Creating a User Interface for Interactive Environments:

With a focus on Interactive Cinema

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“The cinema is born immediately as a social machine… One could just as well propose that it is the spectators who invent cinema.” (Comolli in Tafler, 1999)

i. Prologue: A Definition for Interactivity:

David Rokeby defines interactive art as involving "a dialogue between the interactor and the system making up the artwork. The interactive system responds to the interactor, who in return responds to that response" (Rokeby, 2002). This refers to the concept of a "feedback loop" that many people associate with interactive systems, and which I believe is a very effective way of creating agency.

The extreme view on interactive art is that the artwork cannot be said to be interactive unless both the spectator/interactor and the artwork are in some way changed permanently by each other or affected by the exchange (Rokeby, 2002). In order for a piece of art to meet this requirement it would need to have enough intelligence to be able to adapt and grow according to its surroundings and user interactions. While interesting, I do not feel that the concept of interactivity needs to be so narrowly defined.

For my research in interactive cinema, I am defining interactivity as a relationship between a user and a media object (book, computer, etc.) where the user has agency over the media object's form and/or content, and thus actively contributes to the construction of meaning and/or influences the media object's response(s). A standard novel would therefore not be interactive (under this definition) because the reader has no control over the book's content, whereas a *Choose-Your-Own-Adventure* book, while not digital, is still interactive because it allows for the user to co-construct meaning by deciding on their own story path through the branching narrative structure.

The purpose of this essay is to discuss ideas around how to effectively construct a user interface for interactive installations. In my discussion I pay particular attention to user interfaces for interactive cinema, as that is where my principle research lies. I begin by outlining my model for a particular type of interactive cinema, which I call Object-Oriented Interactive Cinema (OOIC). Next, I talk about some concepts for building a language for an interactive environment, including a discussion of HCI design principles, navigational structures, and the definition of a language for interactive cinema installations. Section 3 of my essay deals with the user experience and how an interactive cinema installation should be designed to meet a user’s experiential goals. Section 4 deals with the many obstacles and challenges encountered when trying to get sensory data into a computer through video capture and analysis. Finally, the last section describes three interactive installations that were designed around the principles outlined in this paper, one which was also built upon the OOIC model.

1. Introduction to Object-Oriented Interactive Cinema:

1.1 Object-Oriented Interactive Cinema (OOIC)

In discussing Dziga Vertov's *Man with a Movie Camera*, Lev Manovich states:

"Vertov is able to achieve something that new media designers and artists still have to learn - how to merge database and narrative into a new form." (Manovich, 2001, p.243)

Object-Oriented Interactive Cinema (OOIC) is an attempt to create a new form of cinema, or a new branch of digital cinema, that aims at effectively combining database and narrative. The term *object-oriented* implies a modular system, and OOIC uses the concept of an *object* comparably to object-oriented design (OOD) paradigms. Just as in computer programming where an algorithm specifies the steps or functions to be performed on any data, the OOIC structure has algorithms and rule-sets designed to dynamically generate navigation paths from a matrix of interconnected film objects.

In computer science, a database is defined as a structured collection of data, or an organized body of related information. There are many different types of databases – hierarchical, network, relational, object-oriented, etc – and they each use different models and algorithms for organizing the data. The Object-Oriented Interactive Cinema model uses an object-oriented database, which stores complex data structures (objects) in hierarchical classes. An object of one class can inherit properties from classes higher than it in the hierarchy.

"... creating a work in new media can be understood as the construction of an interface to a database." (Manovich, 2001, p.226)

The high-level concept for OOIC is simple – an object-oriented database is composed of "film objects" that are assembled in a non-linear fashion (yet with meaning) to create the narrative. Once we start to break this sentence down, however, the immense complexity emerges. For example, what is a "film object?" A film object could be a film clip (of any length – from one frame to many minutes of footage), a sound clip (again, of varying length), a collage of multiple film clips, etc. This brings up issues of granularity. For example, at what point does a film object become so "small" as to lose its effectiveness? How does one decide on a suitable level of granularity? Some points can be obvious – for example, a film object of one frame in length would probably have extremely limited use, if any at all, as it would be undetectable by the human eye. But what about a 1 second film object? Or a film object an hour long? At what point does a film object become so long that it could just as well be presented in a traditional linear fashion?

It is possible that the narrative itself could determine what the effective level of granularity should be in a multi-linear film. For example, one narrative might lend itself very well to a music video style of granularity that uses rapid cutting and shot transitions.

Relatively short film objects would be most appropriate in this case. Another narrative might require some more drawn-out shots, in which case the length of the film objects would need to be longer.

1.2 OOIC Composition

Once the film objects are stored in the database, how is it then decided which objects are shown where, when, and on which screen (for multi-channel video)? The algorithms that run the decision making process would need to respond to user inputs, allowing the user to construct the story content. One of the biggest obstacles for a user-driven environment, however, is how to create a suitably intelligent interpreter to produce a meaningful narrative out of the assembled film objects based on user inputs.

Theoretically, the algorithms controlling the movie content could come with pre-compiled choices (i.e. pre-made different interpretations of the movie content), essentially giving the viewer a number of pre-made storylines chosen by a professional "director." I do not see much increase in viewer satisfaction in this scenario, however, than one would gain from a branching-type multi-linear narrative, and so I have chosen not to include pre-chosen paths in the OOIC model. To reiterate this another way: the model I have created which I have termed Object-Oriented Interactive Cinema implies a narrative construction from user interaction.

1.3 Selection as Authorship

The OOIC approach to moviemaking is an example of selection as authorship. Lev Manovich uses the phrase *authorship as selection* (Manovich, 2001), but I have decided to reverse the terms here for purely semantic reasons. The implication of selection as authorship is that the author is no longer the creator of the original content, but that by allowing the viewer control over content and content order (temporal/spatial organization), a new author emerges – the spectator-author (Barthes, 1977; DeCerteau, 1984).

> *"The creative energy of the author goes into the selection and sequencing of elements rather than into original design." (Manovich, 2001, p.130)*

Thus, in the object-oriented cinema model, the audience is the author because it is their interaction with the film object database that creates the narrative. Their "selections," whether through conscious user inputs or through inputs unknown to the user, construct the cinematic text.

1.4 Compositing as Authorship

In the OOIC model, selection is only one of the many interactive possibilities. For example, there is also the opportunity to incorporate digital compositing in the construction of dynamic film content. For example, rather than a film object being switched for another film object in response to a particular user input, the two film objects could be collaged together, or displayed side-by-side using split-screen effects. The way that the objects could be collaged is open to many different variations (different blending paramaters), and likewise for split-screen effects (horizontal/vertical separation, etc.). Used in combination, selection and compositing are two very powerful tools for the digital age. As Manovich states, "... along with selection, compositing is the key operation of postmodern, or computer-based, authorship" (Manovich, 2001, p. 142).

1.5 Conceptual Justification

Other researchers and research groups, such as the Interactive Cinema group at MIT, are also exploring non-linear cinema from the context of film fragments that get assembled at run-time to construct the narrative. No one has yet, at least in the research that I have performed, attempted to discuss and theorize interactive cinema using an object-oriented model. Having said this, many of the groups have used terminology or concepts that are approaching an object-oriented framework, and so my work fits nicely within the larger body of knowledge around interactive cinema by attempting to take existing ideas one step further.

For a discussion of some of the research and groups that have taken a non-linear, interactive approach to cinema, see my website InteractiveCinemaResearchGroups.

2. Building a Language for an Interactive Environment:

"A technology is interactive to the degree that it reflects the consequences of our actions or decisions back to us. It follows that an interactive technology is a medium through which we communicate with ourselves... a mirror." (Rokeby, 2002)

2.1 Human-Computer Interaction for Interactive Cinema

"Human-computer interaction is a discipline concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them." (Interface and Navigation course notes, SFU Surrey CMS, 2001)

The study of Human-Computer Interaction (HCI) is crucial to the development of a successful interface and navigation structure for interactive environments. A major obstacle to effective design in today's rapidly changing and expanding digital world is that too often software and hardware engineers fail to adequately address how their audience will interact with their product. One of the most important issues in bridging the gap between man and machine is developing a user interface (UI) that is intuitive and easy to learn.

2.1.1 Principles of Design:

The underlying HCI philosophy behind an interactive cinema project is that the design should be user-centered. As Mitchell Kapor states in his Software Design Manifesto:

> *"If a user interface is designed 'after the fact' it is like designing an automobile dashboard after the engine, chassis, and all other components and functions are specified." (Kapor, 2002)*

The important questions in creating a user-centered design are: Who are the users? What are the main functions that the user will need? Why is the user using this particular software/hardware? Is the software/hardware accessible by users of different experience levels? What is the most intuitive way that the user could interact with the software/hardware?

One key issue that designers and programmers alike often forget (or neglect) is that interface design incorporates many different disciplines: hardware and software engineering, ergonomics, psychology, sociology, linguistics, computer science, etc. As such, the second important design consideration is integration of knowledge and experience from all of the HCI-related disciplines.

The third design consideration is that the system should be thoroughly tested before release to ensure that it contains no bugs that will inhibit its function. The quickest way to inhibit enjoyment is to create frustration over simple interface and navigation issues.

The fourth design factor is an issue of commodity: the interface and navigation of the interactive cinema model should be well suited to complement the functionality of the system.

The fifth and final design consideration is less quantifiable, yet important nonetheless. The idea is that the design should be pleasurable to use, incorporating visual and functional aesthetics.

In summary, the five principles of design that should be incorporated into creating an interactive cinema experience are that the model should:

1. Be user-centered.
2. Integrate the HCI-related disciplines.
3. Be free of major bugs.
4. Be well suited to the intended purpose.
5. Be enjoyable to use.

2.2 Navigation in an Interactive Cinema System

One of the most important concepts in navigation is that it should be easily learned. If it takes too long to grasp the navigational flow of a program, the user will become frustrated and lose interest. An easily learned navigation structure is the first step in creating user satisfaction. Instructions can be useful, but the navigation concepts should be intuitive enough that an excessive amount of preparation is not necessary.

> *"The interactive artist must strike a balance between the interactor's sense of control, which enforces identification, and the richness of the responsive system's behaviour, which keep the system from becoming closed." (Rokeby, 2002)*

Another important concept to help the user maintain a sense of spatial orientation is to remain consistent. From the audience perspective, this means not only a consistent look and feel to the physical interfaces, but also that the interactive cinema presentation responds to similar senor data in similar ways. If a user waves their arms, for example, and this is a method of interaction with the piece, the movie should respond in a logical manner, and respond in the same manner if the user repeats the action (unless a sense of abstraction is desired in the particular piece).

> *"Because explicit interactivity is still a relatively new feature in artworks, the audience often approaches the works with skepticism. The audience requires proof that the work is interactive... The proof that will most easily satisfy the audience is predictability (i.e. if one makes the same action twice, the work will respond identically each time). Unfortunately, this test only works for simple interactive devices with no memory and no ability to adapt." (Rokeby, 2002)*

A feedback mechanism is crucial for effective navigation: the user needs to feel that their actions have meaning. For an audience navigating an interactive cinema presentation, feedback could come as sound cues, visual cues, tactile cues, etc. A sound cue could be a noise generated when a user steps into a certain area of the environment. A visual cue could be that when a user steps into a certain area of the environment, not only does a sound play, but the movie changes in response to the user's position.

> *"The issue of who is controlling whom becomes blurred. The intelligence of the human interactors spreads around the whole loop, often coming back in ways they don't recognize, causing them to attribute intelligence to the system." (Rokeby, 1998)*

The navigational tools should be based on the goals of the user, meaning that they should appear in context and support the flow of the composition. Also, does the navigational structure support users coming from different technical or cultural backgrounds? Along with meeting the user's goals, the navigation structure should also be appropriate and support the interactive environment. It is often desirable in an interactive installation to have a transparent interface because it allows the user to participate without having to consider their direct relationship with the underlying system, but no interface can be completely transparent. The most one can hope for is that the interface be so well integrated as to be *subconsciously accepted* by the interactor as transparent.

> *"When an interface is accepted as transparent, the user and his or her world are changed; the transforming characteristics of the interface, no longer contained by a visible apparatus, are incorporated into the user and the user's world view." (Rokeby, 2002)*

To summarize, the navigation framework that should be used in designing an interactive cinema model is based on the idea that the navigation should:

1. Be easily learned.
2. Remain consistent.
3. Provide feedback.
4. Appear in context.
5. Support the user's goals.

2.3 Building a Language for Interactive Cinema Installations

> *"Research in voice and gesture recognition continues to progress. Some exciting work has taken place in sensor technology for music applications and in vision algorithms that can, for instance, read sign language. However, no one has unearthed a more general, universal language for gesture, and none may be forthcoming. We face the sticky problem of predetermining a gesture set for any given application and possibly forcing the user to learn to flap out an arbitrary set of signals to the computer, like a flagman sending semaphore messages." (Davenport, 1996)*

In an installation set-up for interactive cinema, we are dealing with a novice user domain (not performers). Therefore, there are certain precautions which must be acknowledged:

- You cannot predict what people are going to do. Therefore, you must build into the system a certain amount of acceptance that some people won't be doing the "right" things. One way to accomplish this is to limit the flexibility of the interactions.

  "Presenting a limited range of possibilities reduces the likelihood that the interactor will run up against a creative block, and allows the medium to guide the inexperienced hand of the interactor, reducing the fear of incompetence." (Rokeby, 2002)

- If you capture a great deal of subtle variations it's hard for the audience to know how they are affecting the video; if you have the video respond to larger and fewer variations, the audience understands better. More than 2 or 3 different things happening is too many for people to understand what affect they are having.

  "It is ironic that wide-open interaction within a system that does not impose significant constraints is usually unsatisfying to the interactor. It is difficult to sense interaction in situations where one is simultaneously affecting all of the parameters... The constraints provide a frame of reference, a context, within with interaction can be perceived." (Rokeby, 2002)

- You need a comfort level for movements/gestures.

  "I found that as I reduced the number of dimensions of interaction, the user's sense of empowerment grew... In retrospect, the problem seems to have been a linguistic one: people were unfamiliar with the language of interaction that I gave them." (Rokeby, 2002)

- The most reliable tracking techniques are based on detecting location, motion, velocity, and direction of travel.

- All of the above except location are cyclical - meaning they can reverse direction rapidly. Therefore you usually have to average the values to get meaningful results.

- There is typically lots of ambiguity to deal with - context-specific rules need to be made for each installation space. The more rules and constraints that are applied to the installation space, however, the narrower the sensory data flow into the computer.

  "By increasing the amount of filtering that is applied in the perceptual process that the interactive system employs, the designer increases the reliability of the resulting information and therefore the unambiguity of control, but at the same time, the richness of that information is reduced." (Rokeby, 2002)

3. **User Experience:**

   "The interpersonal, back-channel communications and ancillary activities of the audience, which currently remain largely unsensed and unprocessed, can be just as important as the primary authored experience." (Davenport, 1998)

3.1 User-experience for Interactive Cinema

What kind of experience does one wish a user to have in an interactive cinema presentation? What kind of experience does the user themselves wish to have?

> *"Rather than creating finished works, the interactive artist creates relationships... Rather than broadcasting content, interactive media have the power to broadcast modes of perception and action." (Rokeby, 2002)*

Blom and Chaplin discuss ideas around the experiential body of knowledge (Blom and Chaplin, 1988, pg.17). I discuss these ideas below in the context of interactive cinema. The first concept is **kinesthetic awareness**, meaning that in interactive cinema the participant has the opportunity to explore meaning behind his/her own movements. For example, audience members may ask themselves some of the following questions: “What will happen to the movie if I twist my body around this way?” “Is there a different effect produced if I move just my head and try to keep the rest of my body still?” “Which movie clips produce what kind of effects on my kinesthetic awareness?”

> *"An interactive system can be seen as giving the user the power to affect the course of the system, or as interferring in the interactor's subjective process of exploration." (Rokeby, 1998)*

The second concept in Blom and Chaplin’s theory is **phrasing**: “All movement contains innate rhythms and phrases which provide the magic ingredients in any of the performing arts” (Blom and Chaplin, 1988, pg.17). The third concept is **form**. Questions the participants could ask themselves include: “What kind of responses will I get from the movie if I focus on grouping my body movements into circular phrases?” The fourth concept is **relating**: this concept is explored by the participant discovering their relationship to the sensors, the movie projection and the projection surface. The fifth and final concept is **abstraction**: because the movements are not in any way choreographed, each time a participant enters the interactive cinema space they create a new narrative, a new unfolding, and a new cinematic experience.

Stephen Levinson (Levinson, 2001) talks about how "our thinking is fundamentally spatial." This relates to interactive cinema because there is an inherent spatial element to the user's relationship to the screen when participating in the interactive environment, especially when the interface is something more than a mouse and keyboard. In my Re-Waking Life installation discussed below, for example, the user's placement and movement of colored objects in the physical space are mapped into the computer to produce interactivity with a database of film clips.

> *“It is just because, for us, spatial knowledge is a matter of higher-level thinking... that we can be deeply intrigued and tantalized by the artful manipulations of space by which the architect and sculptor play on our minds.” (Levinson, 2001, pg.70)*

Another issue in designing a user-experience for interactive cinema is what role the audience plays in the narrative. For example, the story could be designed around a first-person perspective, where all of the film clips are shot from the audience's point-of-view, and the audience is a protagonist in the narrative. In the Object-Oriented Interactive Cinema (OOIC) model, however, I believe that taking a third-person perspective would produce better results. This would allow for more control and flexibility in the cinematic composition, and ultimately produce a better film. To increase the immersiveness of the experience, it is still beneficial to give the audience a role within the narrative, but one that only indirectly affects the plot. The idea of staying away from a first-person perspective may seem counter-intuitive at first, but there are other interactive cinema theorists who have made a similar argument:

> *"Most designers of cyber worlds remain committed to creating first-person experiences, which immerse the participant in an unknown world of authored action and consequence, despite the limited success of this form... [T]he first-person viewpoint loses meaning as soon as the participant steps back to a more distant experience." (Davenport, 1998)*

4. Issues and Challenges with Video Capture:

4.1 A Media Structure

The steps that can be used to build an interactive media space are outlined by Robb Lovell in his paper "A Blueprint for Using a Reactive Performance Space" (Lovell, 2002a). Lovell encapsulates these categories in the term *media structure*.

- Action: The physical phenomenon used to manipulate the media.
- Sensing: The digitization of the phenomenon from a sensor.
- Processing: The manipulation of digitized data into meaningful information.
- Translation: The transformation of meaning into control signals for a response.
- Control: Coordination of the devices that create or generate the media.
- Generation: The device or algorithm that creates the media.
- Manipulation: Modification of the media after it has been created.
- Rendering: The device that physically produces the media.

There are generally four categories of media that can be controlled by a computer in an installation space: visuals, light, sound, and mechanical systems. Technologies to sense and interpret events that occur within the installation space include "video-based sensing, tracking systems, sound samplers, pitch detection, and analog sensors (heat, touch, bend, acceleration, etc)" (Lovell, 2002b).

4.2 Computer Intelligence

> *"Computer intelligence is defined as the ability of a computer to understand, reason, and apply knowledge. This involves sensing the environment, assimilating what is happening within that environment, and responding." (Lovell, 2002c)*

According to Lovell, there are three kinds of abilities that are required for computer intelligence in the interactive arts: *Perception*, *Reasoning*, and *Dexterity* (Lovell, 2002c). Perception is how well the computer understands the environment which it is trying to analyze through its sensory mechanisms, which can include video images, infrared sensors, proximity sensors, spoken words, text, UI interactions (such as mouse/keyboard input), etc. Reasoning is the computer's ability to interpret the sensed information in a meaningful way, and to make decisions based on the perceived data acquired. Finally, dexterity is the computer's ability to provide a feedback response to the user/performer based on the interaction with the system. Responses involve the electronic manipulation of media, such as changes in lighting, sounds, visuals, robotics, etc.
In complex, well-designed interactive systems, the hope is that the computer would have enough intelligence to facilitate emergent phenomena. Emergent phenomena provide interactive artists with unpredictable behaviors, generated from the program's algorithms themselves, and can produce results that would not have otherwise surfaced.

4.3 Knowledge Representation

> *"What is the glue that allows the computer to transform what it perceives into an appropriate action? This glue is a whole system of inter-related elements that interact as a kind of primitive brain. The most important structure of this system is the representation of knowledge (information) and the mechanism for manipulating that knowledge." (Lovell, 2002c)*

Some examples of how knowledge can be represented include *accumulated* knowledge, *common* knowledge, and *contextual* knowledge. Accumulated knowledge is a recorded history of what the computer needs to do while the program is running. An example would be a digital cue list. Common knowledge is the computer's *a priori* knowledge of the installation space. For example, we program the computer to assume that people stand on a floor underneath them. Contextual knowledge enables the computer to make appropriate decisions given a particular sensory input in the current environment.

All of the above mentioned knowledge representation formats can be represented, controlled, and interpreted algorithmically, although contextual knowledge in particular is directly related to an *inference engine*. An inference engine is similar in concept to an algorithmic process, but it examines the current environment in a non-specific way to decide whether a response is needed. Stated another way, where algorithmic behavior is governed by specific cause-effect relationships, the inference engine can use many different actions for a particular response. The inference engine is heuristic-based. (Lovell, 2002c).

4.4 Video-based sensing

"The environment will, as a given, be ambiguous in nature. The information contained within a video image is incomplete and limited, and since this is the computer's view of the world, its representation of the current state of its surroundings will be unreliable." (Lovell, 2002d)

The task of having the computer understand what is happening in the physical world is a difficult one, for objects contained in a scene are just blobs to the computer. Fortunately, these blobs have a location, size, velocity, and other measurable characteristics – characteristics that can be used for interactivity. But the task is never trivial. Special effects filmmakers get around some of the obstacles of video tracking by matching points on a custom-designed wearable suit to a 3-D model in the computer, but this is not practical for a general audience. While computers today cannot approach the level of perception of the human body, they can understand the outside world in a limited way through image processing techniques, through knowledge representation, and through assumptions about the physical environment (Lovell, 2002d).

A major conceptual hurdle for artists and programmers dealing with video-based sensing is that a camera does not see the world the way humans do. Distance information is very difficult to measure, and as such, "actions that cut across the camera's view appear different than actions that move towards or away from the camera" (Lovell, 2002b). Because of the great challenges with live video capture, many interactive installations use programs where "responses are based upon randomized manipulations or heuristic road maps for the computer to follow" (Lovell, 2002d). The real challenge, then, is to be able to take the interactivity that one step further, to create a reactive space based on highly meaningful user interactions.

4.5 Information Extraction

Lighting is a crucial factor when doing video-based sensing. You need to be very aware, and have as much control as possible, over the lighting conditions of the installation space. How light falls on the people and props in the space determines how they will be seen by the computer.

4.5.1 Extraction Techniques:

1. <u>Motion:</u> "Motion is calculated by subtracting successive images from each other, and counting the number of pixels that have changed... Under constant lighting conditions, motion is the change in surface area of objects in the scene" (Lovell, 2002b). An object that is closer to the camera will appear to have more motion that the same object farther away from the camera because being closer to the camera causes many pixels to be affected.

2. <u>Presence:</u> To detect presence is to detect the simple presence or absence of light.

3. <u>Background:</u> A common practice with video-based sensing techniques is to grab a snapshot of the background without any objects in it to use as a baseline for comparisons. This is effective at showing foreground objects more clearly provided the foreground objects are not the same color and intensity of the background.

4. <u>Objects:</u> This technique tries to distinguish single entities within the camera's view. In order to do this, the objects need to appear different in some way to the computer. The most common methods are by having high contrast objects (i.e. light objects against a dark background), or by color tracking. Once an object is identified, it can be measured for things like motion, speed, location, etc.

Robb Lovell, a Ph.D. candidate at SFU Surrey, has created a software package called "EYES," for use with the Max graphical programming language, which is designed for video-based capture and analysis. Using "EYES," one is able to quite effectively track a number of distinct objects in a scene, and extract from them information such as location, speed, color, etc. Because of the challenges in getting a computer to interpret a scene in the desired manner, the scene must be well controlled. This means that no strict rules for interpretation can effectively be established, but rather that each environment is unique, and that video-based sensing is heavily determined by context.

> *"The person creating the means for a computer to understand part of an environment must make assumptions about the structure and content of the environment in order to create algorithms to extract information for the computer to use." (Lovell, 2002b)*

5. <u>Creating Interactivity – Three Interactive Installations:</u>

> *"You see things; and you say, 'Why?' But I dream things that never were; and I say, "Why not?"*
>
> *- George Bernard Shaw*

The unifying theme behind the three installations described below was to create a journey from a waking state to dreaming to lucid dreaming. In each part, I wanted participants to question the boundaries between the reality that we experience while awake, and the virtual reality that we experience while dreaming. I wanted participants to ask themselves if the clear distinction that we normally draw between asleep and awake is really so clear. For example, could our dreams be an alternate reality, and not just metaphysical creations of our brain? Why is it that for most of the time we spend dreaming, we do not even realize that we are dreaming? What enables someone to experience a lucid dream, and have control over their cerebral musings?

From the process of entering into dream, to performance in a state of REM sleep, to exploring lucid dreaming, my three interactive installations attempted to take the participant through an immersive and playful experience.

5.1 Installation 1: Entering Into Dream

"Nothing happens unless first a dream."

- Carl Sandburg

This is a piece about conversations with ourselves with others.

Designed as a group experience, the participants are asked to sit on a couch at one end of the installation space. They are surrounded on three sides by black, ceiling-high curtains arranged in a semi-circle. There is a unidirectional microphone placed overhead to capture the conversations of the people on the couch. Opposite the couch in the installation space is a projection of the space itself, with the couch in the center. The image projected is actually being processed by the computer to produce an averaging effect (many frames are saved into memory, averaged together, and then displayed). This creates a ghostly feel to the image through persistent frames, such that the changing image is delayed and trails across the screen after the moving objects.

Once the participants are settled on the couch, the microphone is activated and the sounds are fed into the computer. The computer records the microphone input and plays back what it records after 5, 30 and 60 seconds. This creates an interesting echo effect as the participants hear what they say immediately, again after 5 seconds, once more after 30 seconds, and finally after 60 seconds.

Along the theme of entering into dream, my idea in the installation is to have the participants discuss what dreaming means to them, perhaps even getting into some philosophies of dream states. I serve as moderator, asking questions that provoke discussion, such as asking people to define dreaming, or asking them to give their impression of the mysterious state between asleep and awake.

The hope is that the interactors experiences an interesting effect through the combination of discussing dreams, seeing a ghostly image of themselves projected on a screen in front of them, and hearing their conversations repeated back to them after certain time delays.

5.2 Installation 2: REM Sleep Composition

"Dreaming permits each and every one of us to be quietly and safely insane every night of our lives."

- William Dement

The lights are turned off. The participant is given a glowing neon wand and shown a bounding rectangular space which they need to remain within for the interactivity to work. Above their head there are eight sparkling lights suspended in the air, and in front of them is a projection with eight on/off buttons positioned in a row along the top. On the floor in the middle of the installation space is a black rectangle with a silver swirl.

This piece is an experiment in interactive music sequencing and manipulation. Each of the eight sparkling lights controls one of eight musical tracks of a song. Raising the glowing wand up to one of the lights toggles the associated track on or off. In this way the participant can manipulate the sound and feel of the song by deciding which sections of the song (i.e. drum track, bass line, melody) to have on, and which to have off. The interactor is thus a virtual conductor with the light wand as their baton.

The sound is also manipulated by the horizontal and vertical position of the light wand in the space. The x-position of the wand (horizontal position) affects the phasing for all of the tracks, and the y-position (vertical position) affects the degree of flanging. Finally, the participant can change the song, and introduce eight completely different musical tracks, by touching the light wand to the black rectangle with the silver swirl on the floor of the installation space.

The interactivity of this installation is implemented using Robb Lovell's "EYES" software, which is a set of video capture and analysis objects for the MAX graphical programming language. Using "EYES" I set up eight sensor areas corresponding to the eight sparkling lights, and one sensor area for the silver swirl. When the light wand enters any of these sensor areas in the video image, a certain light intensity threshold is crossed and the computer responds accordingly, turning a musical track on or off or switching the currently playing song. I also implemented object tracking to follow the light wand around the space and return its x, y coordinates to manipulate the phasing and flanging.

The conceptual design of this piece is to be playful. Just as REM sleep is the period of our sleep cycle with the highest level of brain activity, this part of the installation allows for a large amount of movement by the user, where they can travel back and forth in the space, and move the light wand around to elicit musical effects.

5.3 Installation 3: Lucid Dreams

"Our truest life is when we are in our dreams awake."

- Henry David Thoreau

The purpose of this section of the installation was to explore ideas and practices around Object-Oriented Interactive Cinema (OOIC). It was my goal to produce an interactive object-oriented digital cinema installation that asks questions about how the project's format and representation affect an audience's cinematic experience.

Re-Waking Life

Re-Waking Life is a remake of the animated feature movie "Waking Life" (directed by Richard Linklater) that adds interactivity and applies the Object-Oriented Interactive Cinema (OOIC) model to the film. The OOIC model uses a database of film objects to construct interactive content, and thus, to begin, I extracted the entire "Waking Life" movie from DVD and broke it up into 36 segments, or 36 film objects. These 36 film objects are loaded into a random access database by the computer when the installation is started.

The installation's main component is a large fold-out bed. The original "Waking Life" movie is about dreams, lucid dreaming, dream states, and philosophy, and thus the installation space is decorated in an attempt to complement these themes. For example, there are stuffed-animals toys and a jester hat positioned on the bed pillows, and a cowboy and fireman hat are hanging on the wall.

At the bottom end of the bed is a purple blanket with fourteen felt squares distributed across its surface, twelve blue squares and two green ones. On each of the felt squares a word is written: Dream, Destiny, Life, Philosophy, Experience, Change, Chaos, Society, Freedom, Time, Human, Lucid, and two special keywords, Play and Mix. This blanket with its felt squares and words is the main interface for interacting with the movie that is projected on a screen directly in front of the bed. I call this interface the "dream map."

Positioned above the "dream map" is a wide-angle low-light camera. The image from this camera is used by the computer to create interactivity. The way the interactivity works is that the interactor uses two stuffed-animals – Tweety bird and a polar bear – to create relationship pairs using the words on the "dream map." The relationship pairs are interpreted by the computer to change the movie's content. For example, if one of the toys is placed on 'Lucid' and the other on 'Dream,' the computer responds by changing the currently playing movie clip (a film object) to one where the narrative content is about lucid dreaming. In the installation there are 47 word-pairs programmed into the system. Because there are a great deal more possible pairs possible using the 14 words, I implemented an algorithm to take effect should no pre-programmed pair be triggered. If the user places the two stuffed-animals on words which don't have a predefined relationship, the computer responds by accessing a table of weighted probabilities and changes the clip according to a probability calculation. For example, if Clip 3 is the currently playing film object and a word-pair is made by the user with no established relationship, the computer looks up Clip 3 in the weighted probability table and transfers to a new clip based on the probabilities associated with Clip 3. Clip 3 may have a 30% chance of going to Clip 4, a 20% chance of going to Clip 10, a 20% chance of going to Clip 21, and a 10% chance of going to clip 35. To avoid repeating those clips with higher probabilities, once a clip is played the probability of any clip transferring to it becomes zero, only to be reset once all of the 36 clips have been played or the algorithm reaches a dead-end transition probability (all possible transfers for the currently playing clip have been used up). The hope is that using a probability table in this way introduces a bit of randomness to the interactivity, and produces a pseudo-generative narrative.

The two green felt squares have the words ‘Play’ and ‘Mix’ written on them, and indicate special functions. Instead of causing the movie to switch to a particular clip, relationship pairs that are formed with either of these two words cause the movie’s visual content to be affected. The ‘Play’ keyword is used to apply special effects to the currently playing movie. For example, placing one toy on ‘Play’ and one on ‘Philosophy’ causes the movie to turn black and white. ‘Play’ and ‘Destiny’ causes an emboss effect to be generated, and ‘Play’ and ‘Time’ causes the movie to play at twice normal speed. The ‘Mix’ keyword is associated with collage and split-screen effects. Some relationship pairs cause two film objects to be played side-by-side on the screen at the same time, whereas some pairs cause two film objects to be played layered on top of each other in a two clip collage. The particular pairs that are made also affect the audio. For example, with one toy on ‘Mix’ and one toy on ‘Dream,’ a split-screen effect is produced with the audio heard only from the left-hand film clip; with ‘Mix’ and ‘Chaos,’ however, the audio is heard from both clips at the same time.

As in the previous installation, the interactivity in Re-Waking Life is also controlled using Robb Lovell’s “EYES” and the MAX graphical programming language. The image that the camera captures of the blanket is divided into 14 sensor regions, each one positioned over one of the word-squares. Whereas in the previous installation the threshold is based on light intensity, in this installation the threshold is configured around color values – those of the two stuffed-animals. Thus if the polar bear is moved into a sensor region, the threshold is crossed for detection of a white-colored object, and the computer responds. The actual algorithm is much more complex than this, of course. For example, in order to filter out the movement of a stuffed-animal across one of the sensors when a user is moving it from one square to another, the computer only acts on a crossed sensor threshold if the movement within the sensor region is also less than a velocity threshold (indicating that the user has put the object down) for a given period of time (to eliminate the zero velocity of an object reversing directions). Also, to prevent overly rapid transitions, there is a slight delay between how quickly a new relationship pair can be activated once a relationship pair is successfully chosen.

The heading for this installation section is Lucid Dreams, and the concept behind this thematic title is that, as we have control over our dreams when in a lucid state, the user in this installation has control over the movie content (which deals with dream and philosophy) through the playful interface. Word relationships are used to imbue meaning behind the interactivity.

Re-Waking Life is an attempt at creating a multi-linear interactive cinema experience using a database of film objects. Each time a user sits down to experience Re-Waking Life, they construct a different narrative through the order and manner in which the film objects are juxtaposed together spatially and temporally (spatial and temporal montage). The method and flexibility through which the interactivity is implemented enables pseudo-generative narrative construction, such that there are literally thousands of different narrative permutations, or paths that a user could follow through the film object database.

The narrative flow is affected by the order in which film objects are presented which is directly influenced by the relationship pairs made by the interactor. The 'feel' of the narrative is affected by how the user decides to implement and manipulate the visual effects (using the 'Play' square), and how the user decides to combine more than one clip together on the screen at the same time (using the 'Mix' square). Some interesting effects and narrative results can be produced through the spatial juxtaposition of two film objects, either in a side-by-side spatial montage, or in a direct overlapping collage. How is the narrative changed, for example, when a clip of a professor discussing the philosophy of the problem of free will is played concurrently with a clip of an angry man in a jail cell speaking profanities against those responsible for his incarceration? Is the effect different when the juxtaposition is displayed as two clips side-by-side versus as a collage? As per one of my goals for this project, I believe that the Re-Waking Life installation raises many interesting and challenging questions around multi-linear narrative and the interactive cinema experience.

6. **Conclusion:**

The series of three interactive installations described above was a semester in the making. Robb Lovell's "EYES" software is still very much in the beta stages, and quite often some collaborative debugging was required to get the programs working properly. My ideas for content also changed over the months as I came to realize technological limitations and the limitations of my own knowledge and experience. What I learned from the creation process, however, is hard to adequately express. A great deal, to be sure. Not only was I challenged technically, but once the technical challenges were overcome, I began to grapple with the conceptual weaknesses of my work. I still feel that, while the technology behind them may be very interesting, my three installations still lack a strong conceptual artistic framework. Perhaps this is just from a lack of experience in the realm of fine and contemporary arts, coming from a traditional scientific academic background. If so, my hope is that my artistic skills will continue to develop and mature along with my technical skills in my quest to become a successful interactive artist.

Artistic weaknesses aside, I tried to construct each of the installations according to the interface and navigation principles outlined in this paper. The third installation, 'Re-Waking Life,' was a successful experiment using the OOIC model for interactive cinema, and has given me many thoughts towards where to take my future research. All three installations were built using the HCI design principles, navigational structures, and language for interactive installations discussed at the beginning of this paper. Although I built each installation with the user's experience in mind, and although each project was modified throughout the development process according to informal user trials and feedback, I do wish that I had had more time to better document the user experiences and interactions with each of the pieces. I managed to bring some students from Tech I into the Interactivity Lab to experiment with the systems, and this was greatly beneficial, but I do not feel that I adequately recorded the participant’s impressions, and this is something that I would change for next time.

All in all, throughout my research into interactivity and installation work, I learned a great deal about building a language for interactive environments. Whenever one is dealing with a non-traditional interface to a computer (i.e. not a mouse and keyboard), it brings up interesting questions about our relationship to our physical and our virtual bodies. I look forward to continuing my research into these areas.

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