, doing so can be cumbersome to edit and manage, which can be tedious to define. Also, with most basic sequencers, sequences tend to be fixed in time and there is little to no variability in the interpretation of the events. Therefore it is necessary to define a

new sequence for every possible scenario that may be encountered when a sequence is needed.

Depending on the sophistication of the sequencing application there are, of course, a number of techniques that can be used to overcome the shortcomings of the basic sequencer. The most basic sequencers define sequences in formatted lists of text, while more sophisticated sequencers provide graphical editors. By using graphical editors end users can draw their sequences, usually in a piano scroll view, similar to the graph in Figure 22. Basic sequencers offer little to no tools for the hierarchical management of events, while sophisticated sequencers provide an interface for events to be grouped and transformed with high-level tools. Finally, greater sophistication can be added to the basic sequencer by ensuring precise quantization and synchronization between events, ensuring greater accuracy, and implementing a method for interpolation between events (also known as tweening).

While the possibility exists to implement a sophisticated sequencing application in the context of the *Universe Model*, it is more practical to describe a structure for event handling that is concise and extensible so that it can be applied to simple applications, while being extensible to complex applications as needed.

From a design point of view a sequencer is a hierarchical construct. Because multiple events can have the same delta time, delta times are defined separately from events. For the sake of organization delta times are used to group events together.

Grouping events by delta times means that groups of events can be moved and copied simply by changing the delta time parameters for that group.

Not only do event players need to be able to handle timing of event playback, event players need to be able to transparently handle events of multiple types. Various event types could be behavioral (such as steady state versus interpolated events), or have format types for controlling different types of contexts (i.e. sounds, images, etc.), or be a combination of the two. In fact, because of the sequencer's ability to transparently handle multiple data types, delta times can be treated as events in their own right.

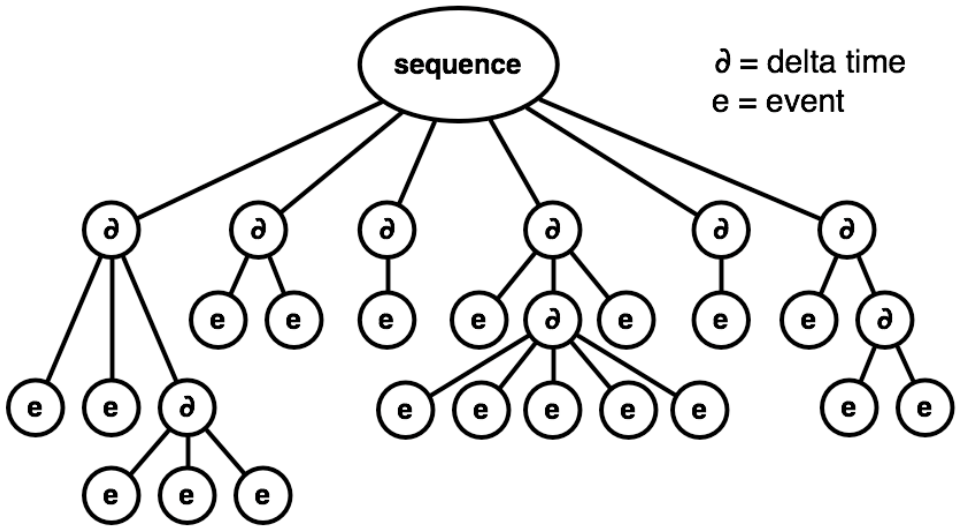

Figure 23. Composite Pattern Sequencer

The prospect of delta times being treated as events has some interesting implications. Because delta times are events and they are collections of events, sequences themselves can be composed of events of events. Looking at the diagram in Figure 23 the hierarchical structure being described becomes clearer. Groups of sequences can be organized into larger groups of sequences, facilitating the organization of larger hierarchical structures, which can be moved and copied with much greater ease.

In design pattern terminology the sequencer application above is described using a Composite pattern. Composite patterns "compose objects into tree structures to represent part-whole hierarchies" (Gamma et al. 1995). As in the sequence structure described above, " the key to the Composite pattern is an abstract class that represents *both* the primitives and their containers" (Gamma et al. 1995).

The following example of a standard song sequence using the Composite pattern will provide a real-world example of the benefits of working with events in a hierarchical manner[29]. Assuming that the form of the sequenced song is A B C A' B' C A, then the top layer of the sequence would be used to define the overall form of the song. An example of a top layer is conceptually the same as the row of delta times shown at the top of Figure 23. Each of the lower layers in the sequence

[29] A general description of the implementation of a sequencer using linked lists can be found in *The Computer Music Tutorial* (Roads 1996) pp. 661-677. Roads' description is conceptually similar to the one provided in this document. The primary difference between the two descriptions lies in the

represents a deeper level of organization of the song. The second highest layer would be the phrase, the next layer the measure, and the final layer would be the note or the beat. These structures are used then to group like events together within the song. Similar groupings within the song could then be cut and pasted, moved and transformed, and redefined to fit the needs of the song at that particular moment. Organizing the song in this way also makes a nice conceptual map for the song, which can be used later for analysis and remapping, or used as a template to create other songs.

b. Database Management

The use of databases in the *Universe Model* serves several purposes. The use of databases provides a method of storing sequences and events, data types, and storage of context state. Therefore, databases are beneficial to all of the elements of the *Universe Model* described above.

Because of the complexity of developing a database from scratch it will be more efficient to interface the *Universe Model* to a standard database, such as an ODBC[30] database (i.e. MySQL[31], or MSSQL[32]), or an Oracle Database[33]. Therefore the discussion on databasing will focus on the organization and usage of databases within the context of the *Universe Model*, rather than how to implement a database.

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implementation, which is analogous to the difference found between procedural and object oriented programming.

[30] see *Microsoft's ODBC Overview*: http://support.microsoft.com/kb/110093

[31] http://www.mysql.com

[32] www.microsoft.com/sql

The primary use of databases in the *Universe Model* is for the storage of data maps, sequences, and state. Most data maps and sequence databases function as an end user configuration interface, while the Logic Engine uses the state database to transparently store and playback *world* states.

As mentioned in the section above on *World*-Views, data maps are typically associated with *World*-View classes. Within the *Universe Model* a data map is an organized collection of a specialized data type. Specialized data types are composed of tags that are used to sort, categorize, compare, and/or identify a particular data element.

Data maps are primarily concerned with content. Figure 24 provides an example of how a data map database is used to describe content. This particular map contains three fields: *name*, *type*, and *mode*. The *name* field is used to store the name of a sound file, which directly references a file somewhere within the application search path. The *type* field is used to determine when to play a sound based on its characteristics (duration, frequency, timbre, etc.) as categorized by *SOUNDA, SOUNDB,* or *SOUNDC*. And the *mode* field is used to determine when to play a sound based on the current state of the *world* (*MODE1* through *MODE5*). Therefore, fields are used as identifying tags by a *World*-View class to determine when to play a

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[33] http://www.oracle.com/database/

sound based on a set of logical conditions. By altering the fields of a data type database, the content and/or the interpretation of the content is changed for the *World*-View class as well.

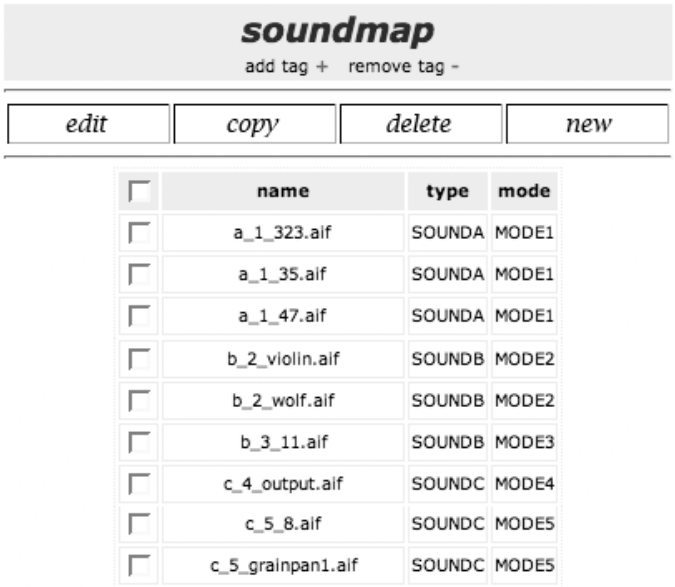

Figure 24. A Data Type Database For Cataloging Sounds

The chart in Figure 25 provides an example of how a database is used to define and store a sequence. The database shown in Figure 25 is a sequence of delta times (called steps), each with its own group of events defined by a *Target*, and some combination of the fields *Message 1, Message 2, Value 1,* and *Value 2.*

During the playback of a sequence the event handler will interpret an event differently depending on the combination of fields defined for that event. For example, an event like [0 star_x1 -0.97 750] would be interpreted as “tell view 0

move star_x1 to -0.97 over the course of 750 milliseconds", while an event like [-1 GOTONEXT OUIJA] would be interpreted as "tell view -1 (in this case -1 is the Logic Engine) update OUIJA, go to the next state immediately." To summarize, sequences are primarily concerned with behavioral control. Therefore by altering the content of a sequence, the behavior of the *World*-View is altered as well.

helloSequence

edit | copy | delete | new step | new event

#	Move	Delta Time				
1		0				
#	Move	Target	Message 1	Message 2	Value 1	Value 2
1		0	star_flash		0	
2		0	star_fade		0.25	0
3		0	clock_fade_1		0.45	0
#	Move	Delta Time				
2		750				
#	Move	Target	Message 1	Message 2	Value 1	Value 2
1		0	star_flash		0	
2		0	star_fade		0	700
3		0	star_x1		-0.97	750
4		0	star_y1		0.6	750
5		0	star_x2		0.83	750
6		0	star_y2		0.56	750
#	Move	Delta Time				
3		2000				
#	Move	Target	Message 1	Message 2	Value 1	Value 2
1		0	clock_scale		0.12	1500
2		0	clock_y		-0.318	1500
#	Move	Delta Time				
4		2500				
#	Move	Target	Message 1	Message 2	Value 1	Value 2
1		0	clock_fade_1		0	1500
2		0	cast_fade		0	1500
3		0	clock_fade_2		0.45	1500
#	Move	Delta Time				
6		250				
#	Move	Target	Message 1	Message 2	Value 1	Value 2
1		-1	GOTONEXT	OUIJA		

Figure 25. A Database For Defining And Storing Sequences

When creating a data map of sequences it is possible to combine the content and behavioral control of the *World*-View class. Such is the case in Figure 26 where the *lightgesture* sequences defined in a sequence database are cataloged in the *light* database. By treating the sequences like any other kind of data type, the *World*-View class uses the various fields of a data map to sort, categorize, compare, and identify the sequences. Once selected the *World*-View class passes the sequence name on to the event handler and it is played back.

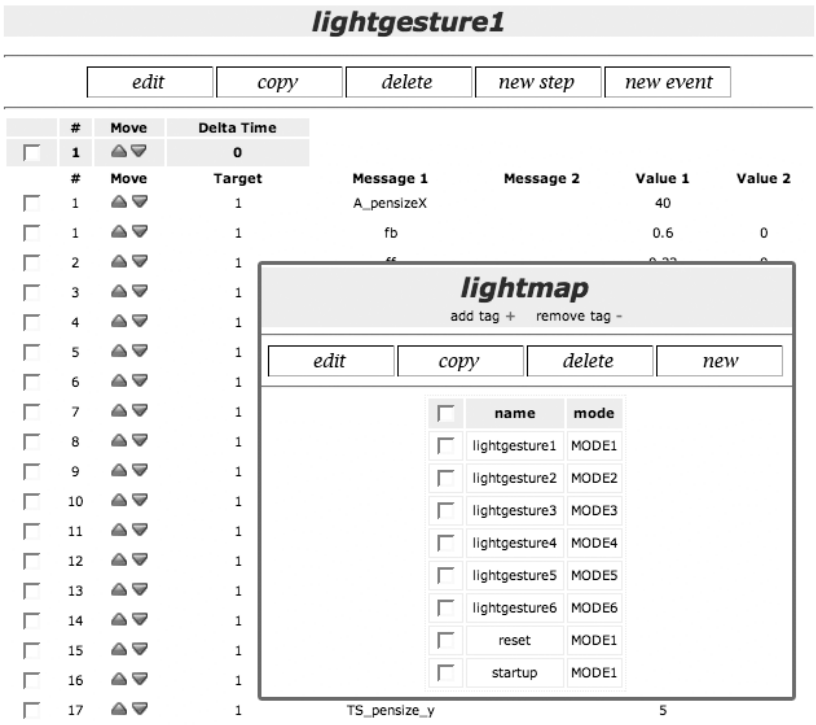

Figure 26. Combined Databases For Defining, Storing and Cataloging Light

Beyond the configuration functions described above, databasing in the *Universe Model* can be used for the archiving, storage and retrieval of *world* state, which has

numerous advantages. For example, the Logic Engine of the *Universe Model* could use a *world* state database to store data needed to determine state changes. The state database could also be used to "playback" past states for recreating the unfolding of *world* states in the *Universe*. Finally, stored states could be used to gather statistics on the behavior of the *Universe* for analysis, documentation, and system optimization.

c. Messaging

Messaging in the *Universe Model* is organized into two systems. There is an internal messaging system that facilitates communication between objects in the *Universe*, and an external system that provides a means of communication with *views* that fall outside the scope of the *Universe Model* proper.

Messaging in the *Universe Model* involves the use of two previously unmentioned design patterns, the Façade pattern and the Observer pattern. The Façade pattern is a pattern that "[provides] a unified interface to a set of interfaces in a subsystem. Façade defines a higher-level interface that makes the subsystem easier to use" (Gamma et al. 1995), while the Observer pattern is a pattern that "[defines] a one-to-many dependency between objects so that when one object changes state, all its dependents are notified and updated automatically" (Gamma et al. 1995). These patterns are used to reduce the interdependency between the objects while messaging within the *Universe Model*.

Figure 27 provides a block diagram of the implementation of objects and the organization of the messaging system in the *Universe Model*. Indicated by the solid black lines in the diagram, the implementation of objects flow from right-to-left. The GUI/Main holds a reference to the *Universe,* while the *Universe* in turn holds references to the Logic Engine, the Sender, and the Receiver. As a result of this implementation strategy the *Universe* acts as a Façade, which hides the routing logic from the GUI/Main.

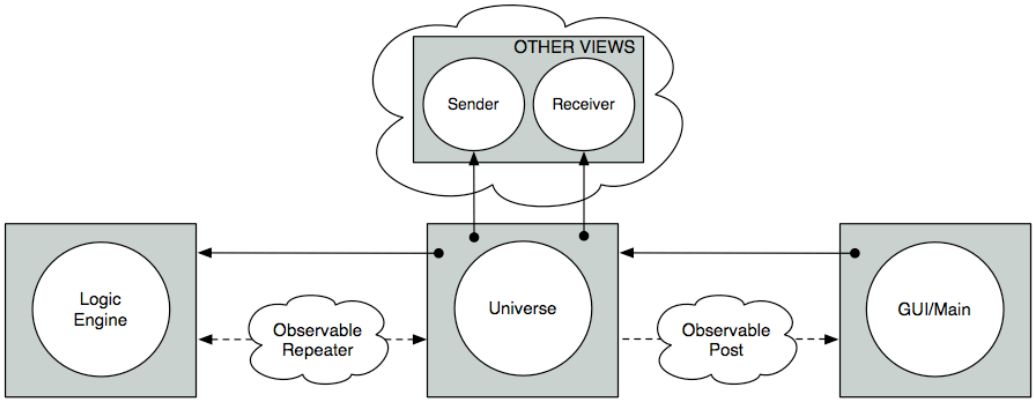

Figure 27. Messaging in the *Universe Model*

In addition to being a Façade, the *Universe* also acts like a switchboard, routing all received messages between the Logic Engine, GUI/Main, Sender, and Receiver as appropriate. Messages received by the *Universe* can originate from any one of the three sources. Messages are routed via two observables called *repeater* and *post*, indicated by the clouds with dotted lines in Figure 27. Bidirectional communication between the *Universe* and the Logic Engine is routed via the observable *repeater*, while messages are routed to the GUI/Main via the observable *post.*

External communications with *views* that fall outside the scope of the *Universe Model* proper are routed through the Sender and Receiver classes. Like the *Universe* class, Sender and Receiver classes are also Façades. By providing a simplified interface to external communications, the Sender and Receiver classes can vary independently of the *Universe*. Independent variance means that the Sender and Receiver classes are able to adapt to any communications protocol as needed without having to change the inner workings of the *Universe* itself. In addition, depending on the communications protocol used, the Sender and Receiver classes are used to facilitate the distribution of the Views over several applications and potentially other computers. Distribution is achieved by transmitting messages, such as state change updates, over standard networking and/or potentially other peer-to-peer communications and control protocols.

4. Overview of the Design of the *Universe Model*

The diagram in Figure 28 provides a detailed view of the inner workings of the *Universe Model*. odel the diagram in Figure 28 is a clearer view of the same structure that was originally depicted by a cloud in Figure 19. This section will summarize the discussion from the previous sections on the *Universe Model* as software engineering in order to provide a better understanding of the *Universe Model* and its functionality as a whole.

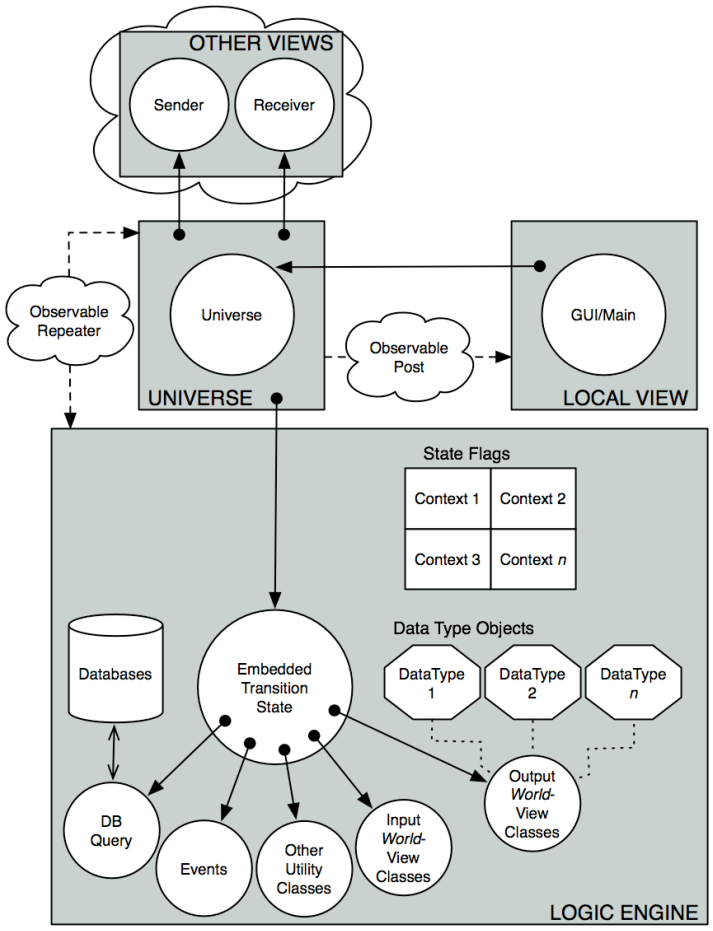

Figure 28. Completed View of the *Universe Model*

a. The Logic Engine

Contained in the Logic Engine are all of the classes used for the management of the application logic. The structure of the Logic Engine is a two-tiered State pattern, called the *Embedded Transition State*, which is responsible for keeping track of changing state, and transitioning. At the heart of the *Embedded Transition State* is the narrative logic modeled as a Strategy pattern, facilitating the encapsulation of various logic systems, and various groupings of independent logic systems.

The execution of state and transition changes is the responsibility of the control and utility classes of the Logic Engine. These classes encapsulate utilitarian functions for the Logic Engine, such as event handling and database querying, making them transparent to the rest of the Logic Engine. Event handling is realized as a Composite pattern that organizes events into hierarchical structures for clarity and modular transformation. The database class provides an interface to querying the database engine being used by the Logic Engine. Databases are primarily responsible for the storage and retrieval of event sequences and data type definitions, which are used by the *World*-View classes for the execution of state and transition updates.

World-View classes are used to contain the logic of the various *views* of the *world* space of the *Universe.* As mentioned, *views* consist of anything that an end user makes contact with within the physical and virtual space of the *world. World*-Views are either input or output *views* and often have specialized data types associated with them in order to handle their particular view. Data types stored in the *World*-View are stored in a map with tags that are used by the *World*-Views for the mapping of data types to update requests.

b. The Views

As shown in the diagram in Figure 28, there are two types of Views, Local Views and *World*-Views. A Local View is a *view* that acts as a local user interface to the *Universe Model.* Although not mandatory, it is useful to provide a Local View that can be used for testing, debugging, and configuration, thereby providing access

to any other controls or feedback that are needed for working directly with the *Universe Model.* The *World*-Views refer to communication with *views* that fall outside of the local scope of the *Universe Model*. *World*-Views are primarily concerned with content and therefore usually employ the resources of other applications and controls. *World*-Views also have the potential to be distributed among several applications and/or computers.

In the previous sections *World*-View classes are intentionally left undefined. The motivation for leaving *World*-View classes undefined in the *Universe Model* is to ensure that the *Universe Model* is adaptable to any future unanticipated View. It is assumed that the *Universe Model* will be adapting to the View, rather than the View adapting to the *Universe Model*.

c. Messaging and Control

The *Universe* serves two main functions in the *Universe* model. First of all it is a switchboard for inter-object and external application communications within the *Universe Model.* Secondly, it provides an interface for the Local View to control the interface through a management GUI, or other control. In both cases the *Universe* serves as the entry point for all messaging and control requests within the *Universe Model.*

d. The *Universe Model* as Model-View-Controller

Thus a stratified system that collectively forms the structure of the *Universe Model* has been described with the assistance of design patterns. In design pattern

terms, the structure of the *Universe Model* is, for the most part, an implementation of the Model-View-Controller (MVC) design pattern. The intent of the MVC is to organize an application into three areas that focus on the application logic, user input and display, and the control mapping respectively (Gamma et al. 1995). As shown in Figure 28 objects in the *Universe Model* can be generally mapped to the MVC with the Logic Engine as Model, the local and other *views* as the View, and the *Universe* as the controller.

Although basically the same structure, the rational for differences in terminology between the *Universe Model* and the MVC exist in order to maintain clarity between the two ideas. In addition, the unique terminology of the *Universe Model* is more descriptive of the way the objects (and groups of objects) behave within the context of the *Universe Model.* Also, closer analysis draws into question the strict following of the MVC by the *Universe Model*. Because of these variations, trying to make the *Universe Model* too close of an analogy to the MVC could ultimately become confused, explaining the need for the unique terminology used in the description of the *Universe Model.*

C. Conclusion

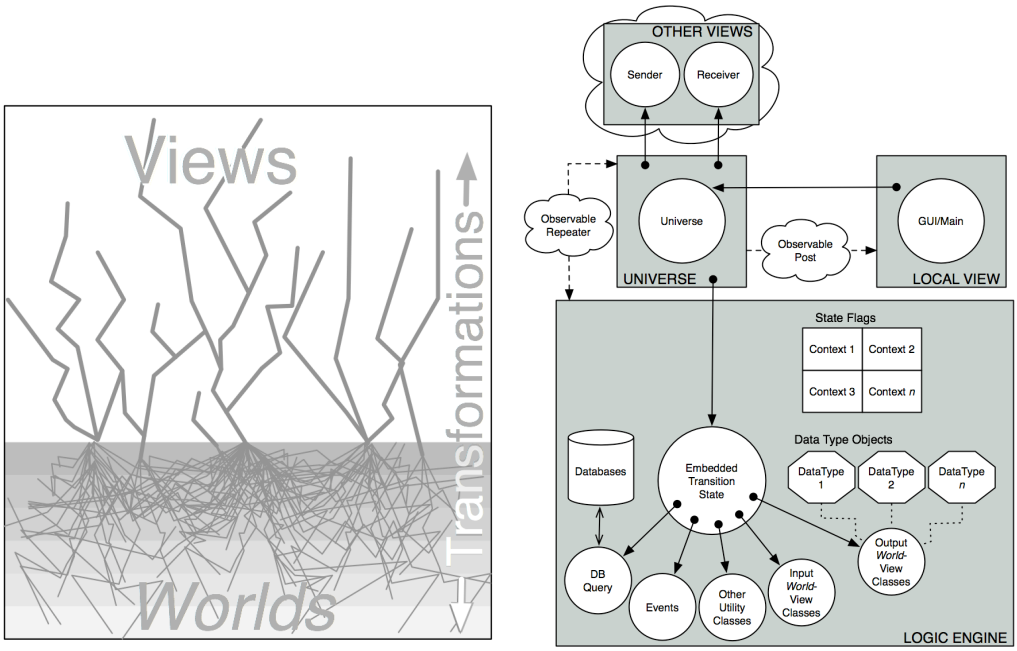

Figure 29. Comparison of the theoretical and implementation models of the *Universe.*

Thus a high level model of the *Universe*, inspired by the theoretical description of the *Universe* as a rhizome, has been defined. Because of the consistency of naming and the analogies given, the comparison between the theoretical model of the *Universe* and the implementation model of the *Universe Model* is readily made (see Figure 29). It is through the abstraction of the *Universe Model* as a collection of design patterns that the theoretical description of the *Universe* becomes real.

The root mass of the rhizome mesh, which represents immersive *worlds*, is analogous to the various components of the Logic Engine of the *Universe Model*, which is an abstraction intended to represent the multiplicities of stratified,

convergent, divergent, and bifurcating of *world* systems that define the nonlinear narrative of a *Universe* as an interactive immersive artwork.

The external messaging and controls of the implementation model, which is managed by the Universe main class through the Sender and Receiver, map to the *views* of the conceptual model of the *Universe*. In the implementation model *views* are user interface elements that exist outside of the definition of the *Universe Model*, and modeled in terms of their state and controls in the *World*-View classes.

For the most part the *World*-View classes of the *Universe Model* map to the *transformations* of the conceptual *Universe* by performing a transform between the *world* system of the Logic Engine and *views* of the physical space of the *Universe.* This connection becomes apparent when considering that the *World*-View classes are not the *views* themselves, instead they are logical models of the *views* that know how to interpret information to and from *world* systems in a manner that is appropriate to the *view*.

The most vaguely defined aspect of the *Universe Model* is the *World*-View class. The vagueness of the definition of *World*-View is intentional in order to allow the *Universe Model* to remain scalable to any potential view. Therefore, in terms of the *Universe Model*, W*orld*-Views are highly abstract encapsulations of the logic and transforms that model a *view's* communications and state. Therefore *World*-View

classes make the connection between the *world* processes (represented by the inner workings of the Logic Engine) and the *views*.

IV. An Evolution and Testing of the *Universe* Through Exploration

The works presented in this chapter trace the evolution and testing of the *Universe* hypothesis through a process of exploration outlined as a history of my work. There are six works presented in this chapter that provide a history of the discovery and examples of the implementation of the *Universe* hypothesis in three stages. The first two works[34] show the beginnings of the concepts that led to the development of the *Universe Model.* The second two works[35] are precursors that contributed directly to the development of the *Universe* hypothesis. The remaining two works[36], unique from each other, were implemented using the *Universe Model* and thus provide a basis for the evaluation and testing of the *Universe* hypothesis.

A. Beginnings

This section describes two of my early attempts at the creation of works using the techniques and aesthetics of nonlinear narrativity, *After-Life on the Bardo Plane of Existence* (1997), and *microMOTET: There Is Only Emptiness In The Eyes Of A Lonely God/Alle Menschen Müssen Sterben* (1999). Through these two works I will describe my discovery of nonlinear narrativity. In particular I will describe my discovery of the possibility of presenting many story paths within a single story space, and the potential for varied individual interpretation of events through

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[34] *After-Life on the Bardo Plane of Existence* (1997), and *microMOTET: There Is Only Emptiness In The Eyes Of A Lonely God/Alle Menschen Müssen Sterben* (1999).

[35] *DEFNEDEX-ESPGX* (2004), and *BitSignalFabric* (2005)

[36] *An Uncommon Affair At Tooting Bec Common* (2007), and *Quasar* (2008).

perceptual saturation and layered meaning within a work. These early approaches provided me with evidence of the nature of nonlinear form, which quickly became a directed pursuit that lead me towards the development of nonlinear interactive immersive artworks as a departure from the practice of music composition.

1. After-Life on the Bardo Plane of Existence

My initial interest in nonlinear narrativity developed around the time I started working on a performance-based work called *After-Life On The Bardo Plane Of Existence* (see Appendix I). Conceived of in November 1996, *After-Life On The Bardo Plane Of Existence* is an immersive multi-media performance-based work. The content of the work is composed of three separate simultaneous streams of information in the form of performance, video animation, and quadraphonic sound. Each stream is meant to represent a different aspect of the *Tibetan Book of the Dead*. While performers act out the literal actions described in the *Tibetan Book of the Dead,* the video animation presents the esoteric elements described in the *Tibetan Book of the Dead*. The sound acts as glue, unifying the performance with the animation, while emphasizing the literal and esoteric actions as appropriate.

Although *After-Life on the Bardo Plane of Existence* has a strong underlying spoken narrative, the work communicates primarily through sound and sense. The intention was to create a work that was an experience, rather than a declarative telling of the story of *the Tibetan Book of the Dead*. Therefore, with the exception of two lines, there is no dialog, and the entire story is expressed through movement, image, and sound.

The layering of the content was designed to overwhelm the senses of the viewers in the audience through over saturation. The intended affect of this mass of information was to create a kind of indeterminacy whereby the audience is forced to choose which element of the story to follow by focusing on either the performance or the animation, as they are bathed in the sound. As a result of this perceptual choosing, each audience member experiences a unique path through the story space of the work.

The performance consisted of three acts that told the story of the Bardo spirit's journey from death into rebirth and a new life:

I. Chakai Bardo The Bardo of the moments of death.
    - Meditation and Prayer.

II. Chonyid Bardo The Bardo of the experiencing of reality.
    - The dawning of the Peaceful Deities.
    - Interlude: The Bardo is Lost!
    - The dawning of the Wrathful Deities.

III. Sidpa Bardo The intermediate state when seeking rebirth.
    - The After Death World: Judgment.
    - The process of rebirth.

a. Reinterpretations

Originally conceived as an interactive documentation of the performance work, the project was reinterpreted for CD-ROM in 1999, and then again as a website based on the CD-ROM in 2000. While developing the story structure of the CD-

ROM I began to hypothesize that, as long as the user explored every part of the work, the sum of the knowledge of the story would be the same when presented in any order. In other words, the CD-ROM did not have to be presented as a linear stream; it could be presented as an interactive story space.

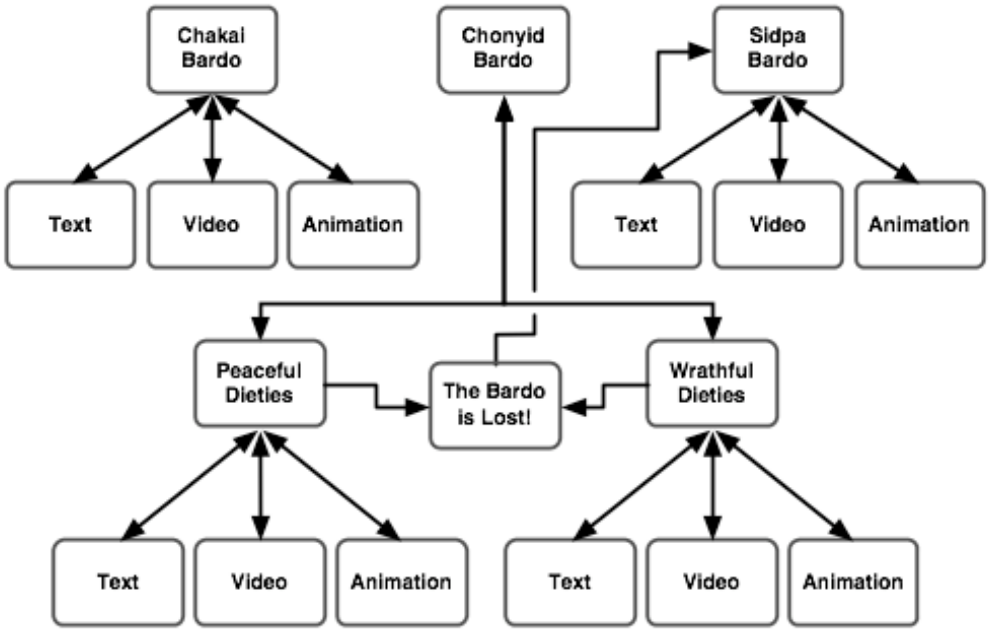

Figure 30. Interaction Diagram for the *After-Life on the Bardo Plane of Existence* CD-ROM

As shown in Figure 30, the CD-ROM was organized by breaking-up the main story into three main areas that mapped directly to the acts of the performance version of the piece. The branches of the three main areas contained sound bytes, film clips, and iconographic environments that were derived from the original production as well. Each area contains a text that describes how a particular area fits into the larger story. In addition, each area contains two film clips that relate to the

current area of the story. One clip is taken directly from the animation video, and the other clip is a video of the performance. Finally, music from the performance plays in the background consistently, with the exception of when the film clips are playing.

Although the navigation flow of the CD-ROM was organized hierarchically according to the narrative arc of the story, the navigation elements were designed to encourage a nonlinear navigation of the CD-ROM. Thus the CD-ROM was designed so that it confused the user. This confusion was intended to be an allegory to the journey that the bardo takes between death and rebirth. The navigation buttons used unfamiliar iconography and offered no assistance about where to go, forcing the user to intuitively choose their path of navigation. Clues and traps placed throughout the interactive space of the CD-ROM meant that the user was likely to get lost within the many paths of the story space.

b. Conclusions

Obviously there were some trade-offs made when creating each version of *After-Life On The Bardo Plane Of Existence*. For example, the CD-ROM and web versions were not able to recreate the saturated experience of the original performance. However, the new medium presented me with an opportunity to rethink the structure of the work as a hypertext, a narrative structure is not easy to achieve in a performance setting. Thus the new manifestations of *After-Life On The Bardo Plane Of Existence* set-up the initial conditions for me to explore immersion and nonlinear narrative.

2. microMOTET: There Is Only Emptiness In The Eyes Of A Lonely God/Alle Menschen Müssen Sterben

microMOTET: There Is Only Emptiness In The Eyes Of A Lonely God/Alle Menschen Müssen Sterben (or simply *microMOTET*) for soprano, alto, tenor, flute, bass clarinet, trumpet, violin, viola, and cello was composed shortly after the completion of the CD-ROM version of *After-Life On The Bardo Plane Of Existence*. *microMOTET* was the continuation and extension of the nonlinear narrativity explored in *After-Life On The Bardo Plane Of Existence*. In particular, *microMOTET* implemented the idea of saturation to create an indeterminate narrative space, whereby the listener is forced to perceptually choose which aspects of the sound mass to focus their attention on. As stated above, this perceptual choosing meant that every audience member would experience a unique path through the narrative of the work.

a. Aesthetic

Saturation in *microMOTET* was achieved primarily through the use of counterpoint and the plurality of style. The centerpiece of the work is based on the style of a three-voiced medieval motet. First appearing in the 12th century, the motet was a secular polyphonic form that used a liturgical song as the *cantus firmus* (a.k.a. the bottom voice) sung by the *tenor*, with each of the top two voices (a.k.a. the *triplum* and the *duplum*) set to a secular poem. The upper voices were often thematically related to the cantus firmus and were sung in either French or Latin, while the *cantus firmus* was always set to a Latin text (Grout and Palisca 1996).

Many aspects of the medieval motet were altered to meet the criteria of the stylistic and formal needs of the *microMOTET*. Instead of using a Latin cantus firmus, the cantus firmus of *microMOTET* uses a Bach setting of *Alle Menschen Müssen Sterben* in German. The triplum and duplum of the microMOTET are taken from two stanzas of a poem written shortly after the death of my grandfather called, *In The Eyes Of A Lonely God* (see Appendix II). Also, in the tradition of contemporary concert hall music, the harmonic language of the *microMOTET* uses a freer use of dissonance than was allowable in the 12th century style.

In microMOTET the strings accompany the three melodic lines of the motet with another layer of three-voice counterpoint based on the micro-canon compositions of Krzysztof Penderecki and Gyorgi Ligeti. In the *microMOTET* the strings are separated according to three strata that are mated to the three voices of the motet described above. Using layered and intersecting glissandi, the micro-canons create a wash of sound in the frequency range of the notes being played by the strings.

Inspired by the works of Luciano Berio, in particular *Laborintus II* and the third movement of *Sinfonia* (described in Chapter II above), the form of *microMOTET* uses the interplay of historical elements to demarcate the structure the work. However, *microMOTET* is preoccupied with a plurality of style and genre, rather than that of quotation, as in Berio's *Sinfonia.*

b. Form

The harmonic language of *microMOTET* functions as a kind of counterpoint as well. The piece starts in traditional harmony, and then decays into dissonance, and finally into the saturated sound mass of the motet. Once the motet is over the piece rises out of the sound mass before returning finally to the initial traditional harmonic language on the final chord.

The graphic in Figure 31 provides a more detailed overview of the *microMOTET*. The piece begins at number 1 with a canon in the strings that quickly disintegrates into a micro-canon counterpoint in glissandi starting at number 2. The glissandi are meant to be smooth, outlining the implied melody of *Alle Menschen Müssen Sterben*.

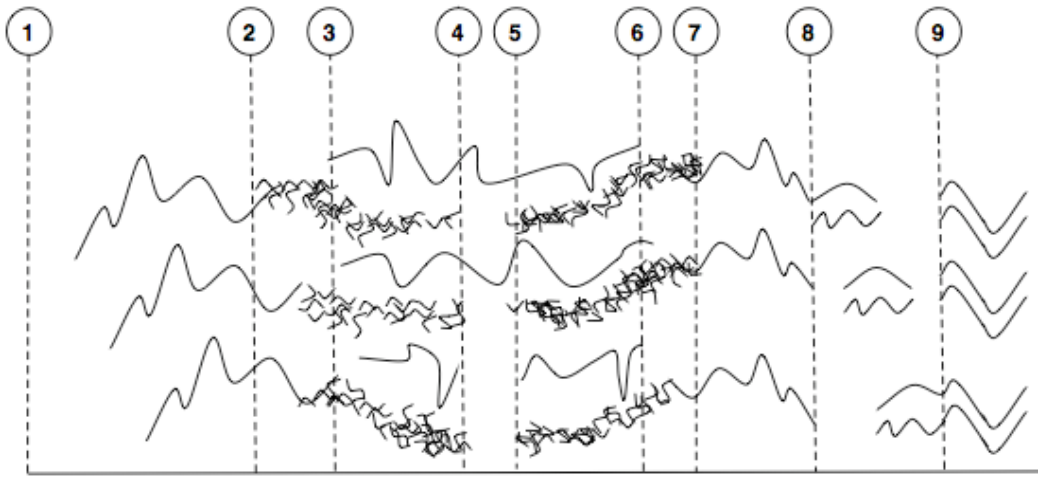

Figure 31. Graphical Overview of *microMOTET: There Is Only Emptiness In The Eyes Of A Lonely God/Alle Menschen Müssen Sterben*

At number 3 the motet begins, un-metered and accompanied by the underlying texture of the glissandi strings. An instrument doubles each vocal line of the motet, the soprano (triplum) is doubled by flute, the alto (duplum) is doubled by muted trumpet, and the tenor (cantus firmus) is doubled by bass clarinet. At number 4 the texture drops out, leaving a duet between the triplum and duplum. Number 5 marks a return to the original sound mass accompanied by a trio similar to the trio of number 3, and continues until the motet cadences at number 6.

At number 6 a kind of de-introduction begins and the micro-canon of the motet untangles (in a reverse of the canon to micro-canon transition at number 2), leading to the return of the conventional canon from number 1. A hanging viola marks the end of the palindrome form that occurs between numbers 1through 8.

The final sections of the *microMOTET* form a cadenza based on the original *Alle Menschen Müssen Sterben*, occurring between number 8 and the end. Starting with an operatic style melody and accompaniment in a baroque character at number 8, the cadenza quickly becomes a fanfare-like chorale starting at number 9. Also, over the course of the final section, the more dissonant harmonic language of the piece untangles, until finally ending on a G-major triad, functioning in a similar manner to a Picardy third.

c. Meaning

The combination of the disparate harmonic and stylistic elements form a complex web of meaning within *microMOTET*. Tying together the various ideas of

the *microMOTET* is Bach's *Alle Menschen Müssen Sterben*, which appears throughout the work and takes on several roles. Most overtly is the pervasiveness of Bach throughout the work, acknowledging Bach as an icon in the history of counterpoint. This connection is emphasized by the use of Bach for the cantus firmus of the motet, a place usually reserved for God. The elevated status of Bach's role in the work is also symbolic of the role that history has afforded Bach, which is the status as an arch deity of composers of Western music.

The lyrics of the *microMOTET* have multiple meanings as well. First of all, *microMOTET* was written as a requiem for my grandfather, Frank A. Hosale. Specifically, the lyrics of the triplum and duplum are from a poem I wrote around the time of my grandfather's death. The meaning of the lyrics of the triplum and duplum, which are about doubt and fear, contrast the meaning of the cantus firmus, which are about faith and affirmation.

The use of harmony in the work contrasts the use of style. As the work stylistically shifts into the past, from a fugue-like canon to a motet, the harmonic language moves forward in time, from consonance to dissonance. This simultaneous decline and progression symbolizes the Emancipation of the Dissonance, which, as described in Chapter II, views the decline of tonality as the denouement of a historical narrative arch.

The pivot point of the declining and progressing narrative arcs of *microMOTET* is centered on Bach and the Baroque. The style and harmony move out and return to the fugue-like canon at the pillars of the palindrome. The final cadenza, which is stylistically based on opera and the chorale (the most common forms in the baroque), celebrates the old as a foundation for the new by fusing the formal style of the past with the language of today.

The decline and rise of the style and harmony is also symbolic of the process of grief. The saturation of melody, micro-canon, and harmony creates a cloud of turmoil from which clarity and hope rises in the form of the final Picardy third.

d. Conclusion

In many ways a more sophisticated narrative structure than *After-Life On The Bardo Plane Of Existence, microMOTET* was an exploration of saturation using a variety of nonlinear operations to form an indeterminate collage-like tapestry of information and sound. Therefore the saturation found in *microMOTET* is not only perceptual; it is a saturation of ideas. As shown in the medieval motet, accompanied by micro-polyphony with an operatic cadenza, *microMOTET* is a knowledge space that simultaneously moves from the past to present, present to past in a historically referential counterpoint that is an ode to life and death.

3. Beginnings: Conclusion

The discussion of *After-Life On The Bardo Plane Of Existence, microMOTET* described some of my first attempts at the creation of works using nonlinear

narratives and my discovery of nonlinear narrativity. The works presented in this section were created using a hands-on approach to producing nonlinear narrative through the domain of music composition, which lies in contrast to the more automated works that will follow. As a contribution to the discovery and evolution of the *Universe Model,* both works represented an exploration of story as an indeterminate knowledge space through the saturation of information and ideas, and provided the basis for the pursuit of nonlinear narrativity in my work.

B. Precursors

The software infrastructures used to develop the works presented in this section (*DEFENDEX-ESPGX* (2004) and *BitSignalFabric* (2005)) were immediate precursors to the current version of the *Universe Model.* The development of these works provided a test bed for the evaluation of the components needed to create interactive immersive artworks, and ultimately influencing the decisions made in the design of the current *Universe Model*. The software infrastructures used to develop these works not only contained many design traits that carried over to the *Universe Model*, they were the origin of the terminology used to describe the *Universe* as well.

1. DEFENDEX-ESPGX

My interest in making immersive nonlinear works, along with a long standing interest in combining various art practices, ultimately lead me to the field of media arts and to the development of installation artworks. The opportunity to further explore the possibilities of immersion and participation initiated in the various

manifestations of *After-Life On The Bardo Plane Of Existence* presented itself while working on *DEFENDEX-ESPGX,* an interactive art object.

Figure 32. MarkDavid Hosale and John Thompson. *DEFENDEX-ESPGX,* 2005. Interactive Art Object. Pescadrome, Santa Barbara, California.

a. Overview

Shown in Figure 32 *DEFNDEX-ESPGX* was developed in collaboration with John Thompson between 2003 and 2005 (for details on the conceptual and aesthetic aspects please see Appendix III). Standing six feet tall, four feet deep, and two feet wide, *DEFENDEX-ESPGX* is designed to look like a 1950's era computer. Fully interactive, users can navigate through the narrative space of *DEFENDEX-ESPGX* using the controls, and a microphone on the front panel. *DEFENDEX-ESPGX* also performs surveillance functions via a robotic camera attached to the top. Feedback is provided to the user via flashing lights, an oscilloscope, vibrating motors, and embedded loudspeakers.

b. Software design

Designed primarily in Max/MSP/Jitter (http://www.cycling74.com), a real-time application-level multimedia graphical programming environment, the software architecture of DEFNEDEX-ESPGX (shown in Figure 33) is a less sophisticated precursor of the *Universe Model*. Based on the Model-View-Controller pattern, the *DEFENDEX-ESPGX* is organized into three global areas that manage the input and output of control, images, and sound respectively. Sound output is also controlled directly by SuperCollider (http://www.audiosynth.com), a real-time audio-synthesis programming environment, which communicates with the Max/MSP/Jitter environment bidirectionally via OSC. Represented by the cloud in Figure 33, the narrative engine keeps track of state and changing state.

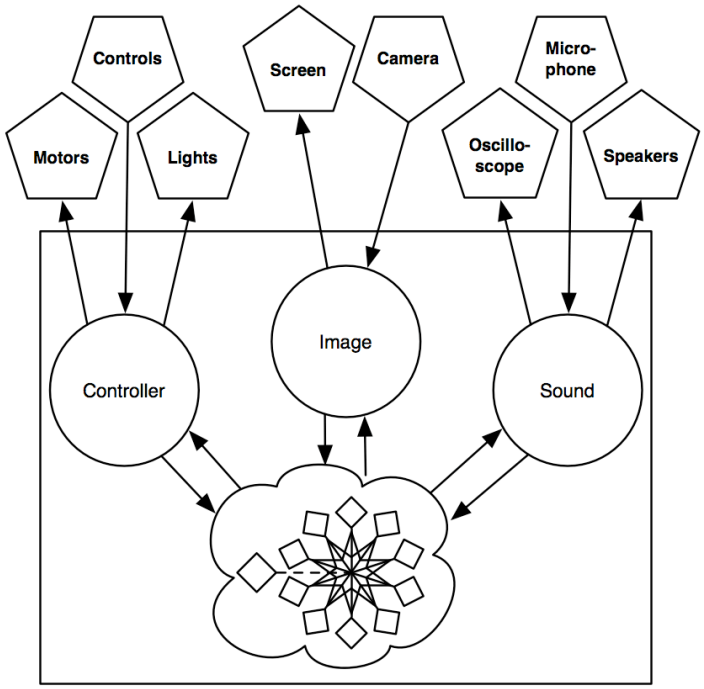

Figure 33. Software Architecture of *DEFENDEX-ESPGX*.

c. Narrative Engine

During the development of *DEFENDEX-ESPGX* a terminology was developed that was useful for the description of the narrative engine. This terminology differs from the terminology used for the *Universe Model,* but is consistent with the thinking behind the development of *DEFNEDEX-ESPGX* (and it is consistent with the documentation in Appendix III), therefore, for clarification, it will be briefly described here.

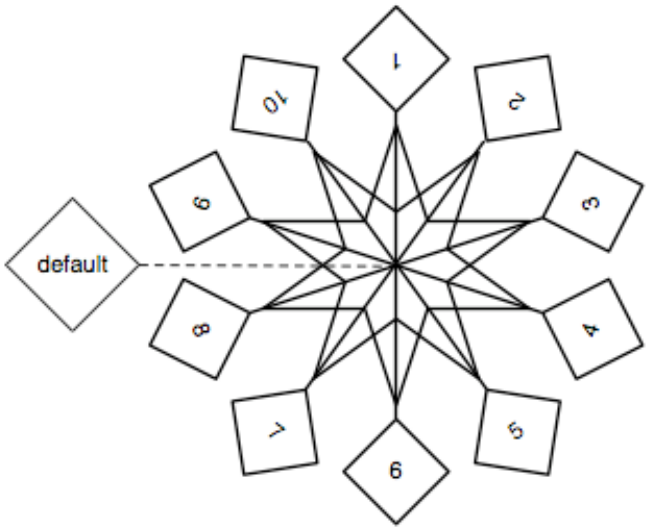

Figure 34. The Narrative Space Of DEFENDEX-ESPGX

Shown in Figure 34, the narrative space of *DEFENDEX-ESPGX* consists of 10 narrative states (called *nodes*) and a resting state (or *default* node). As the narrative engine of *DEFENDEX-ESPGX* began to develop, nodes came to be thought of as *worlds*, and the engine that determined the next *node* was called the *world changer* (the world changer is a nascent form of the *Universe Model'*s logic engine). In the end, the term *node* won out over *world*, because the narrative points of *DEFENDEX-ESPGX* were considered to be like nodes in a web-like network. However, the term *world changer* remained. Therefore, in the context of *DEFENDEX-ESPGX,* the term *node* is used when referring to a narrative state, and the term *world changer* is used to refer to the narrative engine.

d. Nodes

With the exception of the default node, the narrative arc of each node in *DEFENDEX-ESPGX* is categorized as either an active or passive node. Active nodes are interactive and either "reward" or "punish" user activity either by letting them stay in the node, or by forcing them to move on to the next node. Therefore, in active nodes users determine the outcome of the node. Passive nodes are not causally interactive and are primarily used for the play back of narrative content. Any interactive elements in passive nodes do not dramatically change the nature of the content and are not used to determine exiting of the node. For details on the description of each node see Appendix IV.

e. Narrative Space

When not in use *DEFENDEX-ESPGX* rests in the default mode. When a user moves one of the controls or speaks into the microphone *DEFENDEX-ESPGX* exits the default node and then randomly chooses a node within the narrative space of the world changer. Once in the narrative space the user will be delivered a unique sequence of narrative nodes. Node changes are automatic and transparent to the user. The sequence of nodes continues indefinitely, repeating nodes when the narrative engine runs out of new nodes to display. When the controls of *DEFENDEX-ESPGX* have been left unattended for a certain period of time the narrative engine of *DEFENDEX-ESPGX* times-out by returning to the default node/resting state.

Movement between nodes is determined probabilistically in the web-like narrative space of DEFENDEX-ESPGX (see Figure 34). In the probabilistic

narrative engine weights are used to determine the order of node changes. For example, active nodes are more likely to go to passive nodes, while passive nodes are more likely to go to active nodes. The use of probabilities allowed for administrative control over the variety of nodes presented to the user by reducing the possibility of oscillations (moving back and forth between one or two nodes), and bad combinations of nodes (for example moving between nodes that are too similar in quality).

f. Conclusions

The design of *DEFENDEX-ESPGX* is a much simpler precursor of the *Universe Model*. A fixed system, rather than an abstract model, the software of *DEFENDEX-ESPGX* quickly became difficult to expand and maintain. In addition, the software of *DEFENDEX-ESPGX* was lacking in some key features of the *Universe Model*. In particular, the *DEFENDEX-ESPGX* software needed a definition for transitions, communications was decentralized, and the logic of the narrative engine was hard coded and difficult to change. During the development and refinement of the software of *DEFENDEX-ESPGX* these issues became exposed and a need for a better-organized system became apparent. However, due to the scale of the project, the decentralization of certain aspects of the code, and a lack of flexibility within the Max/MSP/Jitter environment, the practicalities of implementing desired changes became unrealistic, but were noted for future projects.

2. BitSignalFabric

BitSignalFabric is an interactive navigable gallery of independently authored immersive virtual worlds[37]. By its final manifestation the framework of *BitSignalFabric* housed contributions from eight different artists including myself[38]. The contributions of the artists were connected by a *transmodal*[39] aesthetic, which developed during discussions that unfolded in a series of seminars lead by Marcos Novak on *transvergence.* Based on the aesthetic of transvergence, the works in *BitSignalFabric* were characterized by the hybridization of sound and image into a single medium that manifested as 3-D navigable virtual worlds. By navigating these *worlds* users could explore and change sound objects within the *worlds* that unfolded as morphing malleable spatial narratives. The framework that joined these worlds together was called the *universe* and is the origin of the term as it is used in the *Universe Model*. In a literal sense, the *universe* of *BitSignalFabric* can be understood as a *world* of *worlds*.

a. Cross-Influences

Because the development of *BitSignalFabric* overlapped with the development of *DEFENDEX-ESPGX*, the two projects had a recursive conceptual influence on each other. Abstractly, *BitSignalFabric* and *DEFENDEX-ESPGX* can be considered

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[37] This section is a technical description of *BitSignalFabric* as it relates to the *Universe Model.* Please see Appendix V for a more detailed description of the context and aesthetic issues surrounding *BitSignalFabric*.

[38] *BitSignalFabric* included contributions from: MarkDavid Hosale, Haru Ji, Dan Overholt, Lance Putnam, Ben Ritter, Wesley Smith, John Thompson, and Graham Wakefield.

[39] *Transmodality* refers to the crossing of media to form hybrids, or new species of media. (Novak 2002)

two solutions to the same problem. *DEFENDEX-ESPGX* was developed before *BitSignalFabric*; therefore the narrative engine of *DEFENDEX-ESPGX* was used as a conceptual starting point for the logic engine of *BitSignalFabric*. However, because of the inflexibility of the *DEFENDEX-ESPGX* software (see the description of *DEFENDEX-ESPGX* above), and other technical reasons, the narrative engine for *BitSignalFabric* was rewritten from scratch. In the end, some of the improvements made in *BitSignalFabric* were included in the final version of *DEFENDEX-ESPGX*.

b. Software Development

Like *DEFENDEX-ESPGX*, *BitSignalFabric* was developed in Max/MSP/Jitter. However, in order to develop a narrative engine that was scalable and extensible we implemented the *BitSignalFabric* logic engine in JavaScript using the *js* (embedded JavaScript) object in Max/MSP/Jitter. The use of JavaScript for the development of the logic engine of *BitSignalFabric* facilitated a more flexible and dynamic design than was possible with the standard Max objects that were used in the development of the narrative engine of *DEFENDEX-ESPGX*.

Over the life of the project, *BitSignalFabric* underwent two manifestations that were of a similar software design. The software architecture of the two manifestations of *BitSignalFabric* is structurally similar to *DEFENDEX-ESPGX* (see Figure 35). There are three global areas that manage and provide an interface for input, images, and sound in the *BitSignalFabric* software. Sound output is also controlled directly by SuperCollider, which communicates with the Max/MSP/Jitter environment bidirectionally via OSC. The transmodal aesthetic criterion described

above is the responsibility of the *world* authors (i.e. contributors) and therefore encapsulated within the *worlds*.

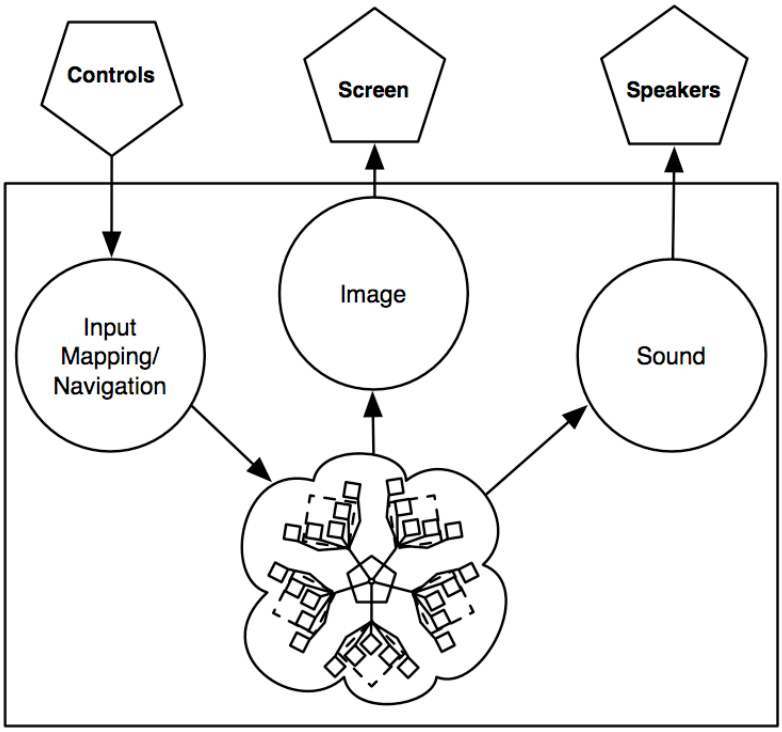

Figure 35. Software Architecture of *BitSignalFabric*.

c. Narrative

The diagram on the left-hand side of Figure 36 represents the narrative logic of the first manifestation of *BitSignalFabric*. In this manifestation *worlds* are viewed one at a time. Users move between *worlds* either by activating a trigger within a *world*, or by leaving the bounds of the current *world*. When the *world* changes the logic engine chooses the next *world* randomly. There is no transition logic; therefore *worlds* change in a "jump-cut" fashion. Also there is no connection between the

worlds, actions that take place in one world have no effect on the other *worlds* of *BitSignalFabric*.

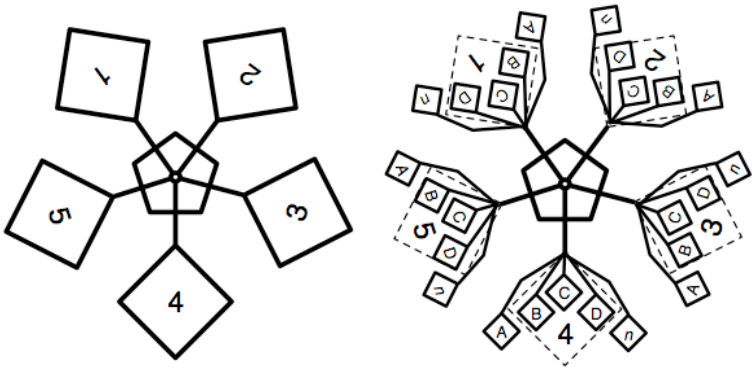

Figure 36. Diagrams of the logic engines of the two manifestations of *BitSignalFabric*.

The second manifestation of *BitSignalFabric*, called *contamination,* addressed the issue of causality by allowing objects from the various *worlds* to be mixed together. Conceptually, it was hypothesized that the *worlds* would become more integrated and connected when they were contaminated by each other. This was achieved by separating all of the *worlds* into two categories, environments and objects. Environments are architectural-scale objects that house or demarcate the territory the other, smaller objects inhabit. The organization of environments and objects is shown in the diagram on the right-hand side of Figure 36, with the dotted diamonds representing environments and the solid diamonds labeled "A" through "*n*" representing objects.

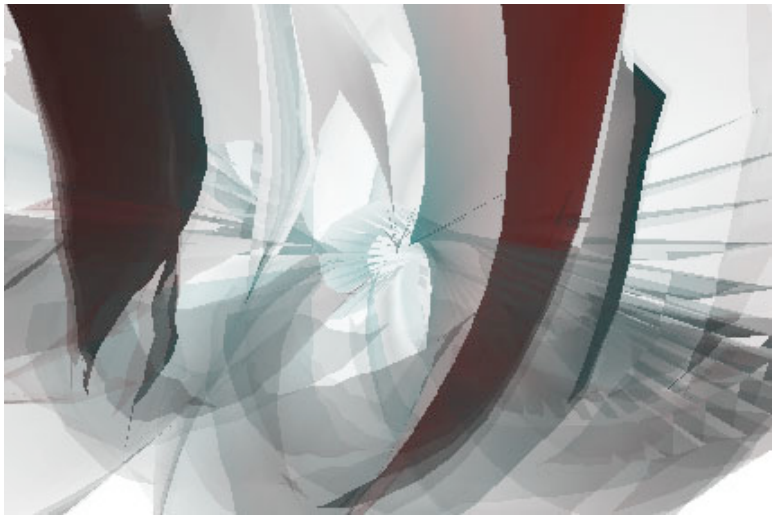

Figure 37. *t0 coincident,* a *BitSignalFabric* environment/world. Used by permission ©2005 Graham Wakefield

d. Comparison of Narrative Models

With the exception of the manner of organization and display of *worlds*, the narrative logic of *contamination* is the same as the narrative logic in the first manifestation of *BitSignalFabric*. A *world* in the logic engine of *contamination* is a randomly chosen environment and mix of objects, resulting in a kind of algorithmic collaborative joining of the contributor's *worlds*.

The mixing of *world* elements from different contributor's *worlds* made a better connection between the worlds in *contamination* than was made between the *worlds* in the first manifestation of *BitSignalFabric*. However, there was still a lack of connection between states. This lack of connection was primarily due to the fact that the *universe* had no model for memory storage and state recall. Because of this lack

of memory there was no way to return to a previous state and there was no causality across states; each new state started with a clean slate.

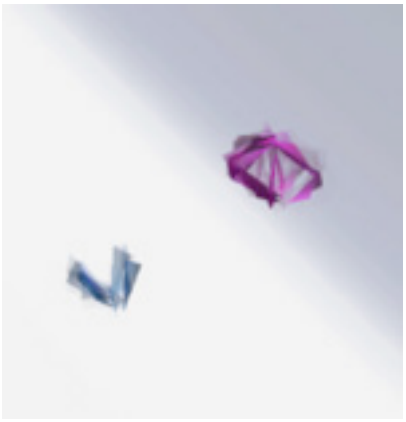

Figure 38. Alien birds from the *AlienAviary,* an example of objects in *BitSignalFabric*.

Another problem with *contamination* was its simplistic (i.e. random) selection algorithm and its tendency towards a total contamination between the worlds, which produced a similar texture between states. This lack of dynamic change resulted in a kind of flat grey effect where one state was difficult to distinguish from another.

Finally, as mentioned, there was no implementation of transition logic in *contamination*, so that state changes still took place in a "jump-cut" fashion. Because of the lack of transitions, lack of state memory, and the grey effect produced by the random logic engine, transitions became unclear. Rather than perceiving a state change during transitions, the world would seem as if it had suddenly shifted, leaving the user disoriented and confused.

e. Conclusion

Besides the issues described above (or rather because of the exposure of the issues described above) the influence of *BitSignalFabric* on the future work of the artists involved was significant. In addition to being a precursor to the *Universe Model,* the *universe* of *BitSignalFabric* was also the precursor to software architectures and works by the other collaborators. Some examples include Graham Wakefield and Wes Smith's *Cosm toolkit*[40] (and the many projects realized in UCSB's AlloSphere using the *Cosm toolkit*), and works such as John Thompson's *Terrains for Percussion and Electronics* and *Sonofusion for Overtone Violin* (Thompson 2006)[41].

3. Precursors: Conclusion

The similarity in the software infrastructures of *DEFENDEX-ESPGX* and *BitSignalFabric* provided evidence that disparate nonlinear works could be developed using a similar construct. This revelation motivated the pursuit of a generalized abstract model for the analysis and implementation of nonlinear narrative works that resulted in the current form of the *Universe.*

The software infrastructures of *DEFENDEX-ESPGX* and *BitSignalFabric* also provided a test bed for the evaluation and development of the components needed in

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[40] The *Cosm toolkit* was designed to facilitate the development of content for use in UCSB's immersive lab, the *AlloSphere* (http://www.allosphere.ucsb.edu/). The *Cosm toolkit* is a refinement and extension of *BitSignalFabric*, including an encapsulated software solution for navigation logic, 3-D audio, and stereoscopic projection. (Wakefield et al. 2008)

[41] Concepts, aesthetics and portions of the code from both BitSignalFabric and *DEFENDEX-ESPGX* were used in the development of *Sonofusion for Overtone Violin*. (Thompson 2006)

the description of the *Universe Model.* In addition to the design traits that carried over to the *Universe Model*, the software infrastructures of *DEFENDEX-ESPGX* and *BitSignalFabric* lacked many characteristics, such as transitions, centralized communications and control, and a flexible logic engine, which (after careful evaluation) were included as well. Therefore the *Universe Model* was built on the strengths, as well as on improving on the weaknesses exposed during the development and implementation of the software infrastructures of *DEFENDEX-ESPGX* and *BitSignalFabric*.

Finally, a significant contribution of *DEFENDEX-ESPGX* and *BitSignalFabric* to the development of the *Universe Model* is that they were the origin of the concepts and terminology used to describe the *Universe.* In the development of the *Universe Model* these concepts and terminology were expanded and refined based on a methodical approach to software design and a transmodal aesthetic for the purpose of the development of interactive and immersive nonlinear artworks.

C. Implementations

The two works presented in this section, *An Uncommon Affair At Tooting Bec Common* and *Quasar,* are examples of two disparate works that were created, from concept to implementation, using the *Universe Model* as a basis for development.

1. An Uncommon Affair At Tooting Bec Common

Figure 39. Promotional Image For
An Uncommon Affair At Tooting Bec Common

An Uncommon Affair At Tooting Bec Common is a user navigable nonlinear film presented on four screens in an immersive installation environment. The interactive film is composed of four tightly wound storylines strategically written so that the plot points can be interleaved, and presented backwards or forwards in time. Each of

the four screens presents a unique path through the story space of the film that is directed by users interacting with an electronic ouija board interface.

The story terrain and presentation of *An Uncommon Affair At Tooting Bec Common* is a stratified and bifurcated nonlinear terrain of data knowledge. As implied, the presentation of the four storylines unfolding on the screens is simultaneous. The cumulative effect of this simultaneity results in an indeterminacy that forces the viewer to parse, interpret, and perceptually navigate the mass of rhizome-structured information encountered in the installation.

While a state of indeterminacy between the screens exists, the connection between the screens is not random. As participants direct the stories, the storylines interact with each other as well. Synchronous, asynchronous, convergent and divergent patterns occurring between the screens are highlighted as meta-events that affect the behavior of the installation work as a whole, providing an ever changing information texture, which shifts as the combined story space unfolds. This textured environment has a cumulative effect that immerses the participants within the story terrain of the film.

a. Development

The development of *An Uncommon Affair At Tooting Bec Common* took place between 2005 and 2007, with the initial concepts going back as far as 2002. The development involved several stages that combined the process of writing and production of a feature film with the process of hardware and software development.

The abstraction of the software developed for *An Uncommon Affair At Tooting Bec Common* resulted in the crystallization of the definition of the *Universe*, as described in Chapter III.

The aesthetics and technical experiments of the past works described above provided a starting point for the development of the software engine for *An Uncommon Affair At Tooting Bec Common* (a.k.a. the *RBUniverse*[42]). The previous projects software models strengths and weaknesses were assessed and taken into account as part of the development of the RBUniverse.

Initially *An Uncommon Affair At Tooting Bec Common* was not created for the sole purpose of developing the *Universe*. However, because of the inflexibility of the code developed for previous projects, the software for *An Uncommon Affair At Tooting Bec Common* was developed the intent of making a model that would be scalable and transferable to other projects.

The main contribution that *DEFNDEX-ESPGX* and *BitSignalFabric* provided to the development of *An Uncommon Affair At Tooting Bec Common* was the concept of the *universe*, a design model for the development of nonlinear immersive artworks. Although at the point of the early development of *An Uncommon Affair At Tooting Bec Common* a conceptual model for the *Universe* existed*,* the *Universe*

Model itself was still not clearly defined. There was, however, a general Model-View-Controller design, which encapsulated the logic engine of the *universe* and separated out the *views* and controls. Therefore, the *universe* was a primitive precursor to the Embedded State Machine as described in Chapter III.

Equally beneficial to the conceptual design of the RBUniverse and the *Universe Model* were insights drawn from the analysis of the shortcomings of the *universe* of *DEFNDEX-ESPGX* and *BitSignalFabric*. Upon evaluation, the weakest aspect of the *universe* of *DEFNDEX-ESPGX* and *BitSignalFabric* was the primitive narrative logic. Although the weighted-probabilistic narrative of *DEFENDEX-ESPGX* proved to be more sophisticated than the random narrative of *BitSignalFabric*, both narrative implementations suffered from a lack of sophistication.

The unsophisticated narrative of the *universe* of *DEFNDEX-ESPGX* and *BitSignalFabric* can be attributed to several factors. First of all, the logic engine of the *universe*, which was basically a giant switch-case with a random number generator, needed to be expanded in order to handle more complex narratives. The second issue is the lack of transition logic in the *universe* of *DEFNDEX-ESPGX* and *BitSignalFabric,* which resulted in jarring and disconnected changes in state. Thirdly, as mentioned in the section on *BitSignalFabric*, there was no model for memory storage and state recall, which meant that there was no way to return to a

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[42] The acronym *RB* stands for Rosemary Brown, the name of the main character of *An*

state, and that there was no causality between states. The implementation of the improvements described ultimately became the architecture of the *Embedded Transition State Pattern* of the *Universe Model* as described in Chapter III.

Like *DEFENDEX-ESPGX* and *BitSignalFabric, An Uncommon Affair At Tooting Bec Common* was developed primarily using Max/MSP/Jitter. However, RBUniverse was developed using Java[43], initially by taking advantage of the *mxj* (embedded Java) object in Max/MSP/Jitter, and later as a stand-alone application independent of the Max/MSP/Jitter environment. From the point of view of Model-View-Controller design, the separation of the RBUniverse from the Max/MSP/Jitter environment relegated the Max/MSP/Jitter environment to the role of a view. The use of Java, and the separation of the RBUniverse from the Max/MSP/Jitter environment proved to have several advantages, a) it facilitated the use of true object-oriented design for the development of the RBUniverse, b) it facilitated the distribution of the software of *An Uncommon Affair At Tooting Bec Common* over several systems, c) it facilitated the abstraction of the RBUniverse resulting in the *Universe Model.*

The software environment of *An Uncommon Affair At Tooting Bec Common* is a distributed system composed of the RBUniverse, the *Ouija* application, and four copies of the *Screen* application (see Figure 40). In the system, the RBUniverse

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Uncommon Affair At Tooting Bec Common.

functions as a server, while the Ouija and the Screens are clients. RBUniverse keeps track of the states of the five client applications, while processing requests from the clients, and updating the clients as necessary. The Ouija and Screen applications are *views*, and therefore are only responsible for containing the logic for displaying their view, and sending and receiving the control messages necessary to maintain their view.

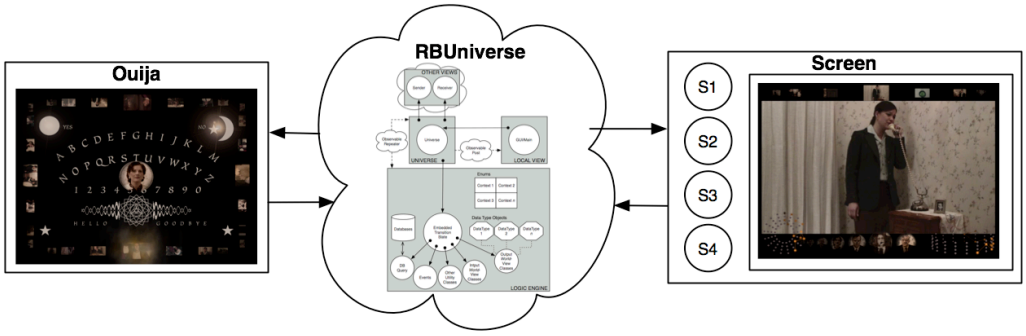

Figure 40. Software overview of
An Uncommon Affair At Tooting Bec Common

b. Story Space

The story space of *An Uncommon Affair At Tooting Bec Common* is composed of four storylines that are centered on events that take place in the lounge of Rosemary Brown. Rosemary Brown is a medium who channels deceased composers and writes down their latest works. Each of the four storylines is a subjective interpretation of the same events taken from the perspective of a different character in the story. The

[43] http://java.sun.com/

roles of the characters (i.e. protagonist or antagonist) and the unfolding of events of the story change depending on which storyline is being followed.

Because the plot points of the storylines are designed to be interchangeable and comprehensible when presented forwards or backwards in time, it is possible to explore the story space nonlinearly. The interchange of plot points through user navigation is analogous to the swapping of lines in Raymond Queneau's *Cent Mille Milliards de poèmes* (see Chapter II). As the story space is nonlinearly explored, roles shift and ambitions change; heroes become villains, villains become heroes, and the line that separates them becomes blurred.

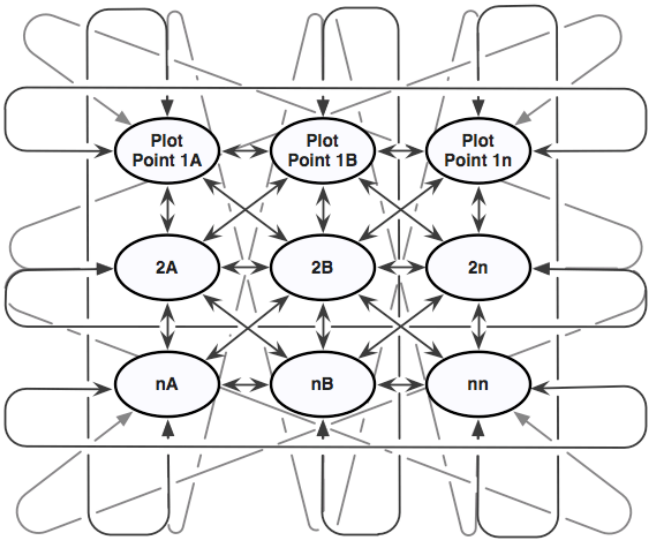

Figure 41. A multi-perspective map-like plot structure.

The structure of the story space of *An Uncommon Affair At Tooting Bec Common* can be likened to a map. Figure 41 is an abstract representation of a multi-

perspective map-like plot structure, similar to the map narratives described in the structures section of Chapter II. The perspectives labeled “A” through “*n*” and the plot points numbered “1” through “*n*” are intended to show that the structure is indefinitely extendable. When traversing the map only stepwise movement is possible, but it is possible to move in any direction. In order to get to a point that is more than one point away it is necessary to go through any connecting points in between.

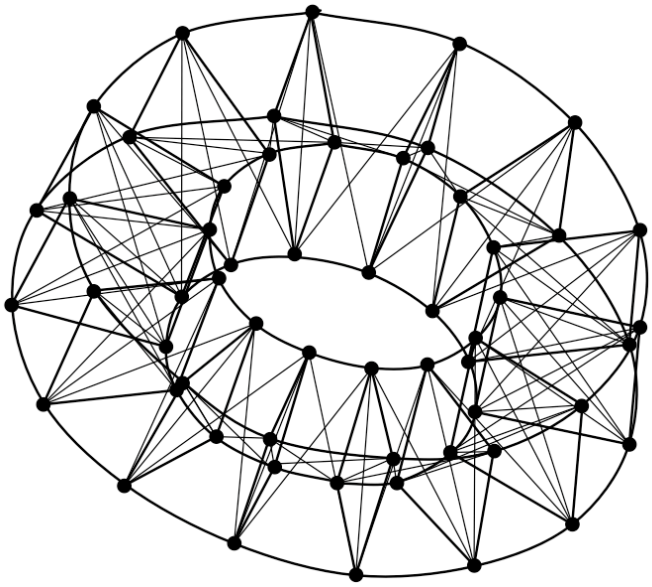

Figure 42. A multi-perspective map-like plot structure in 3-D.

The diagram in Figure 41 would quickly become conceptually unclear when trying to represent the architecture of narrative structures that have greater than three plot points or perspectives. In order to plot larger narrative structures more accurately it is conceptually necessary to represent them as multidimensional structures. Such is the case in Figure 42, which shows a story space with fourteen

plot points and four perspectives as a torus. In the diagram, the black circles are plot points, rings are perspectives, and the interconnecting lines represent the path of travel between the points. There is no significance to the positioning of perspectives as inside or outside rings, or upper or lower rings.

Although the diagram in Figure 42 presents a superior method of showing the narrative architecture of a multi-perspective narrative for the conceptual understanding of a story, for the purposes of defining the map of a story space it is more useful if the torus is flattened out. The diagram in Figure 43 is a flattened map of the story space of *An Uncommon Affair At Tooting Bec Common*. Similar to the plot diagram in Figure 41, the map in Figure 43 is organized with the perspectives running left to right and the plot points running top to bottom. In addition, the plot points are organized into two types; front-story and back-story plot points, represented by the rectangles and ovals respectively. Front-story plot points push the story towards the climax and denouement, while back-story plot points provide additional story details such as character histories, hidden motivations, and so on.

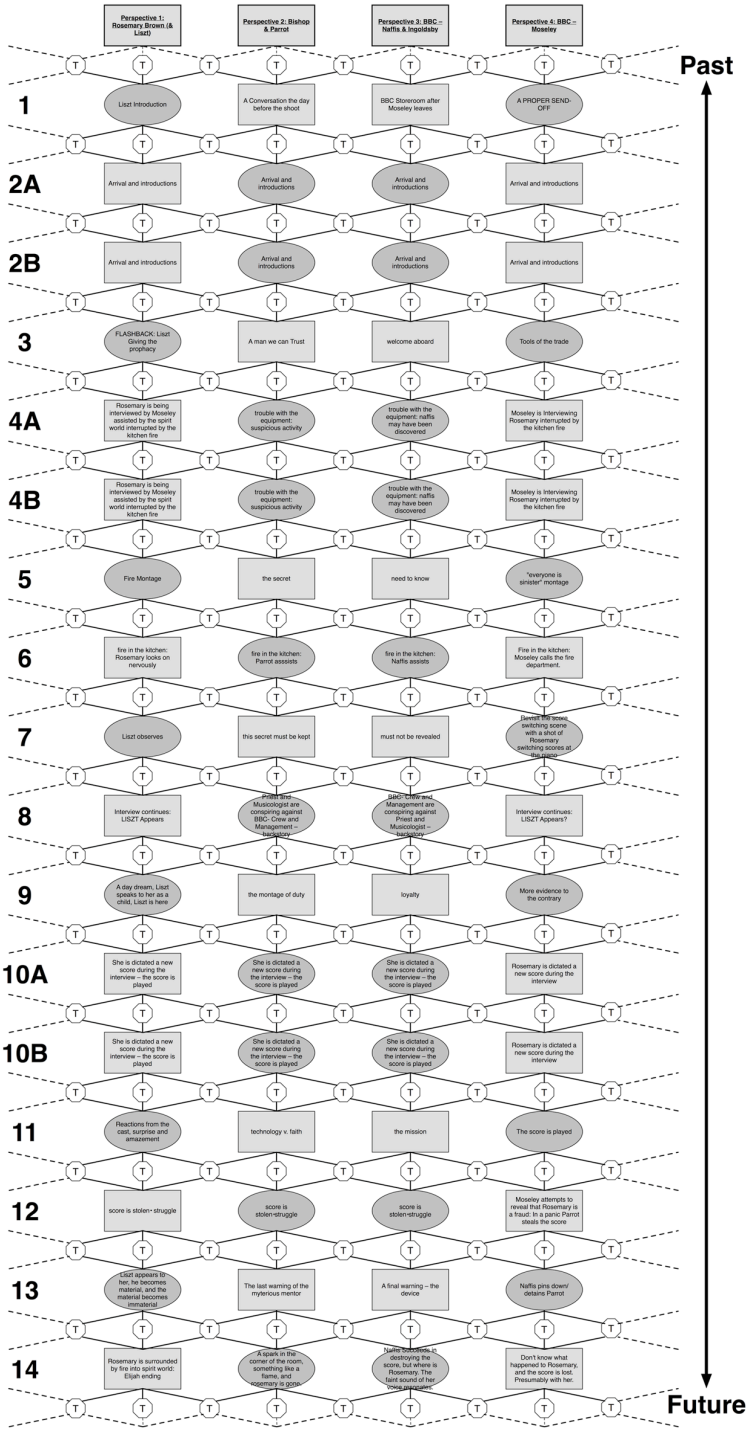

Figure 43. Plot map of the story space of *An Uncommon Affair At Tooting Bec Common*.

Another important addition to the story space map is the representation of transitions, shown as circles with "T's" in them in Figure 43. All transitions in the map are essentially the same transition, occurring between every scene change. Transitions are generated based on the history of where the story has been and where the story is going. As shown in Figure 44, when a plot point is over, the story moves to the next plot point via the transition. The transition automatically delivers a montage of clips of the past five plot points visited plus the next plot point to be visited in historical order. This provides the user with a brief summary of where the story has been and where the story is going.

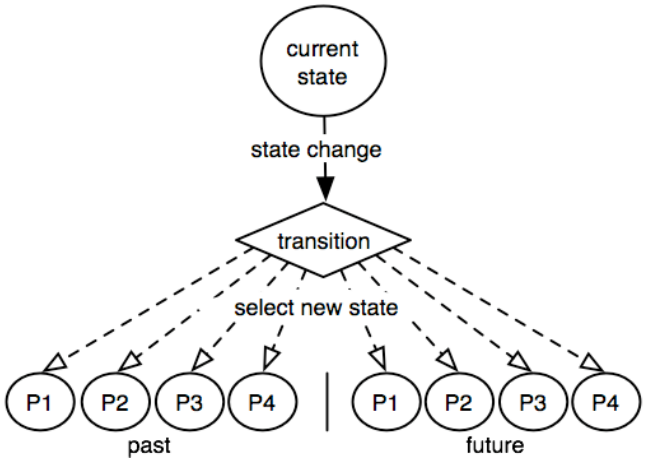

Figure 44. Narrative flow of *An Uncommon Affair At Tooting Bec Common*.

In software, the *World*-View class called *Screen* uses the map in Figure 43 to keep track of the story trajectory. There is an instance of the Screen class for each screen. In the Screen class plot-points are stored in a data-type called a *Scene*.

Scenes store all the data needed by the *World*-View class to execute a request. When the Screen class receives a request it determines the next Scene to play according to the story map logic and uses the tags associated with the scene to determine the execution of the scene (see Figure 45 for an illustration of story tags). In other words, the Screen class uses the scene name to determine *what* Scene to tell the view application to play next, while other tags are used to tell the view application *how* to play the next Scene.

Perspective 3

edit | copy | delete | new

	#	Move	Name	Character1	Character2	Storyline	Related	Bias
	1		P3-01	INGOLDSBY	NAFFIS	FRONT	P4-01	SKEPTICAL
	2		P3-02-A	NAFFIS	INGOLDSBY	BACK	P1-02-A, P2-02-A, P4-02-A	SKEPTICAL
	3		P3-02-B	NAFFIS	INGOLDSBY	BACK	P1-02-B, P2-02-B, P4-02-B	SKEPTICAL
	4		P3-03	INGOLDSBY	NAFFIS	FRONT	P2-03	SKEPTICAL
	5		P3-04-A	NAFFIS	INGOLDSBY	BACK	P1-04-A, P2-04-A, P4-04-A	SKEPTICAL
	6		P3-04-B	NAFFIS	INGOLDSBY	BACK	P1-04-B, P2-04-B, P4-04-B	SKEPTICAL
	7		P3-05	INGOLDSBY	NAFFIS	FRONT	P2-05	SKEPTICAL
	8		P3-06	NAFFIS	INGOLDSBY	BACK	P1-06, P2-06, P4-06	SKEPTICAL
	9		P3-07	INGOLDSBY	NAFFIS	FRONT	P2-07	SKEPTICAL
	10		P3-08	NAFFIS	INGOLDSBY	BACK	P1-08, P2-08, P4-08	SKEPTICAL
	11		P3-09	INGOLDSBY	NAFFIS	FRONT	P2-09	SKEPTICAL
	12		P3-10-A	NAFFIS	INGOLDSBY	BACK	P1-10-A, P2-10-A, P4-10-A	SKEPTICAL
	13		P3-10-B	NAFFIS	INGOLDSBY	BACK	P1-10-B, P2-10-B, P4-10-B	SKEPTICAL
	14		P3-11	INGOLDSBY	NAFFIS	FRONT	P2-11	SKEPTICAL
	15		P3-12	NAFFIS	INGOLDSBY	BACK	P1-12, P2-12, P4-12	SKEPTICAL
	16		P3-13	INGOLDSBY	NAFFIS	FRONT	P2-13	SKEPTICAL
	17		P3-14	NAFFIS	INGOLDSBY	BACK	P1-14, P2-14, P4-14	SKEPTICAL

Figure 45. Scene map for 3rd perspective.

The Screen class determines how to play a Scene by using Scene tags to determine synchronous, asynchronous, convergent and divergent patterns occurring between the current Scene and the Scenes playing on other Screens. The interconnection between scenes is coordinated by the Logic Engine and determined upon request of any of the instance of the Screen class.

Screen classes are unaware of how Scenes are executed by the view application. When a request is received the view executes the request and then notifies the Logic Engine when a task is completed. The Logic Engine then in turn executes a state change as appropriate to the current state of the entire system.

c. Interaction

As described in the previous section, each of the four screens in the installation environment presents a unique nonlinear trajectory through the story space of the film. Story interaction takes place via an interactive electronic ouija board, which is a touchscreen embedded in a table at the center of the four screens (see Figure 46).

The ouija board is capable of controlling the outcome of the four story trajectories. Viewers interactively explore the story space on each screen by choosing the perspective and a future or past temporal flow that the story path will follow when changing scenes. The selection process is executed sequentially for each screen. A smoke-like cursor (shown at the bottom of Figure 46) indicates which screen is currently being set. Screens correspond to the four edges of the Ouija board, which are orientated to face the screen parallel to the corresponding edge.

Figure 46. Stage one of the Ouija board interface from the *An Uncommon Affair At Tooting Bec Common* installation.

The selection of perspective and temporal flow is a two-stage process. As a user runs a finger back and forth across the screen the image of the character in the center of the ouija board changes (see Figure 46), which corresponds to the perspective being selected. Once a desired perspective appears, the user selects the perspective by selecting one of the flashing stars that appear over the "YES" and "NO" areas of the ouija board. Upon selection the board becomes animated and the character in the middle moves to the center of the star in the bottom middle of the screen as in Figure 47.

Figure 47. Stage two of the Ouija board interface from the *An Uncommon Affair At Tooting Bec Common* installation.

During the second stage of the selection process the user chooses the temporal flow of the story in a similar fashion as was done when choosing the perspective. After the perspective is selected and the character moves down to the star a clock appears. The hands of the clock move forwards and backwards through time as the user runs a finger back and forth across the screen. Right-hand motion causes the clock to move forwards in time, and left-hand motion causes the clock to move backwards in time. The selection of the temporal flow is completed when the user selects one of the flashing stars that appear over the "HELLO" and "GOODBYE" areas of the ouija board.

Upon selection the board becomes animated once again. The clock moves down into the star in the same location as the image of the character. At this point the image of the moving clock and the image of the character merge and drop down to the bottom of the ouija board. The merged clock and character image then rotates to the appropriate screen as indicated by the smoke-like cursor and drop into the edge of the screen. Once the merged clock and character image disappears into the edge of the screen the screen is set. The smoke-like cursor then rotates to the next screen position, and the selection sequence starts again.

In the RBUniverse the managing of user input and ouija animations is separated into two *World*-View classes, called *InputMapping* and *Ouija* respectively. The InputMapping class is responsible for the mapping of all input data based on the current state of the board, which is maintained by the Ouija class. The Ouija class is also responsible for triggering animations, which are "played" to the Ouija view application via a stream of control messages.

d. Visualization & Feedback

Besides playing scenes as appropriate, the Screen applications provide visual feedback to the viewer that informs them of the current location and trajectory of the story. Visualization is realized with several indicators shown on the top and bottom of the screen in Figure 48.

Figure 48. A Screen from the *An Uncommon Affair At Tooting Bec Common* installation.

The two wheels on the opposing sides of the bottom of the screen in Figure 48 are two different visualizations of the story map. The map on the left is a flattened version of the map on the right. Both maps are made-up of four rings that indicate the four major perspectives of the story. Movement around the rings represents the movement through the story with clock-wise motion mapping to movement into the future, and counter-clockwise movement indicating movement into the past. A yellow line indicates the trajectory through the story space with the gradient of the line from light to dark indicating the history of the story trajectory going from present to past.

The two bands of images at the top and bottom of the screen provide a pictorial indicator of the story history from present to past. The pictorial history of the top band is made of films that correspond to the last five scenes visited, the current scene, and the next scene in the future. The current scene is in the middle and the future scene just to the right. As the current scene finishes, the bands shift to the left, the future scene becomes the current scene, and likewise the rest of the scenes shift one step into the past.

The band of images at the top of Figure 48 provides a visual connection between the activity on the Ouija board interface, and the activity on the Screen. The four bands of movies surrounding the Ouija board each correspond directly to a screen. For example, the band of movies at the bottom of Figure 46 corresponds to the band of movies at the top of Figure 48. The two bands are completely synchronized, as the scene changes the bands on both screens shift as described above.

The bottom band on the screen (as shown in Figure 48) shows the history of selected perspectives and temporal flow. Merged clock and character images are ordered from right to left with the right representing the next perspective and temporal flow to be chosen, the next image representing the current perspective and temporal flow, and the rest showing the past perspectives and temporal flows as they move to the left.

Like the top band of the screen, the bottom band is directly connected to the activity unfolding on the Ouija board. As the merged clock and character image disappears into the edge of the Ouija board, the merged clock and character image appears at the top of the screen and continues to move to the bottom of the screen. Once it reaches the bottom of the screen it joins the band in the far most right position, which is indicative of the next story trajectory to be played.

As mentioned above, *views* are responsible for maintaining the visualizations and are therefore responsible for maintaining all of the logic needed to display the scenes and visualizations as described. However, screens are not responsible for databasing or archiving. The tracking of the history of the story terrain is the responsibility of the RBUniverse.

The RBUniverse uses databasing for more than keeping track of the state of the various screens in the installation. Behind the scenes of the RBUniverse data is collected on the story trajectories and interaction that is used to later replay, analyze, and ultimately optimize the overall behavior of the system.

e. Overview of the RBUniverse

The diagram in Figure 49 provides an overview of the inner workings of the RBUniverse, a stand-alone Java application that is the manifestation of the *Universe Model* described in Chapter III. As shown in the graph, the architecture of the RBUniverse maps directly to the abstract structure of the *Universe Model*.

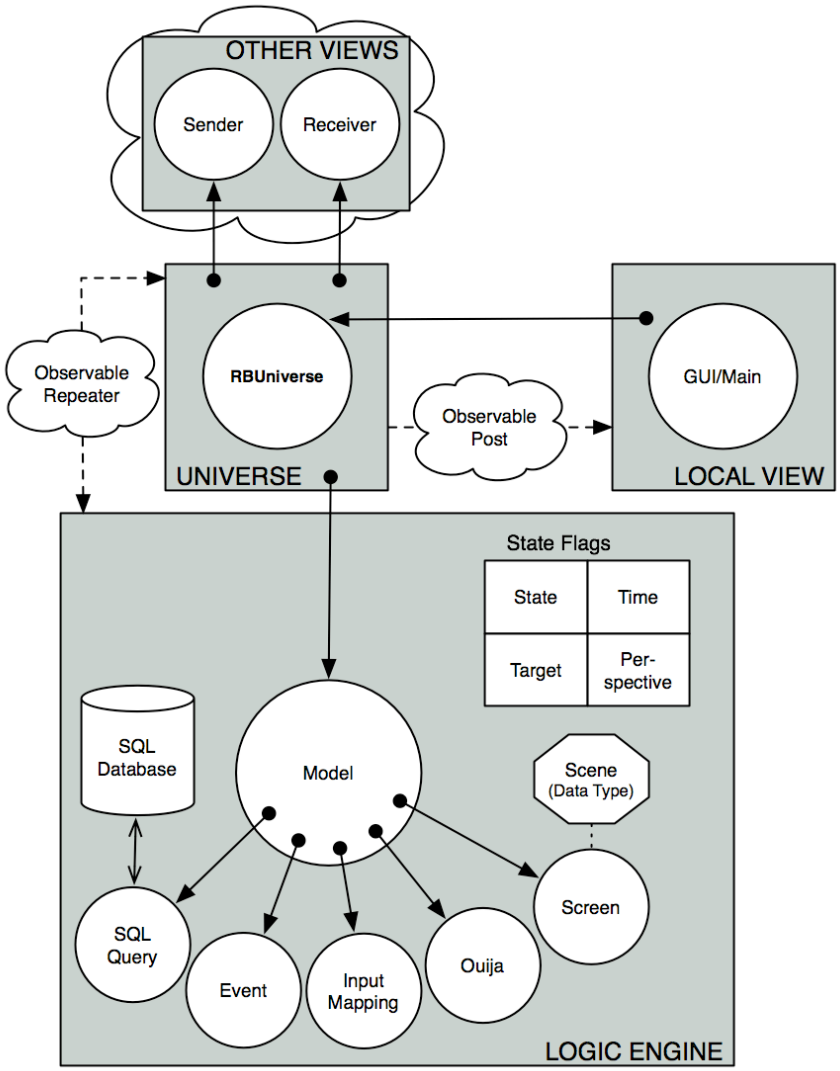

Figure 49. A graph of the RBUniverse.

The core functionality of the RBUniverse is contained in the Logic Engine. InputMapping, Ouija, and Screen are *World*-View classes responsible for the encapsulation of all communications and state storage for their respective *views*. Event is an event handler class that handles the sequencing of events. The SQLQuery class is the database class, responsible for providing an interface to the

MySQL database that stores the Scenes, histories, and sequences used by the Logic Engine of the RBUniverse.

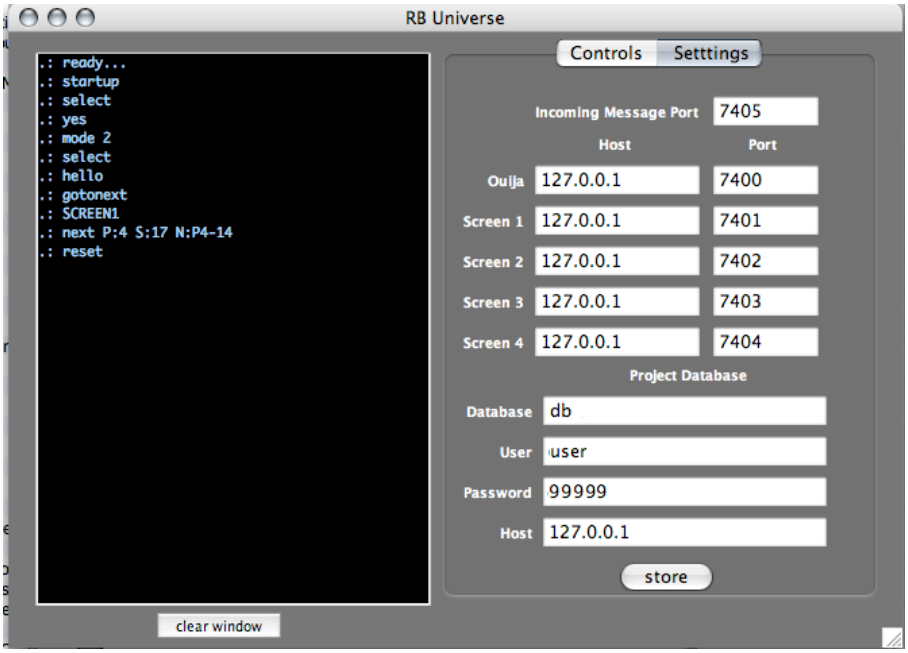

Figure 50. A screenshot of the RBUniverse GUI/Main.

The RBUniverse class also provides an interface to the inner workings of the Logic Engine to the local GUI/Main and the *views*. While the GUI/Main is implemented locally, the RBUniverse communicates with the view applications via the Sender and Receiver classes, which are encapsulations of an implementation of the OpenSoundControl protocol.

f. Conclusion

An Uncommon Affair At Tooting Bec Common represents the crystallization and first implementation of the *Universe* hypothesis. The connection between the theory

and praxis of the *Universe* used for the development and implementation of *An Uncommon Affair At Tooting Bec Common* facilitated the conception and realization of a rhizome-like structure in the work. The use of the *Universe* as a basis for *An Uncommon Affair At Tooting Bec Common,* provided a way of formally evaluating and testing the integrity of the work, as well as providing a methodology for the concept of the work to manifest in physical form.

Based on the *Universe*, the unfolding narrative of *An Uncommon Affair At Tooting Bec Common* was composed of an intricate stratified system of formalized, indeterminate, and montage-like operations. The navigation of the story space of *An Uncommon Affair At Tooting Bec Common* is at once analogous to the combinatorial swapping of lines in Raymond Queneau's *Cent Mille Milliards de poèmes,* as it is the branching navigation of a hypertext novel such as Michael Joyce's *afternoon, a story*, and the cut-ups of William S. Burroughs.

The structure of *An Uncommon Affair At Tooting Bec Common* is composed of an intricate stratified system as well. Synchronous, asynchronous, convergent and divergent patterns occurring between the screens form a web-like indeterminacy in the installation space forcing the user to perceptually make connections between the stories through perceptual choice. Therefore the indeterminate environment leaves the unfolding of events open to interpretation much in the spirit of Cage's chance operations, or Kaprow's *Untitled Guidelines for Happenings*.

Finally, the ouija board provides the user with the proverbial pebble that is used to disrupt and contribute to the unfolding of the layered *world* systems of the rhizomatic *Universe* of *An Uncommon Affair At Tooting Bec Common*. This layered system of interaction provides the user with a deeper sense of agency, which helps to immerse the user in the *world* of the story space of *An Uncommon Affair At Tooting Bec Common*, a *world* that is constructed from a combination of the information space of the work and their imagination.

Thus in context of the *Universe*, *An Uncommon Affair At Tooting Bec Common* can be understood as a structure of *worlds* (in the form of an indeterminate navigable narrative), *views* (in the form of the screens and sound system), and *transformations*. These components form a rhizomatic structure that exhibits the emergent qualities of the layering of the operations, structures, and characteristics of nonlinear narrative described in described Chapters II and III above.

2. Quasar

Figure 51. Jean-Michel Crettaz. *Quasar*, Southern California Institute of Architecture Gallery, Jan. 25th – March 9th 2008. Photo © 2008 Joshua White.

> Quasar is an immersive light and sound space made from prototype membranes and realized as an interactive light/sound object and comprised of a dense array of interlinked elements describing an intricate three-dimensional structure. The gallery is fitted with sensors that draw real-time data from the installation and the people within the exhibition, which is then synchronized with streamed real-time data of solar activity and nuclear processes provided by SLAC and NASA. This information is then fed back into the object through layers of LED strands, re-visualizing the space in order to create an interactive spatial experience. (Crettaz 2008)

Conceived of and created by Jean-Michel Crettaz, *Quasar* was developed in collaboration with Jean-Michel Crettaz, Aaron Bocanegra, Duly Lee, and myself between November 2007 and January 2008[44]. Developed for a six-week installation in the gallery at the Southern California Institute of Architecture, *Quasar* was a

massive undertaking that enlisted a team consisting of more than thirty architects, artists, scientists, and engineers. As a member of the development team of *Quasar* it was my role to develop the software, and consult on the various technical aspects of the *Quasar*, including electronics and sensor design, and hardware/software integration.

a. System Overview

The diagram in Figure 52 provides an overview of the systems, called *circuits*, that make-up the *Quasar* installation. There are a total of eight circuits in the *Quasar* layout labeled "A" through "J". With the exception of circuits "A" (the white ambient ceiling lighting) and "B" (the electroluminescent strands that run from the floor to the ceiling), almost all of the circuits in the diagram are under computer control. From the point of view of the *Universe Model*, the *Quasar*'s remaining circuits (labeled "C" through "J") can be considered five different *views*, with circuits "C" through "F" composing one view.

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[44] Although conceptual work and planning for *Quasar* took nearly two years, *Quasar* was under concentrated development between November 2007 and January 2008.

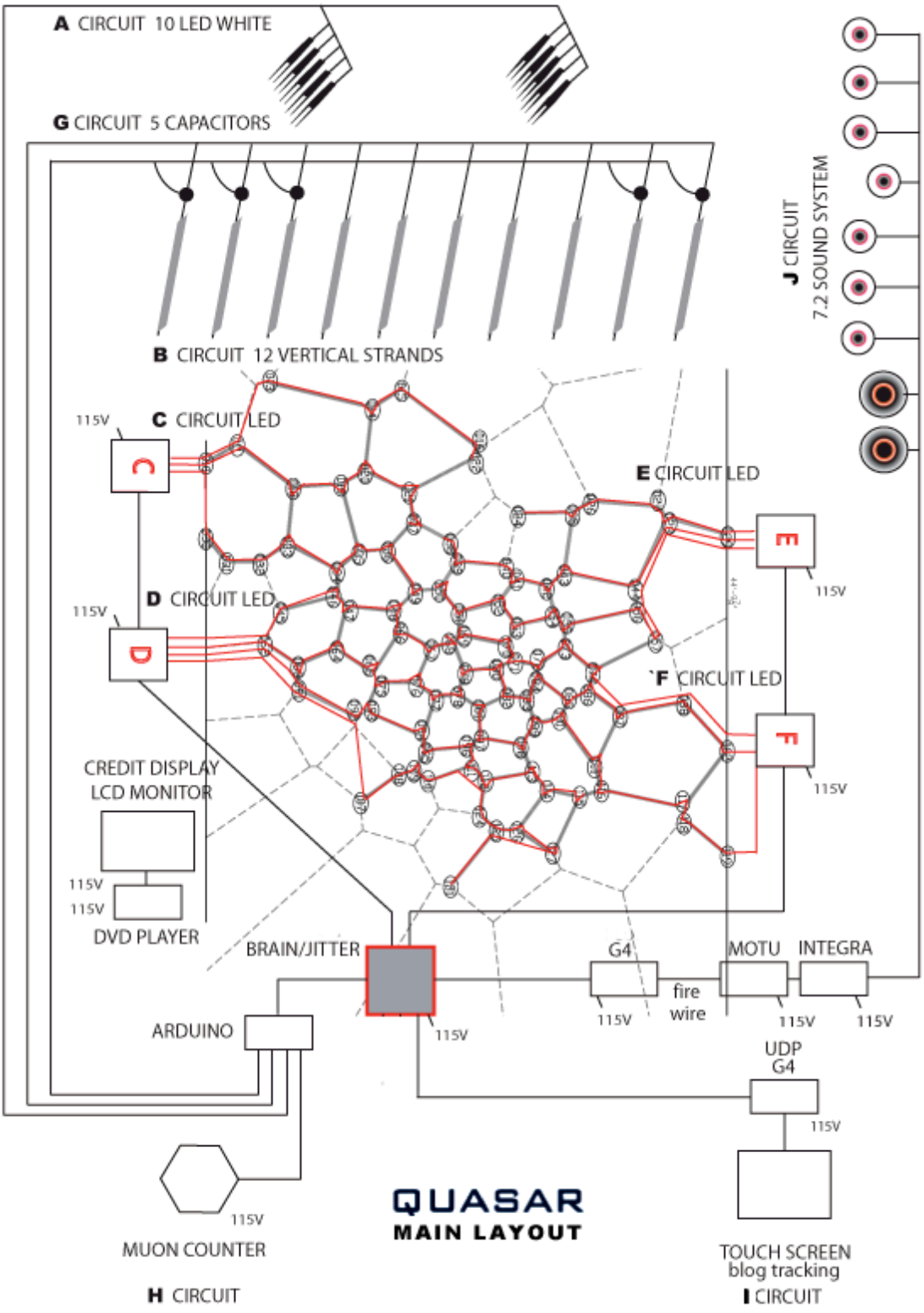

Figure 52. ***Quasar*** **Main Layout. © 2008 Jean-Michel Crettaz.**

b. Narrative Architecture

Light and sound events in the *Quasar* installation are generated as result of a multilayered generative system that forms the narrative structure (i.e. *worlds*) of the work. The narrative structure of *Quasar* is composed of three stratified layers of activity that oscillate through states of high and low intensity, called *modes* (represented by the numbered gradient in Figure 53). All of the various *views* in *Quasar* are connected to bifurcating generative processes oscillating at varying rates, which are in turn affected by the narrative states of the modes. Input controls and state changes do not directly control events in the *Quasar* system, rather they provide a target for the generative systems to follow.

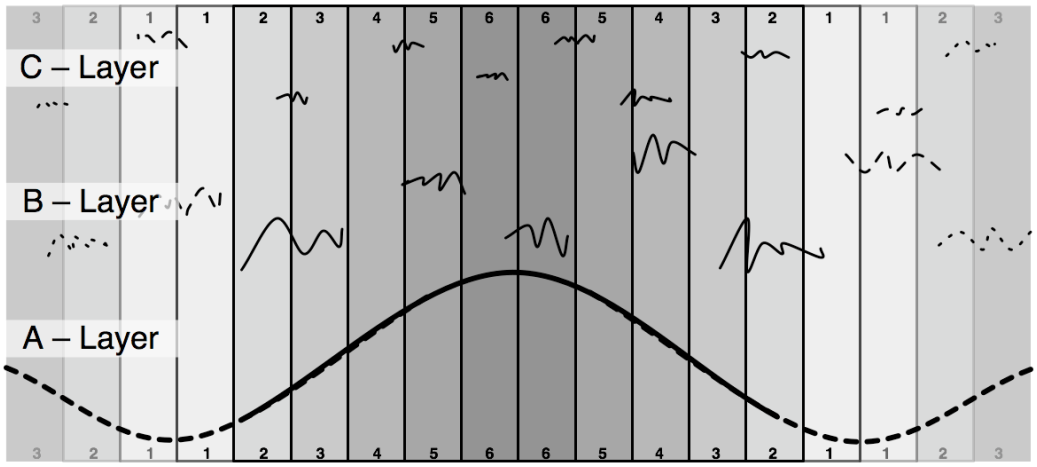

Figure 53. The narrative structure of *Quasar*.

The lowest stratum of *Quasar*'s three narrative layers is called the *A-layer* (see Figure 53). The A-layer provides a basis upon which the other narrative layers are grounded. Constant and slow moving, the A-layer is directly connected to the

modulations of the six modes of intensity, oscillating from high to low, low to high. The B and C-layers of the *Quasar* narrative are higher activity layers stratified according to their duration and frequency of occurrence. As the processes of the higher stratum of the narrative unfold they connect to the activity of the A-layer by changing their behavior in a manner appropriate to the current mode.

Events in the *Quasar* installation occur as flows or interruptions. Fluid events express the unfolding processes of the stratified narrative structure described above, while interruptions disrupt and derail the processes, thereby changing the overall behavior of *Quasar*. Interruptions are triggered by inputs and user actions drawing a connection between the world, our universe, *Quasar*, and the user. The user's connection to *Quasar* is analogous to the observer effect in physics, *Quasar* impossible to observe without affecting its behavior.

c. The *Quasar* Body

The body of *Quasar* (represented by circuits "C" through "F" in Figure 52) is a crystalline web-like honeycomb shaped structure made of acrylic glass and clear vinyl tubing, which extends from wall-to-wall of the gallery (see Figure 51). As shown in Figure 54, the ends of the junctions in the *Quasar* body contain a computer controlled red, blue, and green LED cluster used to illuminate the LED tubes. The combined total of 257 computer controlled LED clusters make the *Quasar* body function as a shifting display of color and light.

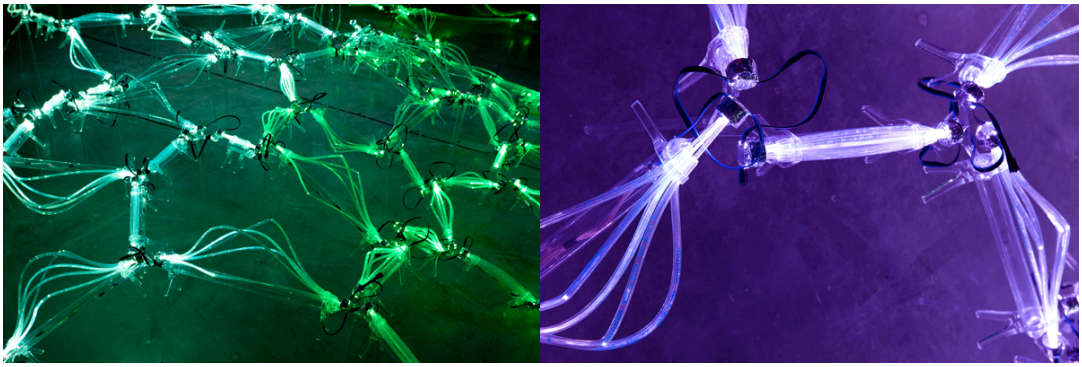

Figure 54. The *Quasar* body. Two views. Photos © 2008 Joshua White.

As light the A-layer is expressed as a large-scale wave-like gesture moving across the body of *Quasar.* The color and the speed of the wave expresses the intensity of the current mode by gradually transitioning from a slow moving blue state to a rapid moving red state, and then returning to blue again, oscillating synchronously with the oscillations of the modes. The B-layer as light is expressed as a bright spot moving across the *Quasar* body in a constantly shifting pattern, called a *LightGesture*. The shifting LightGesture has a speed and quality that changes along with the intensity of the mode. The C-layer as light is expressed as interruptions to the processes unfolding on the *Quasar* body. Appearing as occasional short flashes on the body of the *Quasar,* C-layer events are triggered by cosmic rays detected by the Muon counter (described below).

d. Sound

The sound processes of *Quasar* (represented by circuit "J" in Figure 52) are closely connected to the generative processes of the *Quasar* body. Characterized as long continuous background sounds, A-layer sounds range in quality from low-intensity sparse drones to high intensity dense noises that oscillate in sync with the

narrative modes. A-layer sounds also act as a clock, with their duration determining the duration of the mode. B-layer sounds are medium-length gesture sounds that occur fairly frequently and are spatialized according to the path of the LightGesture patterns described above. C-Layer sounds are of two kinds, some appear occasionally as short sounds at irregular intervals, while others appear as interruptions synchronized with the C-layer light interruptions that flash on the Quasar body.

f. Inputs and Interruptions

The touchscreen, the Muon counter, and the capacitance sensors (connected to the electroluminescent wires) make-up *Quasar*'s input *views*. Shown in Figure 55, *Quasar*'s input *views* interact with the *Quasar* body and the sound *view* as interruptions, mapping directly to the A, B, and C-Layers of activity in the *Quasar* body and sound *views* described above.

Users can actively draw on the *Quasar* body with the touchscreen by pressing with their fingers against the clear acrylic glass. Etched with a map of the *Quasar* body, the user's actions produce a one-to-one gestural effect on the content being displayed on the *Quasar* body, and their relative position on the *Quasar* map. Touchscreen inputs interrupt the B-layer LightGesture by disturbing, adding to, and taking away from the movement of the LightGestures.

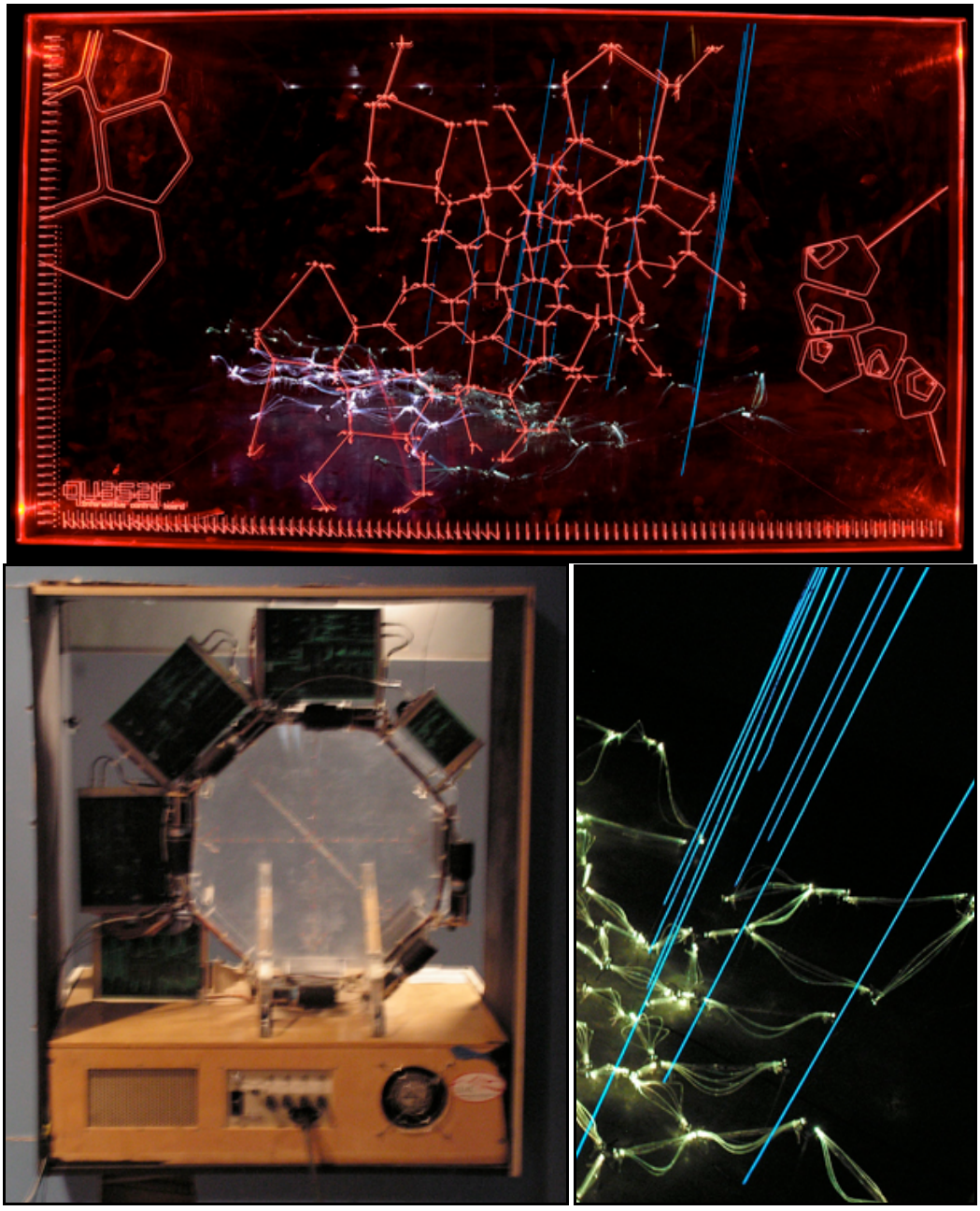

Figure 55. *Quasar* input *views.*
Going counter-clockwise from the top: the touchscreen, the Muon counter, and the electroluminescent capacitance sensors. Photos © 2008 Joshua White

The Muon counter provides real-world data input via the detection of cosmic rays. Cosmic rays consist of high-energy protons hitting our atmosphere from deep space. It is estimated that about 10,000 cosmic rays reach every square meter of the earth's surface every minute [45]. The Muon counter used in *Quasar* is capable of counting cosmic rays from three different directions. When the Muon counter detects a cosmic ray it counts the ray and triggers a C-Layer sound and light event that acts as an interruption to the unfolding processes of the *Quasar* narrative. The sound event and LightGesture triggered by the Muon counter is spatially located in the *Quasar* installation relative to the direction of the cosmic ray detected.

The third mode of input to *Quasar* comes from capacitance sensors connected to the electroluminescent wires that run from floor to ceiling in the *Quasar* installation. Rather than being triggered with direct control, the capacitance sensors are designed with the intent of responding to a viewer's presence. Capacitance input is mapped as interruptions to the process of the A-Layer by changing the current intensity mode. The number and combination of capacitance inputs that are triggered at a time determine how the node is changed. Therefore the number and proximity of viewers within the space of *Quasar* has a direct effect on the overall behavior of the work.

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[45] Source: http://en.wikipedia.org/wiki/Muon, accessed June 2008.

g. Quasar Brain

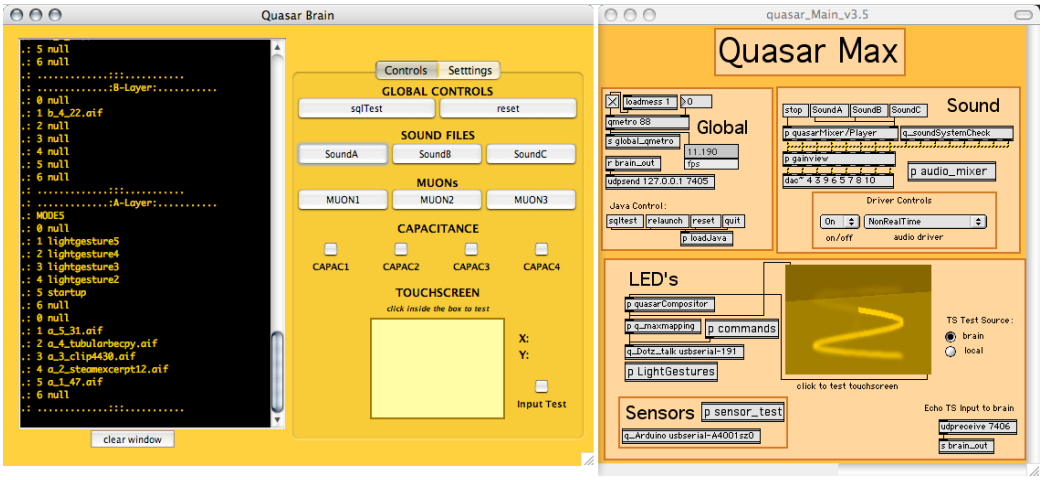

Figure 56. Quasar Brain and Quasar Max.

The software of the *Quasar* is distributed over two applications, called *Quasar Brain* and *Quasar Max*. The Quasar Brain is the *Universe,* which used the software architecture the *Universe Model* described in chapter III as a basis for development. Quasar Max is a view application that encapsulates all the input and output view functions, while providing an interface to the Quasar Brain.

The Logic Engine of the Quasar Brain contains five *World*-View classes that map to the output and input *views* (Light, Sound, Touchscreen, Capacitance, Muon) described in the sections above (see Figure 57). The output *World*-View classes each have a special data type used to represent the states of their *view*. For example, the

Sound class uses a special data type called SoundFile to represent sound files and the tagging data associated with them[46].

The second output *World*-View class, called Light, uses a data type called a LightGesture, which maps to the B-layer behaviors described above. As described in the Database Management section of chapter III, the LightGesture combines content and behavioral control by mapping the qualities of sequences stored in the sequence database of the Quasar Brain. The Light class therefore uses the LightGesture data type to sort, categorize, compare, and identify the LightGesture sequences just as if they were any other data type.

Input *World*-View classes are spread over three classes that are responsible for the encapsulation of all communications and state storage for their *view*. The names of the input *World*-View classes (Touchscreen, Capacitance, Muon) map directly to the input *views* described in the sections above.

The remaining aspects of the Quasar Brain form a familiar implementation of the *Universe Model.* The event handler class handles the processing and sequencing of events. The database class (i.e. SQLQuery) is responsible for providing an interface for the storage of the data types and sequences. And the *Universe* class provides an

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[46] The sound data type database was previously presented in reference to Figure 24, on page 102 of this document.

interface to the inner workings of the Logic Engine for the local GUI/Main and the views, locally and via the Sender and Receiver classes respectively (see Figure 57).

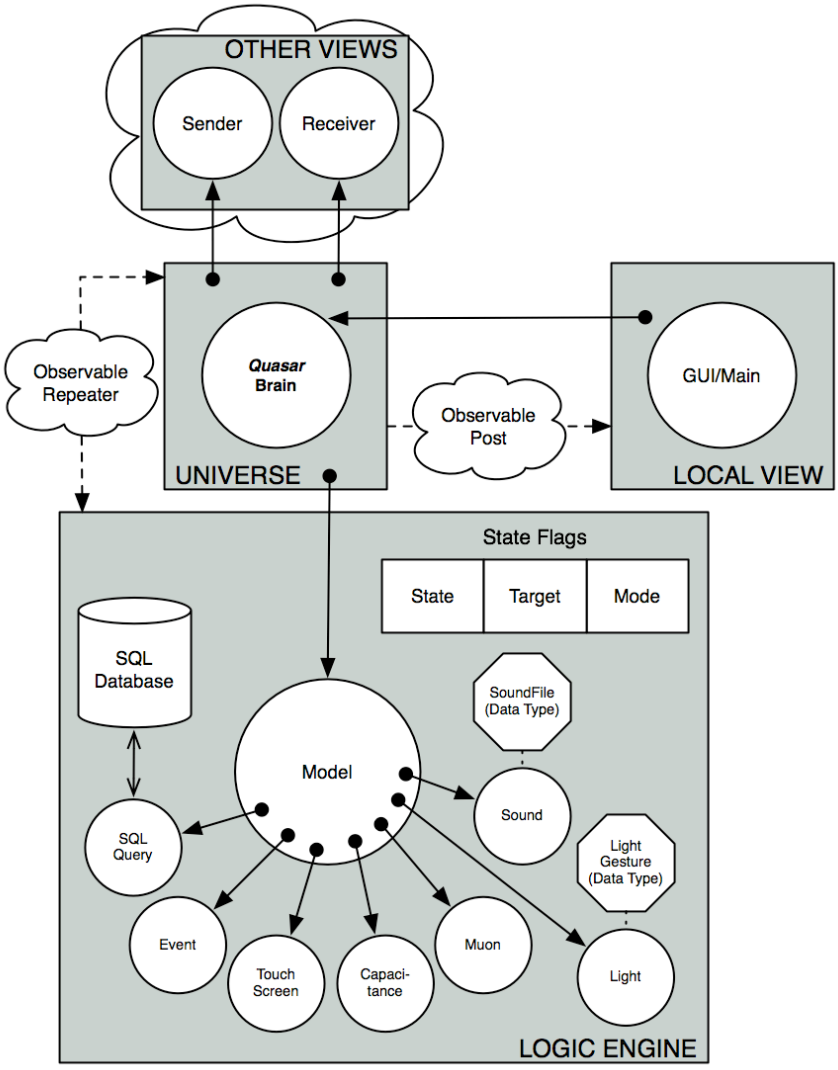

Figure 57. A graph of the Quasar Brain.

h. Conclusion

Working on *Quasar* provided me with the opportunity to test the reusability of the *Universe Model*, which was originally developed in tandem with *An Uncommon Affair At Tooting Bec Common*. The fact that *Quasar* is a very different kind of work, with a very different narrative structure, provides further evidence for the extensibility of the *Universe Model* to a variety of works.

3. Implementations: Conclusion

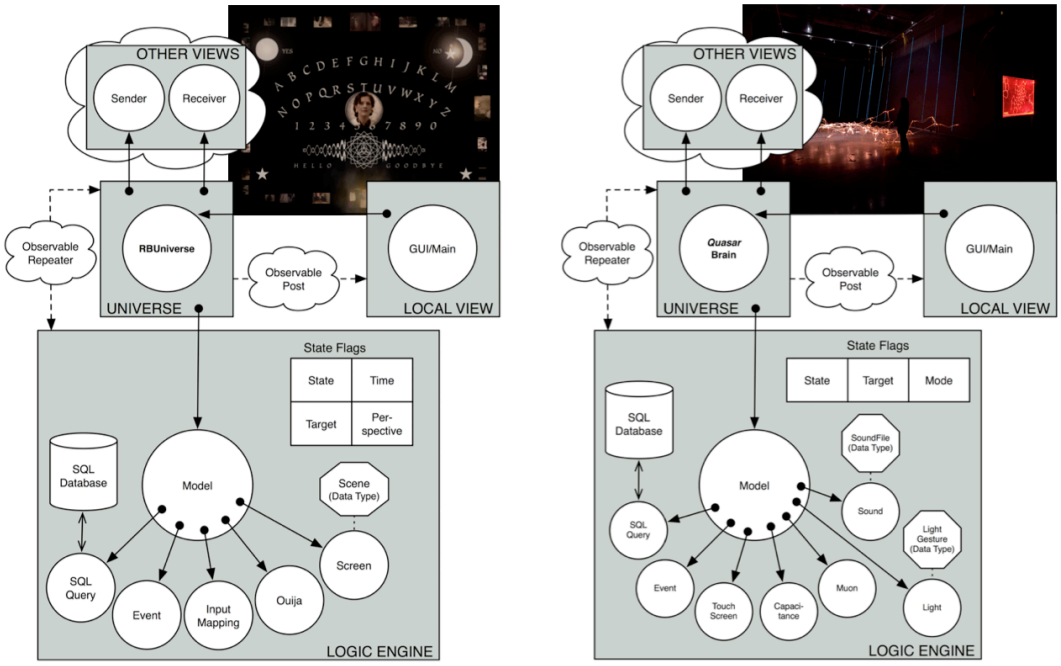

Figure 58. A comparison of the architecture of *An Uncommon Affair At Tooting Bec Common* and *Quasar*.

Like *An Uncommon Affair At Tooting Bec Common*, *Quasar* is an implementation of the *Universe Model* as described in Chapter III. Both implementations of the *Universe Model* are distributed applications implemented in

Java and Max/MSP/Jitter. From the point of view of the software model the differences between the two projects are not structural and can be attributed to anticipated variables in the *Universe Model* that arise when concretely defining the narrative logic, the database structure and the *World*-View classes (in addition to any utility classes, associated data types, and state flags needed for the *Universe* to function).

As a conceptual form of the *Universe,* both *An Uncommon Affair At Tooting Bec Common* and *Quasar* express the emergent qualities of the layering of the operations, structures, and characteristics of nonlinear narrative that can be metaphorically understood as a rhizomatic ecosystem of *worlds*, *views*, and *transformations*, but with radically different forms. *Worlds* in *An Uncommon Affair At Tooting Bec Common* are represented by interrelation between scenes, their ordering, and their transitions summarized as the map narrative. In *Quasar* worlds are represented by the oscillating and stratified narrative structure, which is the driving force behind all of the events that unfold in the *Quasar* environment. *An Uncommon Affair At Tooting Bec Common* has two kinds of *views*, the screen (output) and the ouija (input and output), which provide the perceptual connection to the *Universe* of the work. In *Quasar* this perceptual connection is provided through the output views of the body and sound system, while the EL wires, touchscreen, and MUON counter provide the inputs. The way information is *transformed* in the works between the domains of *world* and *view* differs greatly as well. While *An Uncommon Affair At Tooting Bec Common* interprets interactions as controls that affect the

trajectory of the narrative flow unfolding on the screens, *Quasar* interprets interactions as interruptions that perturb the continuous oscillations expressed in the light and sound of the piece.

The discussion of *An Uncommon Affair At Tooting Bec Common* and *Quasar* provides evidence that the *Universe Model* is capable of providing the scaffolding for the development and implementation of disparate works. Although there are few similarities between the concept, behavior, and physical design of *An Uncommon Affair At Tooting Bec Common* and *Quasar*, both projects are remarkably similar in terms of their software architecture. It is in the works that the domains of concept and implementation come together, thus it is the works that embody the theory and praxis of the *Universe* hypothesis.

D. Conclusions

The six works presented in this chapter provided a history of the discovery and the development of the *Universe* hypothesis in terms of three stages described as beginnings, precursors, and implementations. Each stage provided two examples that trace the evolution and testing of the *Universe* hypothesis through exploration.

In the section on beginnings *After-Life On The Bardo Plane Of Existence* and *microMOTET* provided examples of some of my first attempts at the creation of works using nonlinear narratives and my discovery of nonlinear narrativity. In contrast to the more automated works that followed, the works presented in this section were created using a hands-on approach and fell in the domain of music

composition. As a contribution to the discovery and evolution of the Universe Model, both works represented an exploration of story as an indeterminate knowledge space through the saturation of information and ideas, and provided the basis for the pursuit of nonlinear narrativity in my work.

The second section looked at two works, *DEFENDEX-ESPGX* and *BitSignalFabric,* which provided examples of precursors to the *Universe Model.* The similarity in the software infrastructures of *DEFENDEX-ESPGX* and *BitSignalFabric* provided evidence that disparate nonlinear works could be developed using a similar construct. In addition the software infrastructures of *DEFENDEX-ESPGX* and *BitSignalFabric* provided a test bed for the evaluation and development of the concepts, terminology, and components needed in the description of the *Universe Model*. The *Universe Model* was built on the strengths, and by improving the weaknesses exposed during the development and implementation of the software infrastructures of *DEFENDEX-ESPGX* and *BitSignalFabric*. While the developing the *Universe Model* the concepts and terminology used to describe *DEFENDEX-ESPGX* and *BitSignalFabric* was expanded and refined based on a methodical approach to software design and a transmodal aesthetic for the purpose of the development of interactive and immersive nonlinear artworks.

The two works presented in the last section, *An Uncommon Affair At Tooting Bec Common* and *Quasar*, were examples of two disparate works that were created, from

concept to implementation, using the *Universe Model* as a basis for development. As software both projects strictly follow the *Universe Model* as described in the second half of Chapter III. The differences between the two implementations of the works can be attributed to anticipated variables in the *Universe Model* that arise when concretely defining the narrative logic, the database structure and the World-View classes (in addition to any utility classes, associated data types, and state flags needed for the Universe to function).

Conceptually, both *An Uncommon Affair At Tooting Bec Common* and *Quasar* express the emergent qualities of the layering of the operations, structures, and characteristics of nonlinear narrative that can be metaphorically understood as unique implementations of a rhizomatic ecosystem of *worlds*, *views*, and *transformations*. Although there are few similarities between *An Uncommon Affair At Tooting Bec Common* and *Quasar* in terms of their aesthetic and behavior, both projects are remarkably similar in terms of their software architecture and conceptual design. As a scaffolding and conceptual construct for the development and implementation of disparate works the *Universe Model* facilitates me in the development of meaningful works by freeing my time and energy from the technical and conceptual issues surrounding the logistics of making in media arts practice so that I can focus on what is really important in the work: narrativity and meaning.

V. Conclusions and Future Work

The motivation behind this document was to define a language, based in scholarship and critical discourse, which I could use to describe the procedures and operations employed in the creation of my work. In this sense, this document, although not strictly about music, follows a long line of similar documents in music whereby a composer describes the techniques and theory used in the making of their work. One such document, *Formalized Music* (Xenakis 1992), which was cited earlier, is one of many examples of such a text that includes Paul Hindemith's *The Craft Of Musical Composition* (Hindemith, Mendel, and Ortmann 1941), Olivier Messiaen's *The Technique Of My Musical Language* (Messiaen and Satterfield 1956), and Harry Partch's *Genesis Of A Music* (Partch 1973). These texts commonly contain a strong theoretical and practical description of a compositional technique that contextualizes their work in relation to the aesthetics and practices of other composers from throughout history. From this perspective the comments in this document are not intended to be a final authoritative evaluation of all nonlinear interactive media works, but a description of a working method that can provide insight to other artists and composers, and encourage discussion about formal approaches in art making in the context of nonlinear interactive media art.

This document was an exploration of the question, "*what is the form of nonlinear interactive narrative?*" that provided the impetus for a theoretical discussion and a formal approach to the understanding of my past works. In addition this exploration

provided a basis for the creation of new works that have a dynamic nonlinear structure and reflect on our modern understanding of knowledge and nature. The domain of this document fell within the emerging field of media art and was motivated by a transmodal aesthetic that developed and matured in tandem with my participation in a series of seminars led by Marcos Novak on the subject of *transvergence*. The terms and ideas that were presented in support of the concepts put forth in this document were derived from a variety of sources, including the histories of art, music, and literature; concepts in philosophy (in particular Deleuzeian philosophy); and pattern language as found in the field of software engineering. The result of this discussion was the definition, evaluation, and exploration of a transmodal, generalized description of nonlinear narratives in an abstract formal model called the *Universe*.

Conceptually this document can be divided in two ways that reflect two perspectives on the argument that was proposed. One aspect is the exploration of the question, "*what is the form of nonlinear interactive narrative?*" and the other aspect provides a description of the formal model of the *Universe.* While the first division (based on the 5-part thesis form) is most closely related to the question, the second division (between theory and praxis) is most closely related to the hypothesis. The interleaving of the two formats is representative of how the question and the problem, from conception to implementation, are intertwined.

A. Results

The establishment of the context of nonlinear interactive media was based in the history and practice of media art. An interdisciplinary practice, media art has a varied history that is based in a myriad of seemingly conflicting and/or unrelated disciplines, styles, and structures. Because of the interdisciplinary nature of media arts practice, the field of media art is not based on one history or practice, and therefore was discussed from the perspective of several histories and practices. The unifying feature between the seemingly conflicting and/or unrelated histories and practices of media art can be found in narrative. In particular, the kind of narrative that is structured using nonlinear representations of information, time, and space. Therefore it was from the perspective of art, music, and literature that a general description of nonlinear interactive media was established through a discussion of nonlinear narrativity in terms of its foundations (as a break from linear narratives that coincided with a rise in new technologies), operations (montage, indeterminacy, and formalization), structures (loops, maps, mazes/labyrinths, branches, and webs), and characteristics (immersion, agency, and interactivity).

Having a general description of nonlinear narratives provided a point of departure for the discussion of the concept and implementation of the *Universe* hypothesis. The *Universe* hypothesis attempted to address the question, "*What is the form of nonlinear interactive media?"* by describing an abstract conceptual model that provided a formal approach to the high-level organization and implementation of nonlinear narratives in immersive interactive artworks.

From the basis of the definition of nonlinear narrative a high level theoretical model of the *Universe* as a rhizomatic ecosystem of *worlds*, *views*, and *transformations* was defined using terminology from Deleuzeian philosophy. This theoretical model became a point of departure for a cosmological understanding of the *Universe,* providing a bridge between the theory and praxis of the *Universe* hypothesis by describing the components that need to be addressed when describing the software model of the *Universe*. Therefore, it was from this basis that a high-level software model of the *Universe* was defined using the design patterns of software engineering by dividing the tasks of the *Universe* into three areas (the Logic Engine, the *Universe,* the Views) that correlate to the *worlds*, *views*, and *transformations* of the theoretical model. The integrated *Universe* facilitated the development of richer narratives by defining the components needed to create nonlinear interactive works. The connections drawn between the theoretical and implementation models of the *Universe* form a generalized description of a single abstract model that can be used for the conceptual and technical development of immersive interactive artwork.

Finally, the discussion turned to the evolution and testing of the *Universe* hypothesis through a process of exploration outlined as a history of my work. To this end six works were presented that provided a history of the discovery and examples of the implementation of the *Universe* hypothesis in three stages. The first two works (*After-Life on the Bardo Plane of Existence* (1997), and *microMOTET: There Is*

Only Emptiness In The Eyes Of A Lonely God/Alle Menschen Müssen Sterben (1999)) showed the beginnings of the concepts that led to the development of the *Universe Model.* The second two works presented (*DEFNEDEX-ESPGX* (2004), and *BitSignalFabric* (2005)) are precursors that contributed directly to the development of the *Universe* hypothesis. The remaining two works (*An Uncommon Affair At Tooting Bec Common* (2007), and *Quasar* (2008)), unique from each other, were implemented using the *Universe Model* and thus provide a basis for the evaluation and testing of the *Universe* hypothesis. The description of these works and their relation to the development and discovery of the *Universe* hypothesis presented compelling evidence for the reusability of the *Universe Model* in the creation of various media art projects.

The *Universe* is the baseline model for the development of various works that is abstract enough and open enough that it can be scaled, augmented, and modified as needed. As shown in the examples of works provided in Chapter IV, the *Universe Model* facilitates me in the development of meaningful works by freeing my time and energy from the technical and conceptual issues surrounding the logistics of making in media arts practice so that I can focus on what is really important in the work: narrativity and meaning.

B. Future Directions

The *Universe Model* that is described in this document is the current species of a model that, over time and through the creation of other works, will continue to evolve in order to adapt to unpredictably new and potential forms and contexts. As

the *Universe* is used in the development of more and more works it is my hope the model will continue to evolve and mutate. In this sense the *Universe* is not a fix form, but a snapshot of a deterritorialized form that will change shape through a series of unpredictable future divergences, convergences, and bifurcations that are the result of the accumulations of manifestations of the *Universe* in various works. Therefore the *Universe* is not the end or the totality of a form. In the future there will be a series of new *Universes* that will take on unforeseen structures such as multiverses, parallel universes, and n dimensional space.

Beyond the evolution and transformation of the *Universe* through the development of new works, there lies the potential for the *Universe* to evolve and transform through the evaluation of existing works. The results of the evaluation of these works can be used to facilitate the directed pursuit of new methods that could potentially lead to extensions and variations of the *Universe*, or lead to other forms and models altogether.

Beyond the evaluation and the pursuit of new directions of form in the *Universe* model, there are interesting experiments and new directions that can be taken with the *Universe* as it stands. For example, the modularity of the definition of the *Universe* model facilitates experimentation with the form and structure of works developed using the *Universe* model. Therefore, the aspects of various works can be swapped with each other readily, leaving only the specifics of mapping and other contextual considerations left to be defined. In other words, an assortment of

structures and operations (i.e. *worlds*) could be used with a single *view*, and an assortment of *views* could be used with a single structure and operation. For instance, it would be possible to use the narrative structure of *An Uncommon Affair at Tooting Bec Common* to drive the *views* of Quasar once the lightgestures of *Quasar* were mapped to *An Uncommon Affair at Tooting Bec Common*'s structure and operation for managing scenes.

Another possibility for experimentation lies in the potential for the implementation of the *Universe* in the development of works that are not gallery-based installation artworks. Feasibly the *Universe* could be modified and refined for use in the development of performance works, music compositions, and possibly any other nonlinear narrative based work. The use of new media architecture in the development of works outside of the field of new media could potentially lead to new forms, new directions, and new hybrids of works.

The technical aspects of the software model of the *Universe* could also be further refined in order to improve and optimize the definition and implementation of the *Universe Model*. The continuation of this refinement will ultimately result in the development of a *Universe* framework, which could be distributed and used by others. In order to achieve this goal it will be necessary to make the *Universe* as independent of software packages and operating systems as possible, while remaining in sync with the latest technological developments. Therefore, future versions of the *Universe* will move away from Java, SuperCollider, and

Max/MSP/Jitter (as was used in the projects described in Chapter IV), and move towards a lower-level cross-platform C++ based multimedia library, such as the emerging open source library, *openFrameworks*[47], or Graham Wakefield and Wes Smith's C++ framework and high-level development environment, *Lua A/V*[48]. The change in direction of the *Universe* to a new language and platform is not intended to eliminate the possibility of the use of tools like Java, SuperCollider, or Max/MSP/Jitter in the development of future projects. On the contrary, the change in direction to a new language and platform is intended to provide a robust basis for the development of projects that are flexible enough to be implemented in (or in conjunction with) a multitude of platforms, operating systems, and environments, thus maintaining flexibility and scalability in future versions of the software of the *Universe*.

[47] http://www.openframeworks.cc/, accessed June 2008
[48] http://lua-av.mat.ucsb.edu/, accessed June 2008

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All web links in this document were accessible as of June 2008.

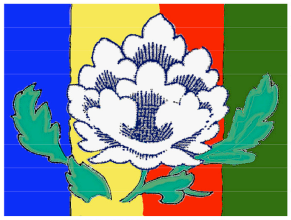
Appendix I. Documentation Of
After-Life on the Bardo Plane of Existence

This is a documentation of three manifestations of the same project:
Premiere Performance (23-5-1998)
CD-ROM (released June 1998)
Web Version (released June 2000 www.mdhosale.com/BookOfTheDead/)

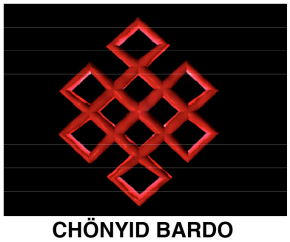
The Dharma-Kaya of thine own mind
thou shalt see;
and seeing that, thou shalt have seen All—
The Vision Infinite, the Round of Death
and Birth
and the State of Freedom.
—Milarep

After-Life

On the Bardo Plane of Existence



CHAKAI BARDO



CHÖNYID BARDO

SIDPA BARDO

INTRODUCTION

After-Life On The Bardo Plane Of Existence was first conceived in November 1996. The idea to was to treat The Tibetan Book of the Dead as if it were an epic poem. As part of the project, I was very interested in trying to place the audience in the experience as much as possible. I accomplished this task by combining several media elements: sound placement, video, and live performance and dance. Each of these elements provide an interpretation of different aspects of the events in the Tibetan Book of the Dead. The sound represents the ambiance and mood, the video represents a more esoteric symbolic interpretation, while the performance and dance represents a more literal interpretation. As a CD-ROM and website my intention was to extend this experience by allowing the user to navigate freely through the work in a non-linear fashion. This is achieved by separating the piece into four pieces, each with their own sound bytes, films and graphics. There is no guide to how to navigate through these sections. The theory is that no matter what order the pieces are explored, same summation of knowledge can be obtained at the end of the experience. Here is the basic outline of the piece:

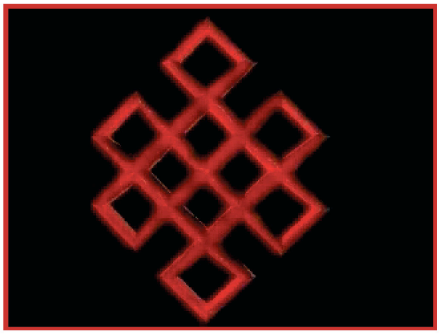
I. Chakai Bardo The Bardo of the moments of death.
A. Meditation and Prayer.

II. Chönyid Bardo The Bardo of the experiencing of reality.
A. The dawning of the Peaceful Deities.
B. The dawning of the Wrathful Deities.

III. Sidpa Bardo The intermediate state when seeking rebirth.
A. The After Death World: Judgement.
B. The process of rebirth.

Chakai Bardo

Meditation and Prayer



Images shown on the screen represent the esoteric images of death and preparations made for the dead

Performers recreate a Tibetan incantation ceremony as a meditation for the dead.

The spirit begins their journey in the after-life in a state of consciousness called the Chakai Bardo. At the commencement of this state the spirit sees a pure light, which symbolizes pure thought. This is the Buddha consciousness. If the spirit is unenlightened, then it will not join the Buddha consciousness and will continue into the world of death. Soon the light becomes dull and unclear, symbolizing confusion, and the spirit begins to see visions of death and preparations being made for the dead.

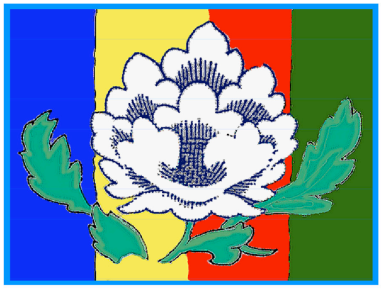
The music begins with a sine wave (an aural metaphore of pure light). As time passes the sound becomes harsher, eventually becoming screams and sirens. The sound then returns to a sine wave and the section ends. The form of the music is based on a Tibetan incantation ceremony.

Like the music, the structure of the performance is a meditation based on a Tibetan incantation ceremony, arranged to look like a funeral. At the center under the screen lies the body of the spirit on a death-bed. Four monks dressed in white appear and sit across from each other, two on each side. They pray and meditate over the body while images of death appear on the screen. After the cycle is complete a gong is sounded and the body is carried off stage.

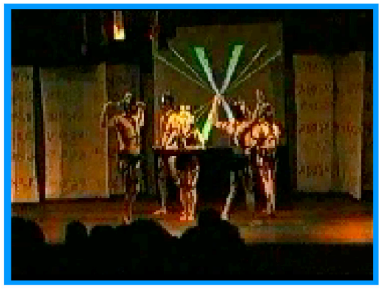
Chönyid Bardo

The Dawning Of The Peaceful Deities

Each of the performers below represent one of the deities above. The lion, the elephant, the horse, and the mythical Garuda.



Lotus Flower, taken from the video behind the performers.



The performers doing a Tai-Chi like meditation using mudras.

After leaving the Chakai Bardo, the spirit enters the first part of the Chönyid Bardo: The Dawning of the Peaceful Deities. It is the goal of the Peaceful Deities to bring the spirit into enlightenment through their compassion. According to the Tibetan Book of the Dead these beings emit from the heart and if the spirit doesn't recognize them for what they are then the spirit will become afraid and continue on into the Chönyid Bardo.

It is from The Tibetan Book of the Dead that I took the form for this piece. In The Tibetan Book of the Dead the peaceful deities present themselves in order and then dance together, as if performing a pageant in a royal court. The dance itself is inspired by my brief exposure to tai-chi. Like tai-chi, the movements of this piece are slow and methodical and each dancer moves in tandem, as if one organic unit. It is a carefully planned process.

Throughout "After-life on the Bardo Plane of Existence" the timbre (quality) of the sound was a very important consideration. Although I didn't use actual Tibetan instrument sounds, I paid great attention to the context of their timbres and what they symbolize in Tibetan culture. My choices of particular instrument timbres were very similar many to Asian instruments. These include Balinese gamelan, Chinese opera and Japanese Noh timbres.

It is the bell that is often used to conjure the Peaceful Deities during prayer and meditation in Tibetan religion. In my mind the ambient sound of the world of Peaceful Deities would sound like a thousand prayers being sung to the Peaceful Deities simultaneously.

Chönyid Bardo
The Dawning Of The Wrathful Deities

A representation of the Wrathful Deities taken from the performance video.

Here the performers fiercely display their triton staves in a war-like gesture.

If the spirit fails to reach enlightenment during the Dawning of the Peaceful Deities, the spirit then continues on to the second part of the Chönyid Bardo: The Dawning of the Wrathful Deities. Unlike the Peaceful Deities, the Wrathful Deities hope to bring a spirit to enlightenment through fear. In this case, the Wrathful Deities emit from the brain. This time if the spirit fails to recognize these deities for who they are then the spirit will continue into the Sidpa Bardo to be judged.

Again when approaching this piece I imagined the ambient sounds that would exist in the Wrathful realm. I thought of a music that would be incessant and harsh like the grinding of gears. In order to maintain a feeling of chaos I wrote music that lacked a feeling of pulse with erratic lines and irregular rhythms, while underneath there is a constant vocal drone imitating the chanting of Tibetan monks.

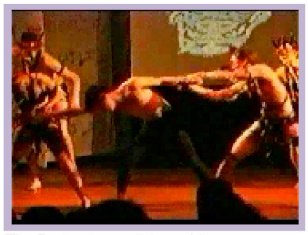
The dance is like that of warriors preparing for battle. While they spin their triton staves, the Wrathful Deities dance in their own warrior pageantry. Here too process and meditative qualities exist. It was actually my intention to show the parallel between the Peaceful and Wrathful deities through the ceremonial quality of the dance.

Sidpa Bardo

Judgement and the Process of Rebirth

The spirit pleads with the good and evil genius' for his soul.

An Image of the Tibetan God of Death taken from the video at the performance.



The Pretas torment the spirit.

The God of Death clears away all of the Pretas and the good and evil genius'.

The God of Death helps the spirit choose his next place of rebirth.

The principal deity of the Sidpa Bardo is the blue ox-headed God of Death. After the spirit leaves the Chönyid Bardo it falls into an intermediate state between realms. As the spirit comes out of this realm the spirit sees two Buddhas, one representing the spirits good genius (who is counting out the spirits good deeds into a bowl) and the other represents the spirits evil genius (who is counting out the spirits evil deeds into a bowl). Afraid, the spirit lies to the Buddhas by saying, " I have committed no evil deeds!" And the God of Death responds, "I will look into my Mirror of Karma." Meanwhile several Pretas (demon-like creatures) come out and torment the spirit. After the God of Death has seen the spirit's fate he clears away all of the Pretas and the good and evil genius'. The God of Death then helps the spirit choose its place of rebirth.

The dance for this section is filled with activity. It was important to give each character independence in movement: the frightened spirit, the accounting Buddhas, the mischievous pretas, and of course, the ominous God of Death. While the Buddhas and the Pretas perform their duties on stage the God of Death enters the audience as he stares into his mirror looking for the spirit's fate.

The music is a combination between Balinese gamelan and drum-and-bass techno dance music. As the Buddhas and Pretas are cleared away and the God of Death and the spirit are left on the stage alone the music returns to the same sine wave that represented purity in the Chakai Bardo. When the spirit chooses its form of rebirth the cycle is complete.

After-Life

On the Bardo Plane of Existence

Premiere Performance (23-5-1998)

Cast

The Bardo	Lloyd Rivera
Peaceful Deity, Wrathful Deity, Preta Meditators, Peaceful Deities, Wrathful Deities, Pretas	Larissa Bovetti Brian Coulson Anthony Diaz Camille Laurence Mark Watson
God of Death	William McVicar
Good Genius	John Syncok
Evil Genius	David Ewald

Crew

Composer, Director, Choreographer, Costume Designer, Videographer, Lighting Designer, And Producer	Mark-David Hosale
Set Design, Extra Props and Materials	William McVicar
Sound Design, Camera Operator	Alex Kouznetsov
Stage Manager	Jason Galuten
Light Booth Operator	Jeff Gordon
Advisor	Jeremy Haladyna

CD-ROM and WebPage layout, Music and Design by Mark-David Hosale

Appendix II. Lyrics of microMOTET: There Is Only Emptiness In The Eyes Of A Lonely God/Alle Menschen Müssen Sterben

Triplum (stanza 1)
In the words of a dying man,
"the soft and young speak
out of turn."
But, the idea is frozen from my mind.
I lose and I learn.
And I learn nothing, Oh God help me.
Strange as ideas become real.
Frozen from my mind.
Still and vanishing.
Open eyes.

Duplum (stanza 2)
Lately things don't seem right to me.
My falling fingers brush my thighs.
Basically I think I'm confused.
Where am I? Where am I going?
Nowhere. Is there anywhere to go?
Is there any-thing to find?
I can't find the answers
I'm cold, I'm blind.
I want to be blind.

Tenor (Cantus Firmus)
Alle Menschen müssen sterben,
Alles Fleisch vergeht wie Heu,
was da lebet, muss verderben,
soll es anders werden neu.
Dieser Lieb der muss verwessen,
wenner ewig soll genesen
der so grossen Herrlichkeit,
die den Frommen ist bereit

Tenor (*translated)*
All men must die,
All flesh must fade as grass;
Only through death's gloomy portal
To eternal life we pass.
This frail body must perish
For the heavenly joys we will cherish,
There awaits a great reward
For the servants of the Lord.

Words: Triplum and Duplum by MarkDavid Hosale, Tenor by Martin Luther

Appendix III. *DEFENDEX-ESPGX*

[abstract]

Originally published in:

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DEFENDEX-ESPGX

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ABSTRACT
DEFENDEX-ESPGX is an interactive art object that combines real-time audio and video synthesis processing with physical interaction. DEFENDEX-ESPGX is designed to simulate the look and feel of 1950's technology. The content draws on nostalgic reference to bring about implied comparisons between the fearful culture of the Cold War and the culture of fear associated with the current War on Terror.

Categories and Subject Descriptors
J.5 [Computer Applications]: Arts and Humanities: Fine arts.

General Terms: Theory

Keywords: Interactive, media art, multimodal, multimedia

1. INTRODUCTION
DEFENDEX-ESPGX (fig. 1) combines real-time audio and video synthesis processing with physical interaction. DEFENDEX-ESPGX provides a meaningful interface that connects the virtual and physical.

Figure 1. The DEFENDEX-ESPGX

2. RELATED WORK

The list of related works to DEFENDEX-ESPGX could include a long rich history of artworks and artists drawn from several areas of contemporary art culture. For the sake of brevity only three such works/artists are cited in this article.

In 1997 the Arizona State University Art Museum held an exhibit of installation artist, Sara Roberts' work entitled, Physical Fiction (http://asuartmuseum.asu.edu/physical/). The exhibition featured three of her interactive works, Early Programming, The Digital Museum, and Elective Affinities. The common thread between these works was the use of art objects as interface to a narrative space. As with DEFENDEX-ESPGX, the media in these works were developed along with the content. The message and the medium become fused, resulting in a continuum between the physical and the virtual.

The MEMEX Engine (www.memexengine.com), by Marc Lafia, is an interactive website where a user explores a nonlinear narrative space. While exploring this space, the user is overtly being profiled and tracked by the MEMEX Engine. Actions are recorded and the user's choices are limited or expanded based on these actions. As for the construction of the narrative, Lafia quotes French director Jean-Luc Godard, "...there's a beginning, a middle, and an end, but not in that order."[1] There are obvious parallels in the narrative structure between the MEMEX Engine and DEFENDEX-ESPGX, as well as parallels in the thematic undertones of surveillance and paranoia in both works. The common reference to Vannevar Bush's article, "As We May Think"[3] with a dystopian twist could account for the synergy in concepts.

World renowned artist Nam June Paik's (http://www.paikstudios.com) life's work centered around the re-contextualization of media (in particular television and video). Significant in relation to DEFENDEX-ESPGX were the works where he recreated objects, such as a cello, an archway, or a person, using televisions as building blocks. The result of these works was something compelling and familiar, but also alien. The assemblage of the television inscribes itself as being in the culture, while configurations and content inscribes the work as being from the other.

3. OVERVIEW AND DESCRIPTION

3.1 Context

The context of the DEFENDEX-ESPGX, which is that of 1950's technology, affects the user's manner of interacting with the medium. The device has a familiarity of a past era in which technologies were seemingly simpler and less abstract. This nostalgia is compelling and draws the user to interact with the device. Users readily engage the device because the controls are familiar even though they are not familiar with the context of the virtual system behind the interface. The device may have compelling nostalgic value, but is interweaved with modern technology. The combination transforms the device to something alien [2]. It leaves its familiar context and becomes foreign.

3.2 Content

The message is sculpted through this contradictory medium. The content of the virtual system draws parallels between past and current technologies and the eras they represent to resolve this contradiction. The content is not meant to be pedantic or convey a particular message, but it draws on nostalgic reference to bring about implied comparisons between the fearful culture of the Cold War and the culture of fear associated with the current War on Terror.

The source material includes pre-recorded political, military, and other footage, as well as audio and video streamed from the sensor space. Additional content is created with audio synthesis techniques such as particle synthesis, trainlet synthesis, and filtered impulse trains. The parametric data of these synthesis techniques is often used to drive visual synthesis algorithms, creating tightly coupled links between the media. With physical interface components, users interact with the audiovisual media and navigate through different nodes arranged in a nonlinear narrative.

3.3 Interactive Narrative

The narrative terrain of the DEFENDEX-ESPGX is composed of a network of nodes, each one of three types: action nodes, consequence nodes, and narrative nodes. In an action node the user completes tasks to move to the next node. These tasks include navigating to a certain area or reaching a threshold of interaction. After completion of tasks, the user might move to a consequence node where the ramifications

of their actions become apparent. Otherwise, the user is taken to a narrative node, which delivers clues to the secrets behind the DEFENDEX-ESPGX.

The classification of the nodes is implicit. In all cases action nodes are interactive and narrative nodes are passive, however, the user is not instructed to interact or watch at any particular time in the work. They are expected to determine this on their own. This adds to the enigmatic quality of engaging the device.

Each node on the network is connected to several other nodes. A weighted probability table determines the node to which the user is likely to be directed. The probability table is formulated to support the architecture of the three node types. For instance, action nodes will have a high probability of moving to a consequence node. Aesthetic decisions, concerned with the context of each node, also play a role in determining the weights of the table. Progress through the nodes does not occur in a linear fashion. The route for each user will be unique.

3.4 Art Object as Human-Computer Interface

Physically the DEFENDEX-ESPGX is a stand-alone unit approximately five feet tall with a surveillance camera mounted above and a microphone attached. It has a data feedback panel, three master faders, and several switches and knobs. At head height a monitor provides a visual interface. Speakers are mounted to the sides of the DEFENDEX-ESPGX providing stereo sound. Haptic feedback is provided via vibrating motors located within the DEFENDEX-ESPGX.

The device uses control data and content from the external video camera and microphone to perform surveillance functions. The system encompasses more than the DEFENDEX-ESPGX itself, but also the entire space in which it is contained (the sensor space).

3.5 Technical Details

The DEFENDEX-ESPGX uses a G5 Macintosh computer running Max/MSP/Jitter (Cycling74.com) and SuperCollider3 (audiosynth.com). Graphics and simple audio is handled with Max/MSP/Jitter while SuperCollider3 handles the more complex audio synthesis. MakingThings (makingthings.com) analog-to-digital conversion (ADC) modules mediate input to the software from the buttons, switches, knobs, and levers Additional MakingThings digital-to-analog (DAC) modules enable the software to control vibrating motors and servos within DEFENDEX-ESPGX. The ADC and DAC modules are all programmable via objects that are available to the Max/MSP/Jitter control environment.

4. CONCLUSIONS & FUTURE WORK

In conclusion this document describes several aspects of DEFENDEX-ESPGX, which are provided for a better understanding of the ideas behind its development. The context of 1950's technology in the work is inscribed onto an art object that is otherwise alien. The context draws parallels between the Cold War of the past and the current War on Terror in the United States. The narrative space of the work is nonlinear and determined by a weighted probability table. The content of the work doesn't stop inside the virtual space of the work; rather the narrative exists in the entire sensor space of the art object.

Although a completed work, the narrative space of DEFENDEX-ESPGX is not fixed. Thus, there is the potential for the addition of new nodes allowing the narrative terrain of the DEFENDEX-ESPGX to continually expand over time.

5. ACKNOWLEDGMENTS

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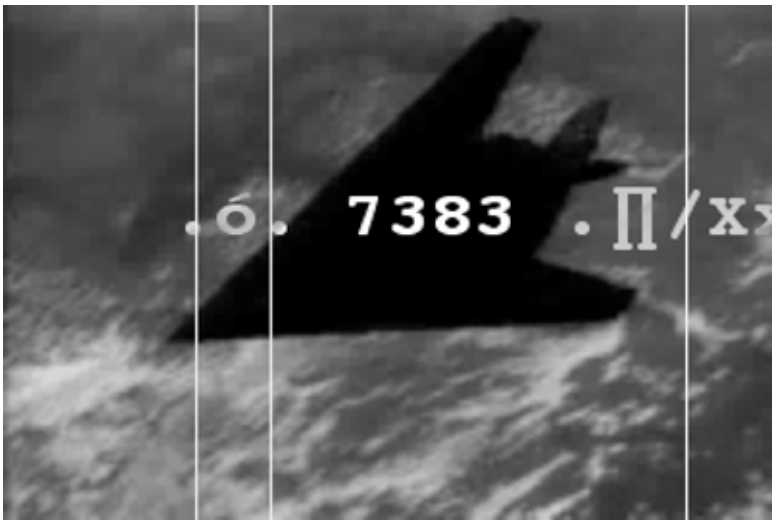
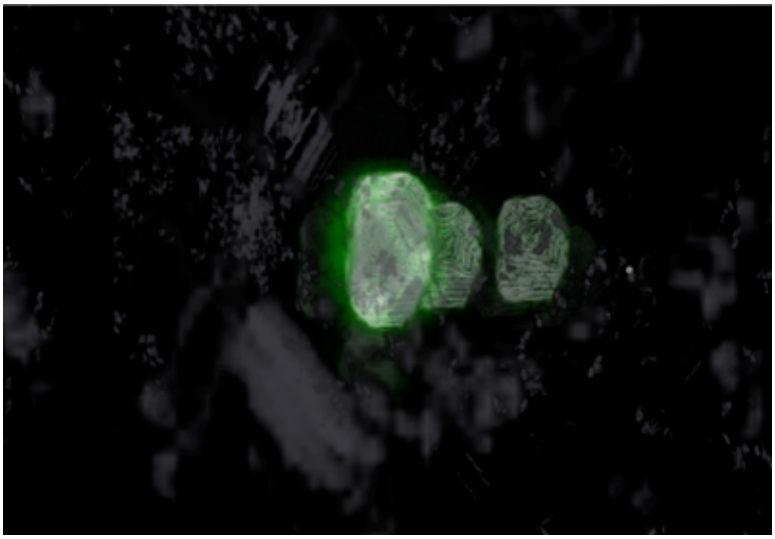
Appendix IV. A Description Of The Narrative Nodes Of *DEFENDEX-ESPGX*

The following is a description of the narrative nodes of *DEFENDEX-ESPGX*. They are presented here in no particular order.



Encrypted Mode or Default Mode – Encrypted Mode is the resting state of *DEFENDEX-ESPGX*. This node can only be reached when DEFNEDEX-ESPGX times-out due to inactivity. During this node clips from propaganda films, war footage, news reports, and arms dealers play randomly. Superimposed over the image is an indecipherable encoded string of numbers and letters that dance around the screen. A jumbled mix of audio clips from similar sources as the videos emerge from a chaotic swirl of static and noise that sounds like an old radio. Encrypted Mode will move to a new node as soon as any button is pushed, a switch is thrown, or the microphone is used.

DEFENDEX-ESPGX Trailer – *active*, The DEFENDEX-ESPGX Trailer is a fictitious propaganda movie about DEFENDEX-ESPGX edited in the style of 1950's propaganda film. During playback users can disrupt the playback of the movie by making it play forwards and backwards at various speeds. In addition, certain controls will make the movie fade into static, an experience similar to tuning in a bad signal. As a consequence of using the node the movie will take longer to time-out. The node ends when it times-out, or reaches the end of the film.

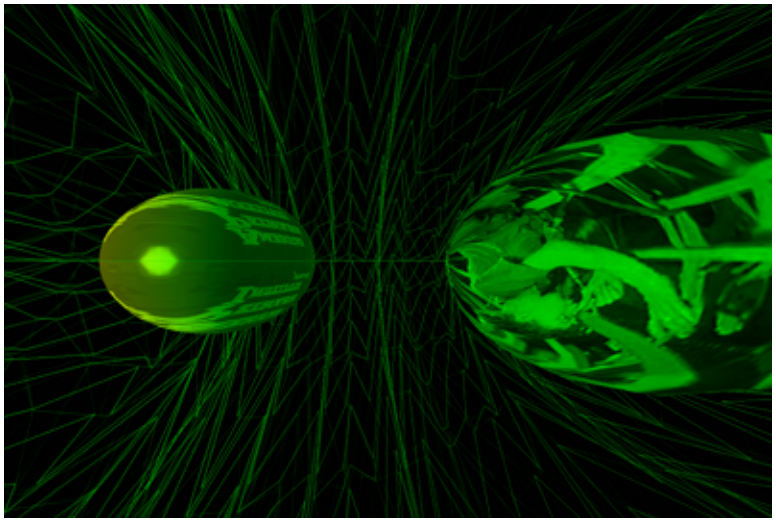


Finger Prints – *active*, Users control visual particles, which are mapped to sounds. Obscured images of fingerprints, war and world leaders, and children who are victims of war are mapped to the particles. As the particles are manipulated by the controls the images become more and more revealed. The node ends after a certain amount of input, or when it times-out.

Flag Wave – *passive*, The narrative of this node is a comment on what the American flag symbolizes to people around the world. A backwards flag waves in a sea of a red, white and blue surrounded by spinning cubes that show scenes of burning American flags from various anti-American protests from around the world. The sound of the *Star-Spangled Banner* plays in the background, which is eventually joined by the sound of fireworks and cheers. Eventually the flag fades into the image of a Palestinian burning a flag at protest, which fades into the body of protester who was killed during a protest. The cheers and fireworks overwhelm the music in a hysterical cacophony. Users can control the number and speed of the spinning cubes, and the orientation of the flag. The node ends when the film narrative has completed.

infraRedSim – *passive*, The content of infraRedSim is a film showing the gunning down of two Iraqis in a field from the point of view of the infrared cross hairs of a Blackhawk helicopter. The film, which circulated on the internet during the early part of the Iraq War, was controversial because the it clearly shows a commanding officer giving a direct order to the gunner to kill a wounded man; a violation of the Geneva convention. As the film is plays it cross fades to a simulated infrared view of

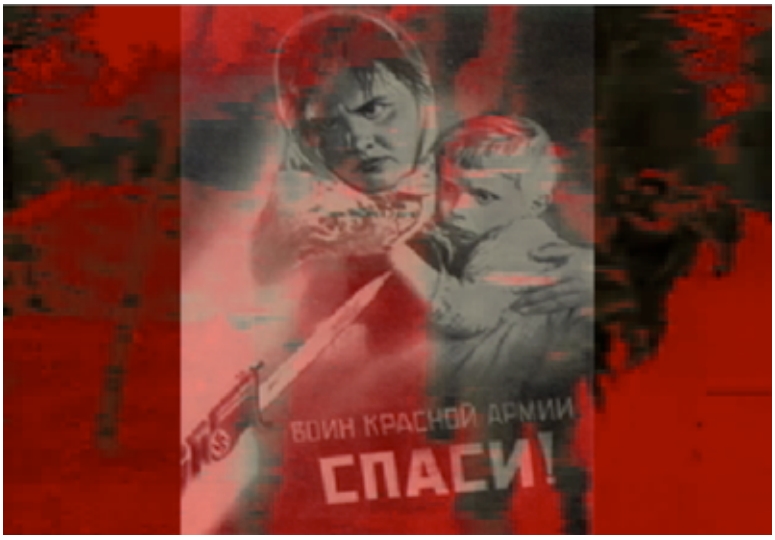
the user with cross hairs superimposed over their face. In the narrative of the node the role of the observer and the subject constantly change roles, which is a comment on the passive role we play in the deaths of others. There are no interactive controls in this mode. The node ends when the film narrative has completed.



Green World – *active*, Two orbs in a monochrome 3-D environment are wrapped with World War II propaganda films that encourage people to work for the war effort. The node is a comment on dehumanization and exploitation by the military industrial complex. Users navigate between the two orbs. The node ends after a certain amount of input, or when it times-out.

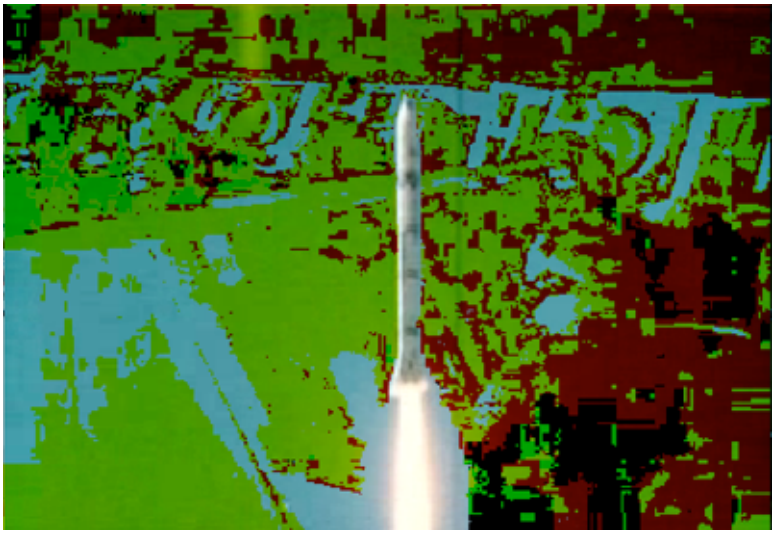
Atomic Koran – *active*, Users navigate through a tunnel of images of the Koran, nuclear weapons, and symbols of nuclear power. The passage through the tunnel symbolizes the morphing from the cold war to the war on terror in American culture. The node ends when the node times-out.

Air Raid – *passive*, An image of the viewer superimposed over a mushroom cloud as air raid sirens sound. The robotic camera pans back and forth across the room. There are no interactive controls in this mode. The node ends when the film narrative has completed.



Propaganda – *passive*, During this node propaganda posters superimposed over propaganda movies and war footage accompanied by the sound track of the infamous World War II propaganda movie, *My Japan*. The narrative of *My Japan* features a Japanese man gruesomely describing how the Japanese will kill Americans during World War II. The audio segment was edited in such a way that it could be any enemy talking to you. Users can control the way the posters are displayed on the screen. The node ends when the film narrative has completed.

Surveillance – *passive*, From the point of view of a surveillance camera users watch several movies of people shopping. Words flash by on the screen that profiles the shopper with statements like "Under Suspicion", "Foreigner", and "Sympathizer". The node then flashes between images of close-ups of eyes of people from different ethnicities. The eyes are interspersed with images of people who previously viewed the node. The profiler keeps going. The node then freezes on a snapshot taken of the viewer, accompanied by a profile. The node ends by zooming in on the viewer's eyes. There are no interactive controls in this mode. The node ends when the narrative has completed.



Sage 2000 – *active*, A 1950's propaganda film about the Sage Computer is superimposed and disrupted by scanning lines, sound dropouts. Images from the film mix children playing at school are mixed with images of the military industrial complex technology readying for nuclear war. Rockets shoot off, and children play in this disturbing mix between 1950's Sci-Fi, Leave it to Beaver, and Cold War propaganda. The images come through, but the reception is bad and the message is unclear, it is not possible to get the whole story. The node ends after a certain amount of input, or when it times-out.

Appendix V. Bit Signal Fabric
[abstract]

Bit Signal Fabric

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ABSTRACT
Bit Signal Fabric is a navigable multidimensional installation, a collaborative effort to build a virtual universe of generative audio-visual systems that explore emergence as a transmodal artistic principle. Our work involves digital media of sound, image, and physical manifestations inspired by algorithmic, dynamic and complex systems.

Categories and Subject Descriptors
J.5 [Computer Applications]: Arts and Humanities: Fine arts.

General Terms
Interactive Media, Virtual Universe, Multiplicity, Computational Beauty of Nature, Continuum, Generative System

Keywords
Transvergence, Computer music, Computer Graphics, Media Art, Interactivity, Collaborate World-Building, Multi-Tiered Algorithmic Networks, N-D Information Space-Times, Transmedia, Transmodality, Navigable Experiential Art, Multiple Participant Interface

INTRODUCTION
Bit Signal Fabric is a virtual universe that consists of many worlds constructed/devised by multi-disciplinary collaborators as an embodiment of a transmodal artistic principle (fig. 1). Each world employs multi-tiered algorithmic networks as ground. These networks are transmodal, enabling fields of expression to grow from modalities of 1D (sound) through 2D (image) and 3D (virtual space), and continuing inevitably towards n-D information space-times. For example, one part of the network might allow musical events to construct a virtual sculpture; while in another sonic clouds may be arranged spatially according to the analysis of a video stream; yet both parts of the network might be directly or indirectly feeding each other through another tier of the universe network.

In the universe of Bit Signal Fabric, worlds are constantly in flux. What the user sees at any given point is not the end point of a work with a single outcome, but a moment in the life of an evolving

work with numerous potential, and changing outcomes.

Figure 1. Several worlds in the universe of Bit Signal Fabric

The virtual universe of Bit Signal Fabric is explored and controlled by many participants, in a shared view. Their traversal of the world-spaces and of the transitions stages an indeterminate narrative, a navigable music. The physical installation of Bit Signal Fabric scales from one to multiple projectors and two to many loudspeakers arranged in such a way as to create an immersive environment. Participants interact with the space using custom rapid prototyped devices containing the CREATE USB Interface (CUI)[1].

RELATED WORK

Joran Rudi's work "When Timbre Comes Apart" (1992-95) presents a virtual 3-D terrain that is constructed from the spectrum of an audio signal. The content of the work explores sound as a structure that can be flown over and under, and viewed from far and near. Significant to Bit Signal Fabric is the manner in which "When Timbre Comes Apart" blurs the lines between sound and image. In "When Timbre Comes Apart" sound and image become fused into a navigable music. However, unlike Joran Rudi's work, which is both pre-compiled (as a digital movie) and embodies a media hierarchy (sound generates image), Bit Signal Fabric is determined in real-time through interaction and algorithm, and eschews the representation of one media within another in favor of the embodiment of processes responsible for deep structure across many media.

Marcos Novak's "Invisible Architectures," as presented at the Venice Biennale of Architecture in 2000, is a work that explores the continuum between the virtual and the physical. The work consists of several sculptures suspended above a table, some are visible and some are invisible. The invisible sculptures are what Novak describes as *everted*, feedback into the physical world from the virtual. In the physical world these invisible sculptures are rendered in *sensels*, a sensor space that is conceptually understood as output and input. As the user explores the *sensel* sculptures, dynamic processes transform virtual sculptures that correspond to the sculptures in the physical. Interaction with the sensor space also synthesizes and transforms sound. Many of the ideas and concerns behind Marcos Novak's "Invisible Architectures" relate directly to the motivations behind Bit Signal Fabric. Both works feature externally realized virtual sculptures that act as interface to the virtual world. As in "Invisible Architectures," transmodality is not only understood as a blurring of the lines between media in Bit Signal Fabric, transmodality also understood as the blurring of lines between the realms of the physical and the virtual.

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1. CUI is an electronic device designed by Dan Overholt for prototyping human-computer interfaces via USB or Bluetooth, http://www.create.ucsb.edu/~dano/CUI/

MOTIVATION

The underlying natural forms and processes that are found around us in the physical universe inspire the content for Bit Signal Fabric. The intrinsic beauty of nature is far from skin deep, hence we aim to recast and amplify the imperceptible, deeper underlying structures of these forms and processes to accord with our senses. Digitally generated media may tend towards the non-representative, yet for the participant the synergetic experience of sounds, images, forms and movements, and their relationships with expression, process and nature, may become deeply resonant within the space of consciousness.

CORE CONCEPTS

Bit Signal Fabric has evolved as a platform to support a manner of working we consider vital and fascinating in time-based media art. The platform is a sketchpad where we can try new combinations of virtual worlds and generative processes, facilitating our exploration of these otherwise imperceptible aspects of our universe. In order to keep this platform open to the introduction of novelty at any stage, we have defined the core concepts of Bit Signal Fabric just enough to facilitate a transmodal artistic principle. These core concepts are:

Multiplicity: By multiplicity, we mean multiplicity on every level, e.g., many authors, many worlds, many inter-relations, many models and algorithms, many instantiations.

Transmedia In contrast to multimedia, in which two or more media are simply mixed, Transmedia works fuse two or more media into a new medium. In transmedia, for example, sound does not simply accompany an image, nor do images simply accompany a sound; rather, both sound and image derive from and drive each other according to deeper underlying processes.

Intrinsic, loose, purpose-free interactivity: We aim to create a universe of possible worlds that await exploration and determination through observation and navigation by one or many participants, in one

or many locations, using one or many physical and logical forms of interaction. There is no scripted narrative, instead multiple encountered partial, personal narratives may be created in the mind of the user. Nor is there any particular goal, though causality may inhere.

CONCLUSIONS & FUTURE WORK

The sequence bit, signal, fabric suggests a continuum from simple, singular information through dimensional time-based message carrying to complex enveloping surfaces; a continuum that leads toward a notion of universe. This continuum is intentionally left incomplete, without a defined endpoint, to afford emergent phenomena and provoke the un-terminated series of instantiations. The sequence is in practice a strange loop; a multi-tiered web in which complex scales, layers and levels are both determining and determined by other scales, layers and levels, with no single determinant path of influence. The universe is made of bits, bits define signals that shape worlds, signals may thread through fabrics, and worlds of fabric may weave the universe.

Bit Signal Fabric is an open-ended artwork, which has been instantiated in various forms in the past, and is intended to continue to evolve and instantiate in new forms in the future, intentionally open to the potential of future technologies. With each instantiation our work progresses towards an infinite generative universe composed of evolving processes whose morphologies intricately intertwine across dimensionality and modality, a perceptible embodiment of multiple user interaction within the context of layered, multi-tiered algorithmic networks. The further future of Bit Signal Fabric is composed of a substrate of fine granularity from which individual creations cohere, dissolve, flow, and morph into surprising forms, and whose state and overlapping morphologies are influenced by experiential participation.

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