Shiftscape: Responsive Visions in Space-time

Jacqueline Sarah Steck

BA Studio Arts
University of Pittsburgh
May 2002

Submitted in partial fulfillment of the requirements for the degree of Master of Fine Arts in Design and Technology Parsons School of Design
May 2005

Marko Tandefelt
Project Director, Curator
Finnish Cultural Institute in New York
Adjunct Professor, Parsons School of Design
Thesis Supervisor

Douglas Repetto
Director of Research at the Columbia University Computer Music Center
Thesis Advisor

Table of Contents

Figures

Acknowledgements

This thesis was in no way the product of one mind, and although I cannot recount everyone involved in this process, some specific shout-outs are in order. My undergraduate Professor at the University of Pittsburgh, Delanie Jenkins, was instrumental in helping me become permanently enthralled with installation art. With her help I interned at the Mattress Factory for two weeks, managing to experience some amazing parties and become thoroughly immersed in the contemporary art scene. I am indebted to many friends have helped in the development of my inquiries: Jon Finstad who first helped me hack into tone dialers and construct LED sushi; Robert Lowe who read the first drafts of my thesis and offered his scientific perspective and ideas; the brown ninja for his suggestions on evolving spaces and neural networks; Brandon Franklin for appearing out of nowhere and inputting his thoughts on my early development; Theo Watson for his crafty technical help; Charles Truett for our long talks about art; and Mark Rzeznik for our arguments about art.

My graduate instructors were utterly fundamental: Marko Tandefelt for his utter enthusiasm and vigor; Zachary Lieberman for his brilliant coding skills and keeping me on track with C++; Dave Kanter for his practicality and frankness; Mark Stafford for pushing me to develop aesthetics.

I must especially thank Loretta Wolozin for her thorough editing and insights: without her this thesis would not be what it is. Additionally, my thesis advisor Douglas Repetto has been fundamental for the development of the core concept. The administration of the Design and Technology department has also been invaluable: Colleen Macklin for her enthusiasm and excellent recommendations; Sven Travis for plunging a handful of us into alife and sending us to the ninth annual ALIFE conference at Boston; and to everyone else who tirelessly helped to put the final show together. And lastly, without my parents' support, I would not have trod down this particular path and discovered many great things.

Shiftscape: Responsive Visions in Space-time

Jacqueline Sarah Steck

BA Studio Arts
University of Pittsburgh
May 2002

Submitted in partial fulfillment of the requirements for the degree of Master of Fine Arts in Design and Technology Parsons School of Design
May 2005

Abstract

Shiftscape is a defamiliarizing spatial experience enabling visual control of the scenery beyond a window. Defamiliarization is a two-step process of introducing participants to an ostensibly ordinary environment, and then of disrupting this familiarity as they move through space. Users' spatial movement affects video imagery of scenery viewable through a window that is embedded within a wall that appears to be a natural extension of the space. The critical moment for defamiliarization occurs when participants realize that they are a part of the scenery; their movement correspondingly affects the horizon line, which is used as a central compositional device to bring about a sense of disorientation within the participant.

Shiftscape: Responsive Visions in Space-time

Jacqueline Sarah Steck

Loretta Wolozin
Instructor, Parsons School of Design
Thesis Reader

"'I think space is folded over through the fourth dimension here and we are looking past the fold.' 'You mean we really aren't seeing it?' 'No, we're seeing it all right. I don't know what would happen if we climbed out this window, but I for one don't want to try.'" - *And He Built a Crooked House*, Robert Heinlein

1 Introduction

1.1 Definition

Shiftscape is a window that serves as a portal between two typically discontinuous spaces, and enables participants the ability to effect visual elements of another dimension. A seascape seen beyond a window changes in response to participants' movement within the space in front of it. The imagery changes as a result of image processing techniques that include movement of video clips, varying opacity, dynamic frame rate and unfamiliar juxtapositions. This portal intends to disorient any gallery-goer with visual shifts in expectations of the natural order of a landscape as it is framed by the window. *Shiftscape* is a visual, poetic interpretation of another dimension which seeks to defamiliarize participants.

1.2 Impetus

I've been an avid reader of science fiction since childhood. The intrigue of it stems from the fantastical ways in which scientific theory and philosophical inquiry concerning the nature of the universe are explored, through literary techniques of defamiliarization and fantasy. It is a form of escapism which allows for fresh perspectives on familiar objects and settings by prolonging perception so that one can experience anew the qualities of life to which one has become habituated.

And He Built a Crooked House is a short story by Heinlein about an architect who attempts to build a house based upon an unfolded tesseract, which is a four dimensional analogue of the cube. When the house is completed, it collapses into one room after a minor earthquake, and the architect and his clients walk inside the house to search for clues for the disappearance of the other rooms.

Everything seems to be intact on the ground floor, but surprisingly they are able to climb up onto the second floor; furthermore, the rooms on that floor have windows that offer glimpses into other dimensions, rather than of the surrounding areas of the house. This disruption of expectation is also the focal point of *Shiftscape*, as participants walk towards the window and realize that their movement triggers changes in the landscape.

1.3 Concept

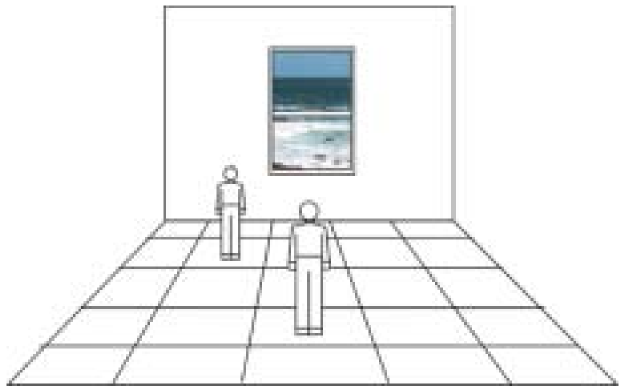
The overarching design problem that I needed to solve was of creating the illusion of another dimension. Given the constraints of time, budget and space, I decided this could best be achieved by constraining the design to a single window, rather than of creating an immersive environment.

Shiftscape is an installation of a window within a wall with a view of a seascape that changes in response to user movement. A typical seascape is visible through the window, with the accompanying sound of ocean waves. When a participant steps in front of the window, (s)he finds him/herself within the seascape, represented abstractly as a force for changing scenery by moving the ocean waves, sky, and changing the speed of the waves. The sounds of waves become increasingly distorted the closer participants are to the window. The user affects the seascape to varying degrees depending upon his/her location in space. Defamiliarization occurs when the user realizes that (s)he has become a part of the seascape.

The wall containing the window is an extension of the existing space, such that it appears to be a permanent part of the environment. The scenery is projected onto a back wall. The window itself is rustic, aged, and starkly contrasts with the dynamism of the changing scenery. Video tracking is used to detect participants' movement through space, which determines the proximity of participants to the window.

The imagery within the window undergoes various transformations corresponding to user movement. The properties of planes, such as position and opacity, are responsive to participants, and the horizon line becomes a central visual device through which a poetic composition is arranged expressing an ideal fourth dimension.

1.1 User movement in space towards the scenery in the window.



As the user walks towards the window, the sounds of ocean waves are played in an increasing number of channels which overlap each other and result in greater degrees of cacophony. The sky is panned to the left or right depending upon the participants' corresponding movement; the position of the ocean waves move up to fill the sky and the speed increases when a participant approaches the window. The opacity of the waves is greatest when there is a single participant, and becomes increasingly transparent with more participants. The number of participants within the space result in a responsive composition.

1.4 Design Questions

Shiftscape consists of three primary design concerns: strategies for defamiliarization, visual composition, and the technical implementation of vision tracking and projected imagery. Together these issues fuse to create a spatially mapped experience that evokes alternate dimensions by jarring our habitual expectations of perceived reality.

Defamiliarization is the central strategy by which *Shiftscape* attempts to evoke a sense of the fourth dimension: it is a process of making something familiar strange, so that the experience of perception is prolonged. Our perceptions are typically automatic, and we habitually try to make the unfamiliar as digestible as possible. This has been identified as a phenomenon of habituation, in which “we become accustomed to a stimulus and gradually notice it less and less. The counterpart to habituation is dishabituation, in which a change (sometimes even a very slight change) in a familiar stimulus prompts us to start noticing the stimulus again” (Sternberg 189). Russian formalist Victor Shklovsky developed the concept of “defamiliarization” in the mid 20th century to counter the then current aesthetic approach to art, which posited that “art is thinking in images”. Shklovsky believed that this definition was exclusive and limited, and expanded art theory by claiming that “The purpose of art, is to force us to notice. Since perception is usually too automatic, art develops a variety of techniques to impede perception or, at least, to call attention to themselves …the technique of art is to make objects "unfamiliar," to make forms difficult, to increase the difficulty and length of perception because the process of perception is an aesthetic end in itself and must be prolonged. Art is a way of experiencing the artfulness of an object; the object is not important” (Shklovsky, 12).

Individual perception may vary, so defamiliarization cannot be consistently effective. Andrey Bely, a Russian poet and theorist in the early 20th century, was ecstatic over the technique used by eighteenth-century Russian poets, in which adjectives were placed after nouns. The reversal of this order, however, is a peculiarity of language, which may have been intended to be prosaic and taken as poetic and vice versa. My intentions for disorientation may likewise have inconsistent “effectivity” on participants.

The visual imagery that is projected has been a difficult design challenge for *Shiftscape*. Imagery of the sky and ocean seemed best suited for conveying a sense of transcendence, and serve as a reference point for normalcy, with the horizon line near the vertical middle of the scenery. This is a main visual element which constantly shifts as participants move within the space. Although the composition may start with a statically positioned horizon line, the movement and disappearance of it provides continuity throughout the piece.

The next design challenge was of considering how technologically enhanced physical spaces can defamiliarize participants. A key factor in achieving this depends on the technology being unobstrusive and non-distracting. Although I initially prototyped tracking the users' movement through space with floor switches, it became apparent after user testing that video tracking would provide for a cleaner, more transparent solution and draw users' attention away from the floor and towards the window.

When these design problems are solved, the project fuses together to become a microworld, which is defined by Mitchel Resnick as "a simplified world, especially designed to highlight (and make accessible) particular concepts and particular ways of thinking. Microworld are always manipulable: they encourage users to explore, experiment, invent, and revise. Seymour Papert describes microworlds as 'incubators for knowledge'" [Resnick 50]. A microworld can also be a physical space, encouraging participants to explore and uncover hidden visual and aural elements which lead to new ways of understanding the space. In this way I hope to bring participants to a greater level of awareness, mediated by the aforementioned techniques of defamiliarization.

1.5 Overview

This thesis is concerned with the ability of participants to effect dynamic composition of the scenery in a parallel reality through their spatial movements. The intangibility of the fourth dimension is explored through a poetic dynamic re-arrangement of video imagery, and is influenced by the creations of other artists in their interpretations of the fourth dimension through visual arts and literature.

Shiftscape focuses on eliciting from users the moment where the boundaries between familiarity and disorientation become blurred;

only then is it possible to prolong perception to create an otherworldly experience within the user. To achieve this state the technology must be transparent and fluid, so that the user is unaware of how the interaction is driven and becomes primarily involved in a sensation of disorientation.

2 Domains and Context

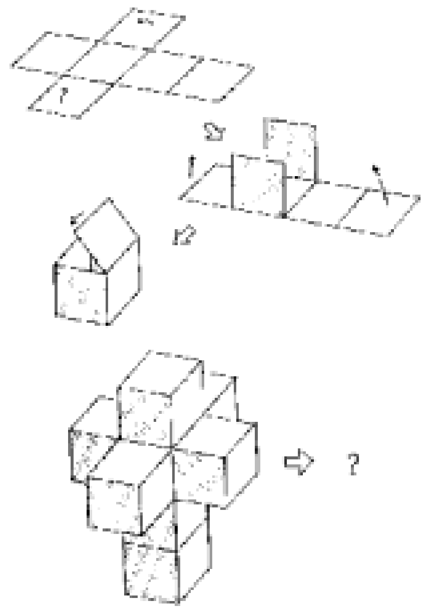
This chapter covers the domains and precedents within which this thesis is rooted and provides contextual grounding. Key domains include scientific theory, science fiction and installation art, which are tied together through an interpretation of the fourth dimension.

2.1 Fourth dimension

What is the fourth dimension? Traditionally the fourth dimension has been known to be the spatial dimension beyond length, breadth and width. Einstein also revealed time to be the fourth dimension; ultimately, space and time are interdependent components of that dimension.

The visualization of an unraveled hypercube offers one means of understanding the spatial dimension. Charles Hinton, an English mathematician during the late nineteenth century, took great strides in explaining the fourth dimension to the general public through his writings and inventions. One of his drawings (Figure 2.1) analyzed the way in which an unfolded cube, a two-dimensional cross, can be folded up to become a cube. Thus a tesseract, which looks like a three dimensional cross when unfolded, becomes a four-dimensional cube when folded up.

2.1 *Hinton's tesseract*



In addition to the spatial dimension, time can also be visualized, though it is much more abstract. According to Einstein, time and space are functions that are dependent on each other; they are only measurable in terms of their relativity. "…recall that any object has length, width and depth. Since we have the freedom to rotate an object by 90 degrees, we can turn its length into width and its width into depth. By a simple rotation, we can interchange any of the three spatial dimensions. Now if time is the fourth dimension, then it is possible to make 'rotations' that convert space into time and vice versa…the meaning of time as being the fourth dimension is that time and space can rotate into each other in a mathematically precise way. From now on, they must be treated as two aspects of the same quantity: space-time" (Kaku, 85). It is this sense that the space within Shiftscape is inextricably linked to the unfolding of time within the dimension beyond the window.

Although such concepts are easy to work out mathematically, they are difficult to visually grasp. The realm of art is free to imagine these theoretical possibilities without the constraints of real world applications. Shiftscape attempts to tie together space and time through a poetic interaction of cause and effect that allows users to effect properties of the imagery displayed beyond the window.

2.2 Fourth dimension in art

A surge of interest in the fourth dimension had a profound effect on art during the late 19th century, and caused a radical departure from a traditional loyalty to imitation. This resulted from a lecture given by the mathematician Georg Bernhard Reimann in 1854, in which he proposed the theory of higher dimensions and single-handedly shattered Euclidean geometry. This idea spread throughout the general public in literary and artistic circles from the years 1890 to 1920, and became a driving force behind the Cubist movement, which revolted against the laws of perspective. “It seized the fourth dimension because it touched the third dimension from all possible perspectives. Simply put, Cubist art embraced the fourth dimension” (Kaku 65). Objects and people could be depicted simultaneously from multiple perspectives as if they were being viewed from other dimensions. The depiction of reality through time was seen through multiple time frames, such as in Duchamp’s *Nude Descending a Staircase,* which depicts a woman descending a staircase at many points in time.

2.2 *Picasso’s “Femme En Pleurs” depicts a woman whose profile is seen from multiple perspectives*

2.3 Duchamp's "Nude Descending a Staircase" depicts a woman at numerous stages of descent within one frame

Thus an exploration of the fourth dimension through art paved the way for modernism and gave artists an entirely different way of perceiving their subject matter.

2.3 Science Fiction

The popularity of the fourth dimension spread to other arts, especially science fiction. Writers were spurred on by Reimann's lecture hypothesizing higher dimensions, and freely explored these concepts in their writings without constraints. Abbot's *Flatland* is one such novel which explores the land of two dimensions, and shows how phenomenon that appears to be mysterious from our perspective are clarified in higher dimensions. Their writings affected culture and may have had a more direct influence on modernism than mathematicians of the day. They continue to influence culture, and Shiftscape has been affected by its very "retro" exploration of scientific theory, as implemented with current technologies.

2.4 Installation art

The form of Shiftscape manifests itself under the rubric of installation art. Shiftscape disorients users through its physical form and structure by disrupting users' expections of a typical view of the space outside. By using the familiar structural device of a wall to dishabituate participants, I seek to reinforce the idea that the 'scenescape' seen beyond the window isn't an ordinary ‘scenescape’, but rather a bizarre, otherworldly one, which isn’t necessarily a dimension that we are familiar with. The window is a gateway between this comforting habitual reality and a disturbing parallel one linked through the connection of space and time. Participants control this parallel universe through their movement in space, and are given illusion of access to another dimension.

The user catalyzes the unfolding of time in a multiply connected space, first studied by Riemann, in which “different regions of space and time are spliced together… physicists are now seriously studying multiply connected worlds as a practical model of our universe. These models are the scientific analogue of Alice’s looking glass. When Lewis Carroll’s White Rabbit falls down the rabbit hold to enter Wonderland, he actually falls down a wormhole” (Kaku, 18).

2.5 Precedents

Reconsideration of spatial perception has been extensively explored by James Turrell, a late 20th century installation artist. He reimagines spaces by using light in unusual ways to provoke uncertainty in a participants’ perception of the space. *Danae* is an empty room with what appears to be a blue light glowing on the opposite wall. After walking halfway through the room one realizes that what seems to be a projection is actually another room beyond the current one; a square hole is cut out of the opposite wall.

2.4 *“Danae”, James Turrell*

A sense of wholeness and transcendence accompanies this moment of realization and understanding, which is the point at which the familiar became unfamiliar and disorienting.

Yayoi Kusama is also an installation artist who experiments with our perception of depth by using a mirror to extend space. *Infinity Dots Mirrored Room* disorients visitors by requiring them to physically adjust to their new settings. First visitors must take off their shoes and put on one of an enormous amount of provided slippers of various sizes (they are more like oversized cloth socks). After putting these on, the visitor then opens up a door into a room with mirrored walls, muted polka dots on the floor and ambient lighting. Another set of doors opens up into another room, also entirely paneled with mirrors, but this room is brightly lit and there were white mannequins in the center with red polka dots. The floor, too, is white with red polka dots.

2.5 *Yayoi Kusama's "Infinity Dots Mirrored Room"*

Kusama has explained her polka dots to be representative of human beings within the cosmos, and the mirrors accentuate the sense of infinity that one has in her pieces. "Two and three and more polka dots become movement. Our earth is only one polka dot among the milllion stars in the cosmos. Polka dots are a way to infinity" (Hoptman 124). Space and time seem to hang still in the space.

Scott Snibbe's Boundary Functions relates to Shiftscape on a more visceral level. The partitioning of space is a strong visual element that serves to break up the piece and dynamically determines its composition. Visitors are first confronted with a square platform on the ground. Two people step on the square, and a line is projected that separates the two participants; more boundary lines appear when there are more participants on the square. It is based upon dynamic voronoi diagrams, and perpetually divides up the number of participants within the space. Likewise, Shiftscape enables a dynamic composition which is activated when participants step in front of the window.

2.6 Context

An ideal setting for the piece is within a seemingly natural environment that offers no indication of an unusual fourth dimension lurking around the corner, with properties changing in response to conditions within the current space. If a natural setting cannot be found then such a space must be recreated via construction of walls and embedded windows. Shiftscape then becomes a portable art project when it can be adapted to fit to any space.

2.7 Target Audience

This experience enables any imaginative mind to play with the notion that actions in our customary three-dimensional space may have consequences in other dimensions. We experience a semblance of this in our daily lives when we effect change in a distant space over the phone or internet. However, rather than affecting other humans, Shiftscape offers participants the chance to affect the physics of another world, and to see this world in various perspectives at the same time.

2.6 *Disneyland can be enjoyed without specialized a priori knowledge*

I intend for the visitor to have a phenomenological, immersive sensory experience not unlike that of visiting Disneyland, in the sense that one's typical surroundings are subtly transformed into more unfamiliar ones, but where some traces of familiarity remain.

2.7 *'Etant Donnes' required the participant to peer through a keyhole in order to view the work*.

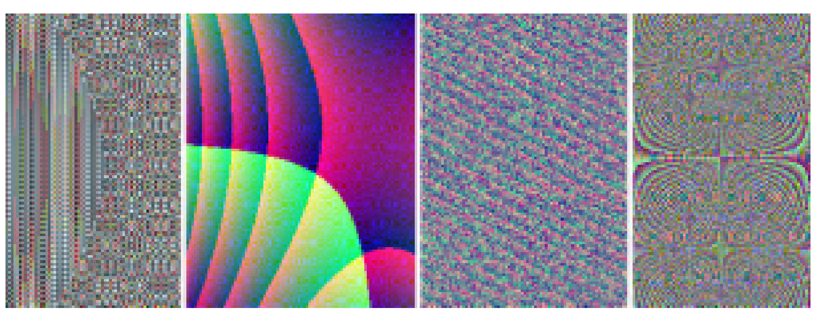
Much like Duchamp's Etant Donnes, the participant must move within the space to complete the piece. Etant Donnes consists of a darkened room that is not much larger than a closet, and the visitor must look through a peephole in order to see what lies beyond that wall. "Here the onlooker 'completes' the work of art, in the classic Duchampian sense, for until the figure in the tableau is spied on, a 'connection' between the work and the spectator is not completed" [Rosenthal 38]. Likewise, without a participant in the space, the view of the seascape would not change; windows are meant to be approached.

3 Methodology

The conceptual resolution of defamiliarizing spaces has strayed into domains and research that seem distant from one another. However, the trajectory leading to a final solution can be traced through the design stages of initial impetus, testing, revision, and completion of the final form.

3.1 In the beginning…

My initial motivation happened upon me while I was at the Ninth International Conference on the Simulation and Synthesis of Living Systems (2004), held in Boston during the first and second weeks of September. The third day into the conference, I imagined a space that evolves over time as one walks through it; I wanted to be immersed in an artificially evolving environment. I began to consider using genetic algorithms to change settings within the space, such as brightness and color of lights, movement of walls, and other fixtures. I began to dig deeper into the realm of evolutionary computation, and created a simple working genetic algorithm; however, I realized that, given the limited amount of time participants will spend with a single project in a gallery setting, it is unlikely that they would become disoriented from it. The complexity of evolutionary computation was creatively stifling because the visual effects were too ambiguous. Still, I pushed on after reading Karl Sims' *Artificial Evolution For Computer Graphics,* and experimented with a Julia-set fractal pattern to create various textures.



3.1 *Experiments with evolving textures to test the genetic algorithm*

However, the rich and varied imagery was merely a technical exercise, and didn't provide a viable path to a disorienting environment. Questions arose, such as: What is the relation between textures and the evolution of a space? What significance would the patterns have for the participants? How do patterns indicate growth or fitness within a space? Experimentation with the patterns seemed too abstract and vague to convey a sense of evolution within the system for the user, and extrapolation from this experiment pointed out that a physically "evolving" environment would probably also be unnoticed. Real evolution takes place on larger timescales, with life and death at stake, and the paradox of creating an artificially evolving environment seemed to indicate decades of research. I needed to find a solution within a much shorter period of time, and thus decided that I should postpone traveling down this. At that point I began to spend more time focusing on the physical, visceral aspects of space.

3.2 Taking Notice

My first physical analysis was of the floor: I considered partitioning the floor space into segments so that quantitative analysis could be derived from specific segments, such as those areas that get stepped on more often. In order to think about the kinds of shapes that the segmented space would take, I marked out frequently traversed areas in order to visualize how an altered space might affect habitual flow, and of what kinds of alterations could be made to the environment to lure participants into the area. This was a first step towards understanding the connection between the physical space and its aesthetic appeal.

3.2 *Marking out a segment of the floor to visualize the segmentation of fitness areas*

I began to discern areas of the floor space that get further worn than others. The space around a door is the most worn area, as it serves as a pathway through space and is an entry point from one place to another.

These experiments helped to determine which areas facilitate the greatest amount of flow for participants. I became increasingly concerned with the ways in which space is traveled, and of how users adjust to unfamiliar situations. It became clear that the relationship of architectural elements within the space was a powerful element that could successfully bring about defamiliarization. I began to re-imagine ways in which spaces could be subtly transformed from structured, habitual experiences to unusual, unsuspecting encounters.

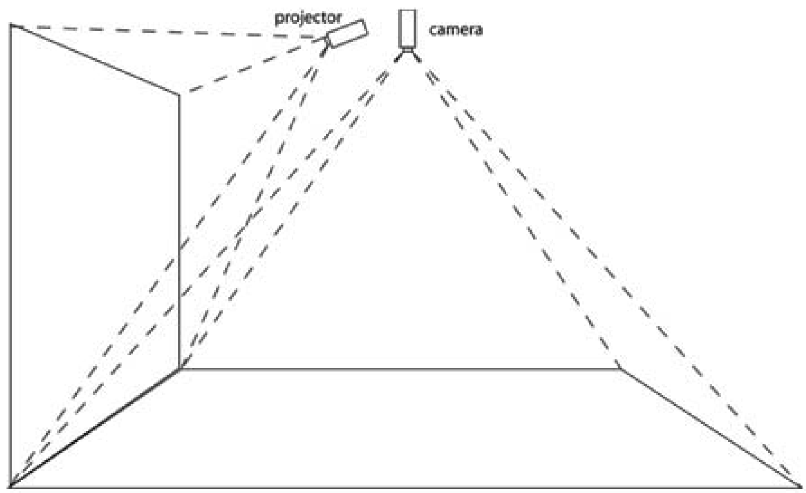
3.3 The Window as a Luring Element

As I narrowed down the possible forms to focus on as elements for defamiliarization, I began to consider other architectural elements that were as practical and vital as the door; the window clearly stood out as an equivalent counterpart. After spending a great deal of time in various coffee shops staring out of floor-to-ceiling windowpanes contemplating this sort of thing, it occurred to me that apparently discontinuous spaces become continuous when our actions within one space affect elements within another. In this manner I could allude to alternate dimensions whose causality depended upon the present one.

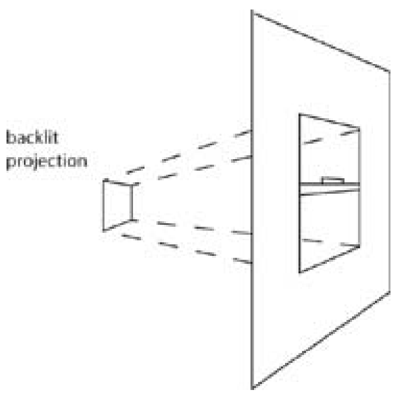
Thus I decided that the window was a viable form for defamiliarization, and provided a reason for participants to walk closer to investigate the imagery behind it. A pathway to the window could trigger various stages of defamiliarization. The expected functionality of the window thus becomes an artistic device for defamiliarization.

3.4 Layout of the Installation

The window and space in front of it determines the physical layout of *Shiftscape*. Imagery is projected onto a wall behind the window, and the pathway towards the window is the area within which users are detected. The wall is extended from one end, such that the embedded window appears to be a natural extension of the space. There is a need for subtlety throughout the piece to conflate two possible devices for defamiliarization, that of the floor space and the window. My hypothesis is that the subtler the physical space and the technology is, the more heightened the sense of disorientation is that can be evoked.



3.3 *The original layout of the space with front projection and video tracking*



3.4 *Early sketch of rear projection onto the window*

3.5 Tracking Users in Three-dimensional Space

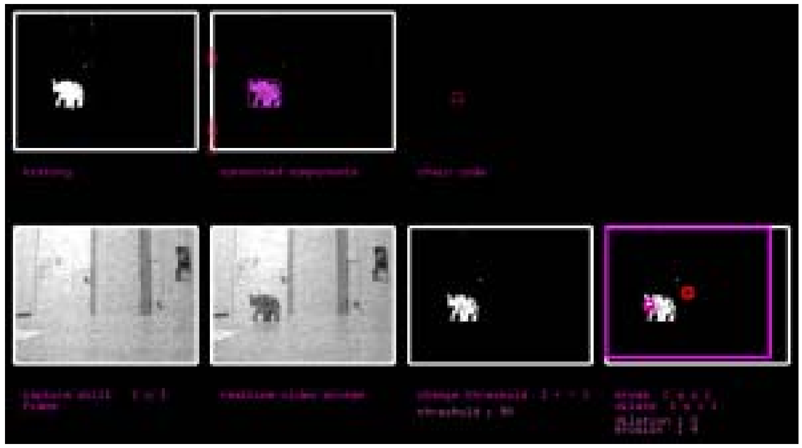
My initial method of tracking users within the space was conceived of with a video camera mounted near the ceiling, pointed towards the floor. Through a series of image processing operations, objects moving through the space would be detected as users, and the position of each user would then control the imagery displayed on the adjacent wall.

3.6 Technical Considerations

The application that tracks users in space is a custom application built in C++, which uses the Quicktime library for video input, and OpenGL for outputting video imagery. The executable is compiled in Codewarrior for a wintel machine. The flow for image processing is as follows:

1. Realtime video is captured from a security camera and inputted into the application.
2. An initial background shot of the scene is taken, and subsequent frames are compared with that initial frame. If there is a difference, something has moved within the image frame, and a binarized image is outputted into another image array.
3. The binarized image array is scanned and pixels that are connected to neighboring pixels become one object.
4. Objects of a certain size (larger than noise from camera input) are assumed to be users walking through the space. The (x,y) positions of these objects correspondingly affects properties of the projected video clips.

3.5 *Control panel for video tracking*



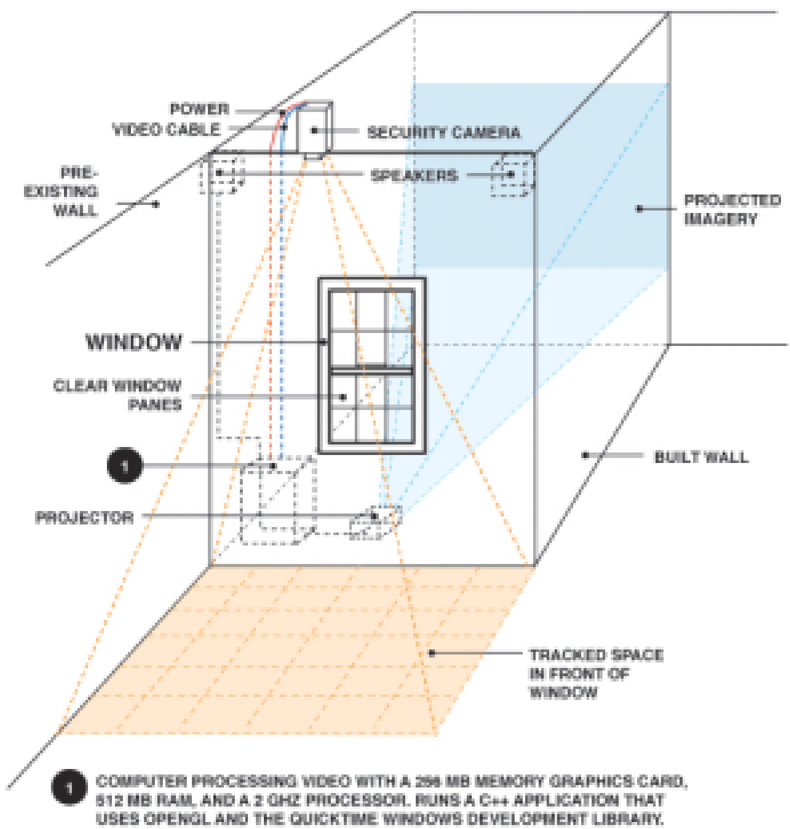
One of the chief technical concerns is that of frame rate: the number of single "frames" that are exposed per second. When a video clip is played on the screen, frames from that clip are stored on the graphics card within the computer. The minimum amount of memory for the video card needs to be at least 128 MB in order to smoothly play back video in OpenGL. Otherwise, the playback of the video clips would be slower than what they are set to, which is 29.97 Hz, and the end result would be video clips that lag in response to user movement.

3.7 Prototype With Floor Switches

The initial concept proposed that partitioned segments within the space affected the surrounding area according to the frequency with which they were stepped on. Even though my concept developed more into an issue of pathways within space, I still prototyped using my earlier technical means of the floor switches to detect user movement through the space. After spending a great deal of time with the switches, it became apparent that video tracking would be a more flexible and transparent solution. During the peer-to-peer presentations I experienced a technical failure, during which the switches stopped functioning properly when I moved them from one room to another. It was at this point that I realized that video tracking would not only save an incredible amount of time as a portable solution, but would also be more flexible with regards to the type of floor space in which it could be situated.

3.8 Turnaround

Since one of my main concerns is to defamiliarize users as they approach the window, proximity detection was a concern, and proved to be a simple matter with video tracking. Added functionality that is inherent to video tracking also enables detection of participants moving left or right. Computationally, video tracking is more conducive for gradual detection, and provides for more flexibility than that of clearly defined on/off states. An open area provides for transparency of technology, and video tracking avoids the complications and constraints that arise with IR sensors, which need to be anchored near the floor. Since the need for a creative partitioning of the space was no longer a concern, the users' attention could be directed towards the window rather than the floor. Video tracking proved in the end to be a cleaner and more graceful solution.



3.6 *Setup of space which depicts the extension of the wall so that the window seems to be a natural part of it*

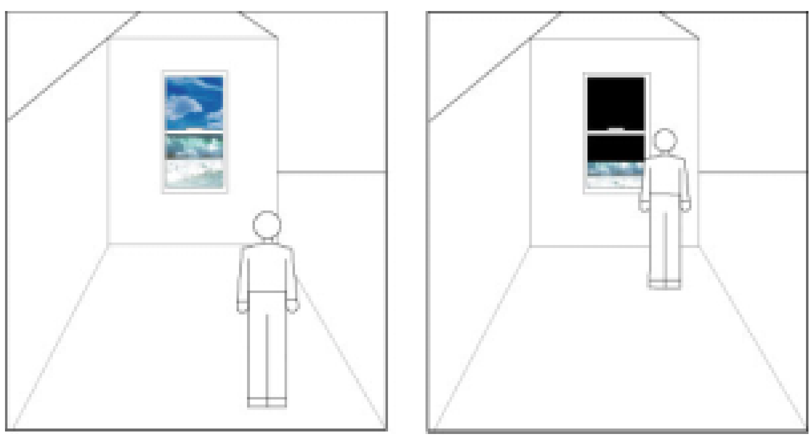
3.9 Visual Content

The visual content is focused on imagery of the ocean and uses the horizon line as a central compositional device. As participants walk through the space towards the window, they navigate an abstracted responsive seascape.

3.7 *Screenshots of early experimentation with juxtapositions of the ocean with elements found above the horizon line*

3.10 User Scenario

3.8 *User scenario depicts what the imagery will look like when the user is furthest away and closest to the window*



The seascape's responsivity to participants becomes apparent when there is a single user within the space. As a participant walks around, the level of the horizon and its transparency corresponds with the proximity of the user to the window. Additionally, when participants move left or right they are able to correspondingly move the sky. The horizon line is a central design element around which the composition is generated.

3.9 *Final images used for elements of sea and sky*

The elements of the sky and the ocean are the literal images to be used for content within the scheme of dynamic repositioning of the video imagery. The compositional changes are never static or predictable, but always responsive.

3.11 Evaluation

The criteria for the success of this thesis lies within a number of areas: technical functionality, conceptual strength, psychological effect, aesthetics, and the strength of the methodology to consistently adapt to a shifting concept. The development of the concept has been consistently challenged and criticized, and some of the changes are a result of reflecting upon these weaknesses.

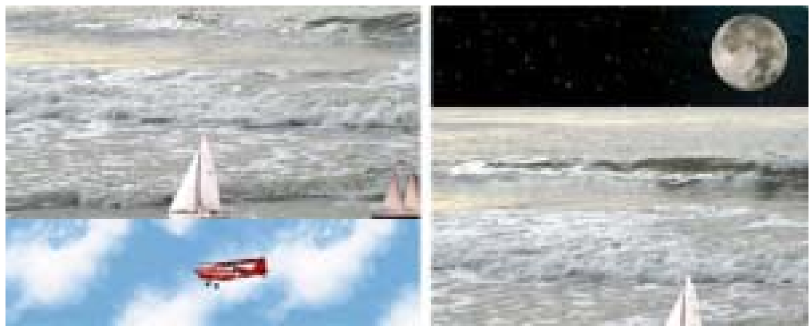
In order to achieve a sense of defamiliarization, the underlying technical implementation needs to be subtle. This can be best achieved if those components are non-obtrusive and hidden from view. After considering the reception of the project during the peer-to-peer presentations, it was apparent that the focus was entirely on the switches and the floor, rather than of the illusion to be seen through a window. Even though I spent a great deal of time with the switches, I took into consideration comments made on how video tracking might be a better solution. After realizing that these suggestions were valid, I decided to risk giving up the floor switches. My attachment to them may have been a technological fetishism with visible technology as well as a fear of alternative technological solutions, but as I needed subtlety in the experience, I had to make the right technical choice that fit the conceptual needs of this thesis.

Regardless of how well the project works technically, its functionality is in service of the overall concept, which is that of discovering and experimenting with strategies of defamiliarization. Design is thus not limited to technical tools or to visual form, but covers every aspect of concept development. The design process sometimes stops at the technical level, with regards to the difficulty of choosing the right tools, and other times with the visual form before a concept is fully developed. Thus the resolution of a technical design problem is not a mark of complete success.

The psychological effect that users should go through is from familiarization to disorientation, and then back to familiarization again. The piece needs to evoke a sense of the familiar before users begin to interact with it. If it doesn’t seem familiar at first, then there isn’t a chance for defamiliarization to occur; therefore, these two psychological states are sequential and must be experienced in order.

In order to evoke a sense of the familiar, the visual imagery displayed beyond the window first displays a typical view of the ocean, and it becomes increasingly unfamiliar as participants walk towards it. During the final thesis presentation, I showed imagery which had a surrealist undertone, with boats floating on the ocean and planes whizzing by in the sky. Unfortunately, rather than presenting a consistently responsive system, I had two states, one composition of an ordinary seascape, and another of an unfamiliar setting in which the ocean replaced the sky and the boats sailed on the rim of the sky. One of the criticisms which I was well aware of was that the responsivity of the system was lacking, and the reason that it was absent was because I decided to focus on creating a visually compelling sense of disorientation. Bringing the concept to its completion required that I think about the system without those visual elements, and the critique prompted me to decide to incorporate those elements at the last stage of defamiliarization, when the user is as close as possible to the window.

3.10 *Imagery displayed at the final thesis presentation*



In order to fulfill all of the aforementioned criteria, learning to adaptively design has been a crucial aspect of the overall design process. Without fully understanding what a tool has to offer, I've gone through an iterative process of estimating its effectiveness and testing it within a short period of time. My artistic development throughout this thesis project has been a maturation of conceptual skill, technical know-how, planning and synthesis of elements to create a unified project. The trial and error process of technical implementation was a necessary component for the realizing the concept in a fully meaningful level. Finally, it fused with the concept of establishing a sense of familiarity with nonobstrusive technology, in order to bring about a state of disorientation within the user.

4 Conclusion

4.1 Summary

Shiftscape is a disorienting experience which enables users to change video imagery of the scenery outside of a window through spatial interaction in front of it. The strategy used to defamiliarize participants is to initially create a familiar experience, which is that of walking towards a window, and to disrupt this experience through varying degrees of unfamiliarity. The seascape encourages dynamic exploration of the composition of the scenery.

Shiftscape uses vision tracking to determine users' location within space, and their movement and proximity to the window are factors for effecting compositional change. The aim of the system is to create a sense of defamiliarization through a two-step process of familiarization and defamiliarization. Familiarity is introduced through non-obtrusive technologies situated within an ordinary environment, and defamiliarization occurs when there are subtle changes in the imagery. The key visual element within the seascape that structures the composition is the horizon line, which serves as a repeated motif throughout the changing composition; the content is that of the sea and the sky.

The development of this thesis has undergone a progression of design changes, from technical implementation for user tracking, to visual change, from abstract to literal imagery of the sea and sky. This thesis is greatly influenced by various literary interpretations of the fourth dimension, and perceptual strategies for adapting to new environments.

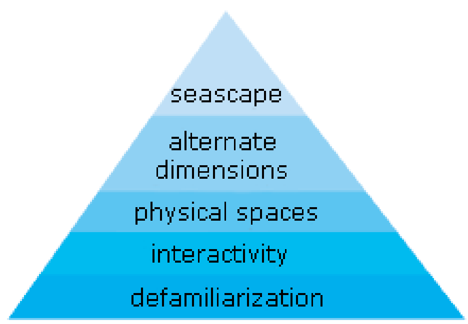
4.2 Design Inquiry

This thesis has aimed to solve the problem of understanding how strategies of defamiliarization can prolong perception through the union of spatial and visual technologies. My hypothesis is that a crucial step of introducing a sense of the familiar can only be brought about by subtlety in technological implementation and form. After this stage has been reached, the next step for defamiliarization can be employed. The realm of the unfamiliar is inextricably tied to the ways in which the familiar is brought about, and the final form of these thesis inquiries is the familiar device of a window. Video imagery has been used to simulate what appears to be a view of a continuous outside environment. This scenery beyond the window is the area for an artistic exploration of unfamiliarity.

4.3 Future Directions

The strategy of defamiliarization implemented in this thesis has focused on physical space to extend our awareness of familiar environments. Future directions will explore other means of defamiliarization through virtual and electronic spaces, with an exploration in other interests such as robotics and information visualization. A pyramidal scheme of research interests starts with a foundation of defamiliarization, as depicted in Figure 1.4. Further projects will be based upon this scheme to varying degrees, but will necessarily be rooted in strategies of defamiliarization.

4.1 *Hierarchy of research interests*



Works Cited

Heinlein, Robert. *The Fantasies of Robert A. Heinlein*. Tor Books, New York. 2002.

Hoptman, Tatehata and Kultermann. *Yayoi Kusama*. Phaidon Press Limited, New York. 2000.

Kaku, Michio. *Hyperspace: A Scientific Odyssey Through Parallel Universes, Time Warps, and the 10th Dimension*. Oxford University Press, New York. 1995.

Oliviera, Oxley and Petry. *Installation Art in the New Millenium*. Thames and Hudson, London. 2003.

Resnick, Mitchel. *Turtles, Termites, and Traffic Jams*, MIT Press. 1994.

Shklovsky, V. *Art as technique*. In L. T. Lemon & M. J. Reis (Eds. and Trans.), *Russian formalist criticism: Four essays*. University of Nebraska Press, Lincoln, NE. 1965.

Sternberg, Robert J. *In Search of the Human Mind*. Hartcourt Brace and Company, Orlando, FL. 1995.

Works Consulted

Abbot, Edwin A. *Flatland*. Signet Classics, New York. 1984.

Bayles and Orland. *Art and Fear.* Santa Cruz, California, Image Continuum Press. 1993.

Buckland and LaMothe. *AI Techniques for Game Programming*. Premier Press, Ohio. 2002.

Paul, Christiane. *Digital Art*. Thames & Hudson, London. 2003.

Dawkins, Richard. *The Blind Watchmaker.* W. W. Norton & Company, Inc., New York. 1986.

Hickey, Dave. *Air Guitar*. Art Issues. Press, Los Angeles, California. 1997.

Lovelock, James. *Gaia: A New Look at Life on Earth*. Oxford University Press, Oxford, 1979.

Mitchell, Melanie. *An Introduction to Genetic Algorithms.* MIT Press, Cambridge, Massachusetts. 1996.

Myler and Weeks. *The Pocket Handbook of Image Processing Algorithms in C*. Prentice Hall, New Jersey. 1993.

Petroski, Henry. *Invention By Design*. Harvard University Press, Cambridge, Massachusetts. 1996.

Wiener, Norbert. *Cybernetics: Control and Communication in the Animal and the Machine.* MIT Press, Cambridge, Massachusetts. 1948.

Web References

Porter, Jane. *Defamiliarization and Renewing the Art of Perception in Thomas Carlyle, D.H. Lawrence, and Annie Dillard.* http://www.victorianweb.org/courses/nonfiction/dillard/porter14.html: 2003.

http://www.conversations.org/99-1-turrell.htm
An interview with James Turrell and Richard Whittaker.

http://www.cwru.edu/artsci/engl/VSALM/mod/ricca/paper.html
Signifying Nothing: The Fourth Dimension in Modernist Art and Literature.

Appendix 1: Triggering degrees of Unfamiliarity (fragment)

```
glEnable(GL_BLEND);
glBlendFunc(GL_SRC_ALPHA,
GL_ONE_MINUS_SRC_ALPHA);

float opacity;

if (numberOfUsers > 2) {
    opacity = numberOfUsers/100.0;
    opacity = 1.0 - opacity; }
else
    opacity = 1.0;
    if (CC->numberOfComponents > 0) {
    prevTime = currentTime;
    currentTime = QTVP2->getTime();
    if (currentTime < prevTime) {
            forward = false; }
    else if (currentTime > prevTime)
            forward = true;
            float newRate;
            // do the zone thing
            if ((avgY > 0) && (avgY < zone1))
                    newRate = .8;
            else if ((avgY > zone1) && (avgY < zone2))
                    newRate = 1.3;
            else if ((avgY > zone2) && (avgY < zone3))
                    newRate = 1.7;
            else if ((avgY > zone3) && (avgY < zone4))
                    newRate = 2.0;
    if (forward == true) {
            QTVP2->setNewRate(newRate); }
    else if (forward == false){
            newRate = -newRate;
            QTVP2->setNewRate(newRate); }
```

```
            seaPos = ((float)avgY/CAM_H) * 300.0 -100.0;
            skyPos = ((float)avgX/SCRN_W) * 1200.0 - 1600;}
            else if (seaPos > -100)  {
                    seaPos--;
                    QTVP2->setNewRate(.3); }
            else if (numberOfUsers == 0)
    bgControl->captureBackground(CAM_IMG[1]->image,
CAM_W, CAM_H);

    cloudTex->renderTexture(skyPos,0,2500,600,false, 1.0);
    oceanTex->renderTexture ( 0,0,FLICK_W, FLICK_H,
false, 1.0 );
glDisable(GL_BLEND);
```

Appendix 2: Genetic Algorithm

```
genetic::genetic(){
      avgFitness = 0;
      offspring = 0;
      c=0., x2=0., y2=0., n=0., z=0.;
      r=0., g=0., b=0.; }

void genetic::init(int population){
      float randomBit;
      pop = population;
      //set seed
      srand((unsigned)time(NULL));

// set the size of the new population
      chromosome = new chromoStruct[population];
      offspringPop = new chromoStruct[population];
      memset(chromosome, 0, sizeof(chromoStruct)*population);
memset(offspringPop, 0,
    sizeof(chromoStruct)*population);

// set random alleles in chromosomes
      for (int i = 0; i < pop; i++) {
      for (int j=0; j < ALLELES; j++){
              randomBit = (float)rand()/RAND_MAX;
              if (randomBit>.5){ chromosome[i].allele[j] = 1; }
                      else{ chromosome[i].allele[j] = 0; }
              }
              chromosome[i].xpos = 200;
              chromosome[i].ypos = 200; } }

void genetic::calculateFitness(int gen, int xpos, int ypos){
      int totFitness;
      totFitness = avgFitness = 0;

      // initialize the fitness values to zero
      for (int j = 0; j < pop; j++){
```

```
            chromosome[j].fitness = 0; }

        // add up fitness values for the chromosomes
        for (int i=0; i < pop; i++) {
            for (int j = 0; j < ALLELES; j++) {
            if (chromosome[i].allele[j] == 1)
                chromosome[i].fitness++;      }

            if ((chromosome[i].xpos !=
            xpos)&&(chromosome[i].ypos != ypos))
            if (chromosome[i].xpos < xpos){
                chromosome[i].xpos++;
            else
                chromosome[i].xpos--;
                if (chromosome[i].ypos < ypos)
                {       chromosome[i].ypos++;  }
                else
                    chromosome[i].ypos--; }

            totFitness += chromosome[i].fitness;

            // find absolute value of distance between
            // (x,y) mouse coordinates and the chromosome
            //
            // the closer it is, the fitter it is

            int fitnessX = abs(chromosome[i].xpos - xpos);
            int fitnessY = abs(chromosome[i].ypos - ypos);
            chromosome[i].fitness = (fitnessX +
            fitnessY)%255; }

            //avgFitness = totFitness/pop; }

    void genetic::chooseParent(int parent){

        // select four parents at random;
        int Pa, Pb, Pc, Pd;
```

```
    Pa = (int)pop * rand()/RAND_MAX;
    Pb = (int)pop * rand()/RAND_MAX;
    Pc = (int)pop * rand()/RAND_MAX;
    Pd = (int)pop * rand()/RAND_MAX;

    int parents[4] = { Pa, Pb, Pc, Pd };

    // select the most fit of the four parents
    int n = 4;
    for (int i=0; i<n-1; i++) {
    for (int j=0; j<n-1-i; j++)
            if (chromosome[parents[j+1]].fitness >
             chromosome[parents[j]].fitness) {
            // compare the two neighbors
    int tmp = parents[j];
    // swap parents[j] and parents[j+1]
            parents[j] = parents[j+1];
            parents[j+1] = tmp; }  }
    // set the parents
    if (parent == 1){
            parentA = chromosome[parents[0]];
            parentA.label = parents[0]; }
    else if (parent == 2){
            parentB = chromosome[parents[1]];
            parentB.label = parents[1]; }
    else {} }

void genetic::crossover(int locus){
    bool tempChromoA[ALLELES];
    bool tempChromoB[ALLELES];
    int beforeLocus = 0;

    // swap alleles
    for (int i = locus; i < 8; i++){
            tempChromoA[i] = parentA.allele[i];
            tempChromoB[i] = parentB.allele[i];
```

```
            parentA.allele[i] = tempChromoB[i];
            parentB.allele[i] = tempChromoA[i]; }
    child = parentA; }

void  genetic::mutation(){
int randomBit;
    randomBit = rand()%ALLELES;
    parentA.allele[randomBit] = !parentA.allele[randomBit];
    child = parentA; }

void  genetic::copyGen(){
    if (offspring == 0){
            offspringPop[0] = parentA;
            offspringPop[1] = parentB;
            offspring=2; }
    offspringPop[offspring] = child;
    offspring++; }

void  genetic::replaceGen(){
memcpy(chromosome, offspringPop, sizeof(chromoStruct)*pop); }

void  genetic::loadPop(unsigned char * imageSrc, unsigned char *
imageDest, int w, int h){
    int k =0;
    int totalSize = w * h;
    for (int i=0; i<totalSize; i++){
// FIND A RANDOM MEMBER OF THE POPULATION
    int randMember = rand()%pop;
    int r = (chromosome[randMember].fitness*10)%255;
    int g = (chromosome[randMember].fitness*20)%255;
    int b = (chromosome[randMember].fitness*30)%255;

    x2 = (x2 * cos(n) + c);
    y2 = (y2 * sin(n) + c);
    n+= c;
    c+= 10.;
```

```
    int pix = i*3;

    if (imageSrc[i] == 255){
            imageDest[pix]=x2;
            imageDest[pix+1]=y2;
            imageDest[pix+2]=x2;  }
    else {
            imageDest[pix]=r;
            imageDest[pix+1]=g;
            imageDest[pix+2]=b;  } } }
void  genetic::drawPop(int x, int y, int w, int h){
    glTranslatef(x, y, 0);
    glPushMatrix();
    int start_x = x;
    int start_y = y;
    int expand = 30;
    int i=0;

    while (i < pop){
            glBegin(GL_QUADS);
            int randMember = rand()%pop;
            float r = chromosome[randMember].fitness/255.0;
            float g = (r*10)/255.0;
            float b = (r*20)/255.0;
            int draw_x = chromosome[i].xpos;
            int draw_y = chromosome[i].ypos;
            glColor4f(r,g,b,100.);
            glVertex3f(draw_x, draw_y, z);
            glVertex3f(draw_x, draw_y+expand, z);
            glVertex3f(draw_x+expand, draw_y+expand, z);
            glVertex3f(draw_x+expand, draw_y, z);
            glEnd();
            glPopMatrix();
            i++; }    }
```

Appendix 3: Fractals

```
fractals::fractals(int scrsizex, int scrsizey){

    minx = -2;
    maxx = 2;
    miny = -1;
    maxy = 1;
    ITER = 50;
    conx = -0.11;
    cony = 0.66;
    pixcorx = (maxx - minx)/scrsizex;
    pixcory = (maxy - miny)/scrsizey; }

void  fractals::fractalize(unsigned char * imageSrc, unsigned char *
imageDest, int w, int h,int mouse_x, int mouse_y){

    screen_w = w;
    screen_h = h;

    mouseX = mouse_x;
    mouseY = mouse_y;

    for (int y=0; y<screen_h; y++){
      for (int x=0; x<screen_w; x+=2){
                  int pixIndex = y*screen_w+x;
                  julia(imageSrc,imageDest, x,y);
                  if (lastcolor!=newcolor)
                  julia(imageSrc,imageDest,x-1,y);
                  else {

                          int altPix = y*screen_w+(x-1);
                          int rcol = (lastcolor)%255;
                          int gcol = (lastcolor+100)%255;
                          int bcol = (lastcolor+200)%255;

                          imageDest[altPix*3] = rcol;
```

```
                imageDest[altPix*3+1] = gcol;
                imageDest[altPix*3+2] = bcol; }
            newcolor = lastcolor; }  }  }

fractals::fibonacci(int n){
    if ((n==0) || (n == 1) )
        return n;
    else
        return fibonacci(n-1) + fibonacci(n-2); }

void  fractals::julia(unsigned char * imageSrc, unsigned char *
imageDest, int xpt, int ypt){

    long double x = xpt * pixcorx + minx;
    long double y = maxy - ypt * pixcory;
    long double xnew = 0;
    long double ynew = 0;
    int iter = 50;
    int pixIndex = ypt * screen_w + xpt;
    int i;
    for (int i =0; i < iter; i++){

        // julia function:  z = z * z + c
        xnew = x*x - y*y + conx;
        ynew = 2*x*y + cony;
        x=xnew*mouseY*mouseY;
        y=ynew*mouseX*mouseX;
        //x=xnew;
        //y=ynew;
        if ( (x*x+y*y)>4 ) break;
        // so that this sucker doesn't
        // run to infinity
    } // End each pixel loop

    int color = x * screen_w + x ;
    int r_val = color+mouseX;
    int b_val = color+mouseY;
```

```
    int g_val = color+200;
    if (r_val > 255) r_val=r_val%255;
    if (b_val > 255) b_val=b_val%255;
    if (g_val > 255) g_val=g_val%255;
    if (i >= iter) {
            imageDest[pixIndex*3] = 0;
            imageDest[pixIndex*3+1] = 0;
            imageDest[pixIndex*3+2] = 0; }
    else {
            imageDest[pixIndex*3] = r_val;
            imageDest[pixIndex*3+1] = g_val;
            imageDest[pixIndex*3+2] = b_val; }
    newcolor=color; }

void fractals::flow(unsigned char * imageSrc, unsigned char *
imageDest, int w,int h){
    int totSize = w*h;
    int pixIndex;

    for (int i = 0; i < h; i++){
            for (int j=0; j < w; j++){
                    pixIndex = i*w + j;
                    imageDest[pixIndex*3] =
                     imageSrc[pixIndex*3]+1;
                    imageDest[pixIndex*3+1] =
                    imageSrc[pixIndex*3+1]+2;
                    imageDest[pixIndex*3+2] =
                    imageSrc[pixIndex*3+2]; } } }
```