Interactive Environments: Bridging the Digital and Physical

An exploration of strategies for designing digitally interactive exhibits with a focus on video navigation

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Thesis submitted in partial fulfillment of the requirements for the degree of Master of Fine Arts and approved by MFA Review Board of the Massachusetts College of Art and Design in Boston.

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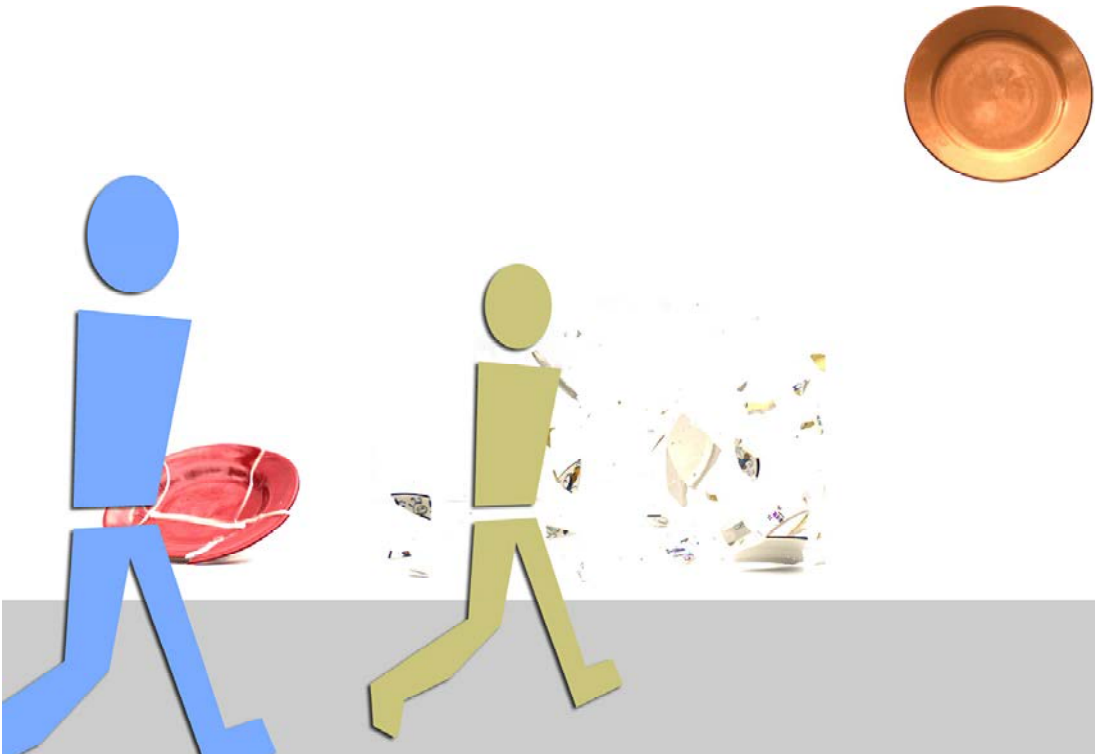

ABSTRACT

My thesis project, *Falling Up*, is motivated by my fascination with the difference between reality and how we perceive reality; how we make sense of that perception, and finally how we represent that meaning.

The statement above is reflected in my thesis project in two ways:

One: Regarding how we make sense of reality and how we represent it, digital media interests me because it's able to recreate in the material world the actions of our minds in a way that previous media could not. Digital media because of its interactive and time-based nature, makes it possible for people to move both forward and backward in representations of time – something we do all the time in our thoughts. A major goal of my thesis project is to take this element of the internal thinking process – our ability to mentally move through time – and to make it as external and physical as possible.

Two: A secondary goal of my thesis project is concerned with exploring the difference between reality and our perception of reality. Our eyes and ears are only capable of perceiving information within a certain range. With my thesis project I was interested in creating a playful interaction that made it clear how technology can expand and change our perception.

With both goals, my desired outcome and my methodology remained the same. I wanted to create an interactive environment that people found easy and engaging to use.

In developing this environment I researched two fields with a history of creating interactive spaces: art installations and science exhibits.

From examining those fields and pursuing my own work, five strategies emerged that became important to me in developing my own exhibit:

- Body as Interface
- Mirroring
- Multi-user Interactions
- Immersive Environments
- Playful Interactions

ACKNOWLEDGEMENTS

The process of making my thesis project a reality wouldn't have been possible if it wasn't for the help, generosity, skills and inspiration of many people, some who I have forgotten, and some of who are strangers.

Among the people who I can thank by name are the staff and faculty of Massachusetts College of Art and Design. From the DMI department I want to thank Jan Kuba for encouraging me to dream big during my first semester at DMI, Brian Lucid for his interactive insights and for introducing me to phidgets, Joe Quackenbush for his feedback on my thoughts, and my advisor Gunta Kaza for her questions, advice and support.

Besides classes in the DMI program, two classes at Mass Art gave me a foundation for my thesis project: Denise Marika's Video Sculpture, and Electronic Projects for Artists taught by Dana Moser.

During the Spring semester of 2008, I was constantly using and borrowing equipment, be it video cameras, projectors, sound recording, tripods, lights or a modified lighting pole from which I could hang a projector. I wish to thank Anthony Flackett, Adam Savjez, Robert Kephart, Steven Gentile and Bruce Bowen for not only letting me borrow this equipment, but for also showing me how to use it.

Both Nadia Savage and Fred Wolflink helped me in innumerable ways. Fred helped me with coding, electronics, equipment and setting-up my show at Axiom Gallery. Nadia helped me solve some of my most pressing problems, from signing-out a projector so I could show at Axiom Gallery to helping me secure a studio space.

I wish to thank the staff at the woodworking department: Ken Hartl, Ted Southwick and Judith Hanson. Without their expertise, patience and help I would have been stuck making my projects out of cardboard and tape.

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CONTENTS

INTRODUCTION

This thesis document consists of six sections: The description of my thesis project, titled *Falling Up,* The evolution of the project, research into related fields, the results of people interacting with the project, my conclusions, and finally the process of creating the thesis project.

Thesis Project Description

The project description consists of an idealized description of my project, along with three personal interpretations of it.

Project Evolution: Mass Ave and video journeys

In this section I explain how earlier projects led to the development of my thesis project. Included in this section is an earlier concept for an exhibit, *Mass Ave* that utilized, at least in concept, interface ideas similar

to my thesis project. Also covered in this section is my "video journeys." Video journeys is my term for the collection of videos I produced while in graduate school in which either the camera captures a traveling object, or the camera itself moves from one location to another.

Research: Five design strategies

In the third section of my project, I detail my research, which consisted of investigating the history and current state of interactive art installations and science exhibits.

In looking at these two fields, I distilled five design strategies for creating effective interactive environments that I was interested in using in my own work. They are:

- Body as Interface
- Mirroring
- Multi-user Interactions
- Immersive Environments
- Playful Interaction

In this section of the paper I analyze each of these strategies, and I explain why I'm motivated to use them in my own work. I include examples of how they are used in practice. If applicable, I also include my reflections developed from either using or observing the use of each strategy.

Project Results: Three Shows, Three Versions

In this section, I detail the installation of three different versions of my thesis project in terms of physical set-up, the interface, user participation, and verbal feedback.

Conclusions

In Conclusions, I review my intentions for my thesis project and compare it to the feedback I've received from sharing my work. I also look ahead, and cover what areas of interactivity I'd like to focus on in the future.

Process

In the final section of my thesis document, Process, I detail how I put the first version of my thesis project together from a practical, technical, and physical point of view.

1. PROJECT DESCRIPTION

PROJECT TITLE: FALLING UP - By walking down a hallway visitors control the video and audio playback of plates falling and crashing. The speed and direction of the plates falling is controlled by the speed and direction of the user's movement. For example, if the person moves slowly in one direction the plates fall down slowly. Conversely if he or she moved quickly in the opposite direction the shattered plates would quickly regroup and rise again.

Three Interpretations

Over the course of conceptualizing and creating Falling Up I've developed three, related interpretations.

CONTROLLING TIME: In our thoughts, we often go back in time and replay events, but in our everyday experience the flow of time is something over which we have no control. Falling Up gives people the experience of controlling the flow of time by manipulating digital media.

THE DIFFERENCE BETWEEN REALITY AND REPRESENTATION: In our thoughts and through media we can imagine changing events or undoing events. But in reality time only flows in one direction. A plate that is broken stays broken. You can't hit "undo."

EXPANDED PERCEPTION/DIFFERENT PERSPECTIVE: *Falling Up* is recorded with high-speed video which when played back slowly allows visitors to experience time in a way that is not possible through their normal perception.

For example, the high-speed video allows the visitor to see that at the moment of impact the plate holds its round shape for a second before exploding outward.

By creating a playful digital interaction, which allows users to control the speed of the video and sound, I hoped to create an experience that would demonstrate that there is more information in the world than can easily be perceived with our senses.

The next portion of the paper details my research and effort in transforming my internal interpretations into an engaging interactive environment. My research consisted of investigating the fields of art installation and science exhibits, as well as what I learned from my own work.

2. PROJECT EVOLUTION: MASS AVE AND VIDEO NAVIGATION

One of my first projects at DMI, *Mass Ave*, started me on the path of exploring video navigation in an exhibit space. Like *Falling Up*, in this earlier project I imagined that visitors would control the playback of video journey by walking.

In the case of *Mass Ave*, that journey was relatively long, about 12 miles down Massachusetts Avenue, traveling from Lexington to the heart of

Boston in little under an hour. I captured the journey by taping a video camera out of the window on the driver-side of my car. In the case of *Falling Up* that journey was short - plates falling about seven feet in less than four seconds.

I had two goals with the *Mass Ave* video. One was to capture and remember the road in one moment in time, a sunny summer afternoon in

2006. My other goal was to create an interface that communicated clearly the relationship between the location on the video and the location on the map.

I started with creating a computer screen and mouse-based interface that combined the scrubber bar of the video with the road on the map. The video was navigated by moving the mouse along the road on the map. Technically the interface wasn't perfect; I didn't account for the curves along the road so there wasn't an exact match between a point on the map and the video. Despite that I did find it a satisfying experience to navigate the video by tracing the mouse along the road.

I also tried a second interface that combined the video, road and scrubber bar onto one element. In this scenario the video stayed centered on the screen while the road would flow through it. To navigate the user would press-on different areas of the circle. By pressing on the top of the circle the video would move forward, by pressing on the bottom, backwards.

In a third iteration, which I never built, I moved the concept to an architectural space and had user's bodies serve the same purpose as the video scrubber bar in the first version of the project. So just as in the screen version, which had the scrubber bar control place and time in the video, as well as marking place on the map; In this version people controlled the video by walking, while their location signified place on the road, represented by a line painted on the floor.

Mass Ave: Effective Interface, or memory keeper?

While working on *Mass Ave* I found my goal of creating an effective interface was, in some ways, in opposition to my goal of remembering a specific journey.

When I thought about creating an effective interface I found myself taking out the times stopped in traffic and the red-lights, because the point was to get from one end of the road to the other.

At the same time, another part of me was holding onto the entire record of the trip. So instead of simply deleting the times I was stuck in traffic I started to think of the "slow-times" in the video as hiding places. If I visualized the time in the journey as a straight line, then I started to see the stops as pockets of stillness along that line. In an exhibit space I visualized these curves as enclosed circular rooms that someone walking along the exhibit could choose to skip or to enter.

When I later read Jorge Luis Borges short story, *Funes, The Memorious* I was reminded of this project and my desire to capture every detail. In this story the character Funes remembers in great detail everything he ever experienced, which can be seen as both a gift and a curse:

An unnamed narrator describes Funes memory by saying "He remembered the shapes of the clouds in the south at dawn on the 30th of April of 1882, and he could compare them in his recollection with the marbled grain in the design of a leather-bound book, which he had seen only once."

Despite these gifts the narrator states "the truth is that we all live by leaving behind." And that he suspect that Funes "was not very capable of thought. To think is to forget a difference, to generalize, to abstract. In the overly replete world of Funes there were nothing but details, almost contiguous details."

Although I never built *Mass Ave* as an exhibit, thinking about it conceptually gave me a framework to compare the different elements of an interface and how they change depending on the environment. For example, when I worked on *Mass Ave* as a computer screen and mouse-based interaction I thought of the interface elements as being the input device, the representation of the input device, the digital tool, and the media. So the input device was the mouse, which was represented on screen by an arrow, with which I could manipulate the digital tool of the scrubber bar, with which I controlled the video media.

In the exhibit version of *Mass Ave* the input device was a person who controlled the video media by their movement. There was no representation of the input device (in this case the person) or the digital tool (the scrubber bar).

This interaction in some ways is similar to the interface qualities of the iPhone in that people use their body (in the case of the iPhone their hand) to manipulate media without a separate input device, representation of an input device, or a digital tool.

Although thinking about *Mass Ave* conceptually as an exhibit gave me plenty to think about, the project had a drawback in that I didn't know how to actually create an interaction without using a mouse and keyboard as input.

During the next two semesters of school, I pursued the project by taking *Video Sculpture* and *Electronic Projects for Artists*. *Video Sculpture* gave me experience with how to use video in exhibits. Electronic Projects moved me towards creating interactions that weren't keyboard, mouse and screen based.

During this time I also continually filmed what I thought of as video journeys, in which either the object or the camera moved from one point to a second point.

Some of the things I recorded included: a swim from one shore of Walden pond to another, filmed from the point of view of the swimmer, snow falling from the sky, tracking the twisting lines of a vine, thread falling and accumulating in a pile, shoes dropping, keys falling, red-super balls bouncing, and paper airplanes flying across one side of a room to the other.

The videos I recorded were diverse, but they shared a similar point of view. In them the video camera records the journey with a steady unblinking gaze. Either the camera stays still or the object stays still - with no edits. In other words, no cuts where made in time or space.

When I think of these video pieces in terms of interactive navigation the steadiness of the camera is important. I didn't want to act as a director manipulating the journey, instead I wanted the user to choose where they wanted to go and at what speed.

Other than working on *Mass Ave*, my thesis project also developed from these video journeys. I was partly inspired to create *Falling Up* by my experience of using the Final Cut, a video-editing program that allows users to control the speed and direction of video and audio playback by dragging the mouse. Using the program I enjoyed playing back video clips faster and slower, forward and in reverse, as well as "scratching" the video clip like a D.J. scratches a record. In creating *Falling Up* I was interested in giving people this experience on a larger scale.

3. RESEARCH: FIVE DESIGN STRATEGIES

Working on *Mass Ave* had me thinking about the challenges of interactive exhibit design, and set the stage for two events that got me started on my thesis topic in earnest.

One event was the visit to the Technology Museum of Innovation in San Jose in January 2007. (More commonly known as The Tech.) The second event was a lecture two months later given by the founder of Boston's CyberArt's Festival, George Fifield, entitled "A Short History of Interactive Installation."

I went to the Tech Museum with the idea of observing what exhibits worked and which exhibits didn't and to analyzing why. Most of the exhibits seemed to fall into one of three pitfalls: Visitors where intimidated or couldn't figure out how to use the interface, only one person could use the exhibit at a time, or the exhibit was broken.

Around exhibits at The Tech, like *Interconnected City*, I observed visitors making comments along the lines of "how does this work?" and "I don't get this."

Interconnected City revealed where Internet access was available throughout the city by moving a clunky, hard to maneuver screen over another screen. During my observations, the exhibit was mostly ignored, with some visitors approaching the installation but then reluctant or unsure how to interact with it. Other people tried to interact with the installation but where confused once they did.

If *Interconnected City* had a more usable interface, meaning that people glancing at the exhibit grasped immediately that they were suppose to

maneuver the screen, and if that screen was easy to move – the exhibit would have a second drawback in that only one person can appreciate the exhibit at a time, because unless the user is very short (or a small child) the person interacting with the exhibit blocks other people from seeing what is happening on the screen.

In contrast, one of the most popular exhibits at The Tech was a large screen suspended from the ceiling that remotely sensed heat off of peoples' exposed skin. At this exhibit nobody asked "how does it work?" because the screen itself gave visitors obvious and immediate feedback to its purpose by mirroring the image of the visitor back to themselves in a new way. Therefore, unlike the first exhibit, visitors easily interacted with this exhibit; they didn't need to learn a new skill, or figure our how to use a gadget – they just needed to stand under the screen. Also, unlike the first exhibit, since the exhibit was interactive over several square feet, many people could use the exhibit at the same time.

The observations I made at the Tech Museum:

- that new interfaces can confuse people
- that exhibits that worked best were the exhibits that had no interfaces and could be used by multiple people
- and the power of mirroring in engaging visitor's attention

were clearly articulated and reinforced by Fifield's talk, "A Short History of Interactive Installation" given on March 20 at Art Interactive in Cambridge.

Fifield concluded his talk by summing-up what he thought worked for interactive installations. Some of his conclusions where that installations that worked best had "no interface" (his term for body as interface), engaged everyone in the space, and often employed mirroring.

All three of Fifield's criteria held true for the heat sensing exhibit at the Tech. There was no interface to learn, a group of people could interact with the piece at once, and the work engaged visitors by giving them a mirror image of themselves.

In the next section of the paper I will examine Fifield's three design strategies, plus two others - immersive environments and playful interactions – in terms of art installations, science exhibits and my own work.

Design Strategies

Body as Interface

Body as interface uses the movement of the visitor's body to manipulate digital media without the intermediary of an input object like a mouse, a video controller or a keyboard.

My purpose in using the movement of visitors' bodies to control the interface in *Falling Up* is to give the visitors the experience of directly controlling the video of the plates.

Unfamiliar interfaces of all kinds, digital included, often block people from participating in exhibits. From the point of view of the user, an exhibit that uses body as interface well has no interface, removing this barrier to visitor participation.

A second benefit to using the body as interface is that, depending on how the exhibition is set-up, people may be interacting with the exhibit before they realize it, thereby removing the initial barrier in participating in an exhibit.

Although science museums have a history of creating non-digital exhibits where visitors directly manipulate media, I found few examples of this type of science exhibit in the five museums I visited.

An early example of an art installation that uses the body as interface to control video projections is (1992). In this installation visitors' movement down a hallway triggered ghostly images of people projected on the wall. As the visitors walked by, the images came forward as if to acknowledge the viewers' presence.

Brain Knep, Healing Series (2003-2004)

Another example of an interactive art installation that recreates some of the experience of direct physical interactivity is Brian Knep's *Healing Series*. In this collection of work, Knep created spaces where animated abstract images projected on the floor responded to peoples' movement through them. The images moved apart to make room for the person walking through the space, and as the person moved away the images gradually came together again.

In his lecture, "A Short History of Interactive Installation," Fifield compared the interactivity of Knep's piece to the real-life experience of "walking through a field of grain" and as an example of "no interface."

On the other hand, Jan Kuba, the Coordinator of the DMI program at Massachusetts College of Art and Design, prefers the term "body as interface," which acknowledges that there is a physical input to the computer, even if it isn't obvious. In this case it happens to be the person.

In practice: While creating my thesis project I concluded that using the body as interface doesn't necessarily equal a good interface, it still needs to be designed well. The interface design principals of mapping and feedback are still relevant, although at times these principals can be used differently in interactive environments.

In the book *The Design of Everyday Things* natural mapping is defined as "taking advantage of physical analogies and cultural standards" so that users immediately understand the design. (Norman 23)

Working with *Falling Up* I tried both approaches. In the first version of the project I used the cultural standard of video remote control icons. Visitors to the exhibit controlled the video by stepping on back and forward arrows. When a visitor stepped on an arrow to the left the video played in reverse, while if the visitor stepped on an arrow to the right the video moved forward. If both forward and reverse were stepped on at once the video froze.

With this version of the project I had escaped the world of the computer screen and the mouse. However, I was still working with buttons even if they were large flat ones on the floor. In was still using mapping and feedback in a traditional way.

In the version of *Falling Up* described in my project description, I used a physical analogy, mapping the playback of the video to the speed and direction of the visitors' walking.

What's interesting about this version of the project - and with other interactive art installations and exhibits like it - is that it's possible to set-up an exhibit in such a way that visitors interact with the piece and receive feedback from it without having had to consciously decide to interact with it.

An example of such an interaction is *SoundStair,* at Boston's Museum of Science. SoundStair allows visitors to play a set of stairs in the museum as if the stairs were a musical instrument. The piece works by projecting an infrared beam across each of the stairs. When a visitor breaks the beam by stepping on the stair, the computer plays a note.

Unless they have observed someone else using the piece, visitors using *SoundStair* don't expect to be creating music when they use the stairs. They first become aware of the piece through its feedback.

This reverses the customary order, where designers employ mapping to make an exhibit inviting and easy to use. In this case the feedback reveals the mapping, instead of the other way around. In a sense visitors learn to use the exhibit by self-modeling.

In the book *The Museum Experience* the authors define "modeling" as visitors watching other visitors to learn how they should interact with an exhibit. The example the authors use is an exhibit where visitors are supposed to examine rocks by touching them. Despite a sign, museum employees found visitors were reluctant to do so. Visitors didn't change their behavior until a museum employee posing as a visitor "began to touch the exhibit, acting as if he knew what he was doing." (Falk and Dierking 52)

The study notes that after the employee modeled the correct behavior, parents no longer reprimanded their children for touching the rocks and

"single adults now touched the rocks, whereas they had rarely done so before." (Falk and Dierking 53)

Mirroring

People universally find images of themselves fascinating. There may be no better way to make a connection to a user than to mirror them.

An example of mirroring, used non-digitally, is the exhibit My how we've grown at Boston's Museum of Science. The exhibit has visitors stand in front of a mirror and use their body as a representation of the earth's population. It points out that if the top of the visitor's head represents the 6 billion people alive in the year 2000, the top of the visitor's toes represent the 5 million people alive 10,000 years ago.

The heat-sensing screen at The Tech museum uses mirroring in a similar way. An image of the visitor's body is reflected back to them with the augmentation of additional information. Because the heat sensing screen is digital, it is able to incorporate information directly onto the visitors' representation.

Being able to relate information to visitors in such a direct and personal way is powerful. According to a New York Times article, researchers show that when people watch an avatar of themselves that mimics their every move they start to "mentally inhabit this avatar at some level, regardless of its sex, race or appearance. In several studies for instance, researchers have shown that white people who spend time interacting virtually as black avatars become less anxious about racial differences" (Carey).

In digital interactivity, mirroring often fulfills a second purpose of being the digital representation of the person. In these cases mirroring serves the same function as the arrow cursor on a computer screen, or an avatar in a video game.

An example of mirroring used this way can be found at the exhibit *Freeze Game* at the Liberty Science Center, in Jersey City, New Jersey. In *Freeze Game* visitors' shadows are projected onto a wall, inserting the visitors' images into a scene depicting a savannah with a fruit tree and a tiger. The exhibit graphic asks visitors to collect the fruit from the tree without catching the tiger's attention and thereby becoming its prey. If the visitor doesn't hold still while the tiger is looking their way, he or she risks getting pounced on by the tiger.

An example of mirroring in an art installation is, *Text Rain* by Camille Utterback & Romy Achituv, which allows users to catch words onto a shadow projection of their body. If enough words are collected visitors can start to make out the lines to a poem.

Freeze Game, Liberty Science Center. Jersey City, New Jersey

T

Text Rain, by Camille Utterback & Romy Achituv (1999)

When mirroring is used as it is in Text Rain or Freeze Game, it enables a precise mapping between the movement of the person to the digital media, making precise interaction possible.

This precise mapping can also be made without mirroring when visitors directly touch the digital representation, as is the case with Knep's Healing Series. Or to use a non-exhibit example, the touch screen on the iPhone.

Falling Up doesn't use mirroring or direct contact with the digital media. Since I was interested in mapping only speed and direction of the users' body to the playback of the video, there wasn't a need for precise mapping between the two.

Multiple-User Interface

Ideally an exhibit should be a group experience. If the experience is supposed to be personal then why have it in a public space?

From the standpoint of usability, most people visit exhibits in groups, and it can be boring for members of a group if only one person can interact with an exhibit at a time. In the case of a family visiting a science museum, exhibits that only occupy the attention of one child or family member at a time are impractical.

Most interaction in exhibits and installations that employ mirroring and body as interface are also capable of multiple-user interactions.

This is true of the two examples I described in the previous section on mirroring. Both *Text Rain* and *Freeze Game* can be used by multiple people. When I saw Text Rain a group of people formed a line with their arms to catch the words as they fell.

Immersive Environments

Immersive environments are designed with an awareness of how physical space, as well as how the size of the media itself will effect the visitor experience. Immersive environments imply motion, because they create a space for the visitor to move in.

My aim in wanting to create an immersive environment for *Falling Up* fits in with my desire to create an exhibit that is external and physical. The videos I projected, although not immersive, were larger than life size, and not private images that could be held in your hand. To control the video projections you had to move through space.

An example of a current art installation that uses video in an immersive way is Pipilotti Rist, *Pour Your Body Out (7354 Cubic Meters)*, which is currently installed in the Museum of Modern Art, in New York City. The exhibit covers the museum's atrium in twenty-five-foot-high moving images.

In talking about her work on a video on MoMa's website Rist notes the physical aspect of creating a large exhibit: "the visitor comes to the museum, so they bring their body to the museum, that is the biggest difference to the mass media coming to your living room. You move your body."

She also talks of how the huge room makes people walking into it "feel stretched." (Rist)

Pipilotti Rist, Pour Your Body Out (7354 Cubic Meters)

Playful Interaction

From the point of view of an interaction designer, I see play as a by-product of a design that has succeeded. It demonstrates that an interaction is intuitive enough that people cannot only use it, but that they can manipulate it to their own end.

I wanted *Falling Up* to be a playful interaction because I enjoyed manipulating the speed and direction of video, and I wanted to share that on a larger scale.

Two installations or exhibits that I already mentioned are good examples of interactive environments that employ play. One is the *Freeze Game* at the Liberty Science Center, the other is *SoundStair* at Boston's Museum of Science.

SoundStair allows visitors to play a set of stairs in the museum as if they where a musical instrument. Observing the exhibit it is common to see visitors walk down the stairs, notice they are creating music, and then to walk back up the stairs to try it again.

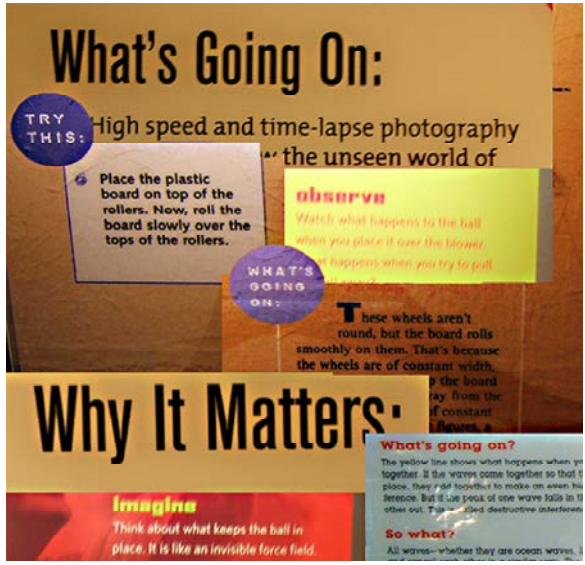
The quality that I most appreciate about *Soundstair* however is that it allows the visitor to have a moment of accidental discovery.

SoundStair at Boston's Museum of Science.

Frank Oppenheimer, the founder of the Exploratorium makes an analogy between the dangers of trying to have too much control over how someone learns to a hurried hike up a mountain peak. In both cases the guide has the best intentions. He wants to show the best way to reach the goal while pointing out what is note worthy along the way. However, the danger is "if the trip was spoiled through hurry or painful effort, then no one was moved to go searching for views of his own" (Oppenheimer 1-2).

Being in a science museum can sometimes feel like an overeager tour guide is dragging you around. You are asked to do this, then the next thing, to notice that – and then you are told why it's important.

Soundstair works without the visitor having to do anything extra but walk down the stairs - something that they were going to do anyways. In the context of a science museum it can be a relief to have a few exhibits that don't demand anything of you. I envision Falling Up as having a similar quality if placed in the proper setting.



A collage of signs from the Exploratorium, Bosotons Museum of Science and the Liberty Science Center

4. PROJECT RESULTS: THREE SHOWS, THREE VERSIONS

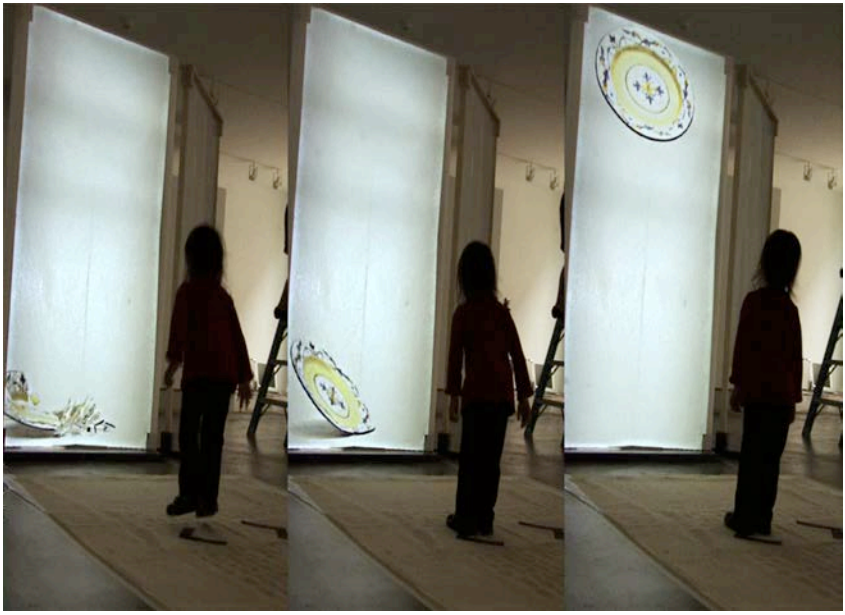
I showed three versions of Falling Up at three different installations of the work.

The third version is the closest to how I originally envisioned the project. In this installation the body was used as the interface, multi-user interaction happened, and the scale of the exhibit made it closer to being an immersive experience.

At all three installations I collected feedback from observing people interact with Falling Up, and from verbal feedback I received from attendees. At the first and third installations I also video recorded visitors interacting with the exhibit.

I'll describe the feedback I received from each show individually. But my general impressions from attending all three installations was that at each show there was a group of people who were not interested in interacting with Falling Up. One person at the first show interacted very briefly with the piece and commented that they didn't like breaking plates. Conversely at each show there were one or two people who engaged with the piece for a prolonged periods of time, or who kept returning to it. Most people seemed to interact with the piece for about a minute.

Doran Gallery, May 8, 2008



Overview: The first time I showed Falling Objects I based the interface on the arrow icons of remote controls and online video players. Visitors controlled the video by stepping on these icons. When a visitor stepped on an arrow to the left the video played in reverse, while if the visitor stepped on an arrow to the right the video moved forward. If both forward and reverse icons were stepped on at once the video froze.

Participation: With Falling Up I wanted to create an interface that was immediately accessible. I didn't want the interface to be a mystery - as is sometimes the case with art installations - but to be a tool that people could easily manipulate to control information, in this case a high-speed video of a plate falling.

In showing this version, I was pleased with how well the interface worked. Most people were able to quickly figure how to control the video, and from watching the video I recorded at the show it was clear that some people enjoyed playing with the interface.

Feedback: My approach to collecting feedback the first time I showed Falling Up was to passively collect what people shared spontaneously without asking follow-up questions. My classmate Agata Stadnik, said that she enjoyed dropping the plate just to the point before it would break, and

then raising it up again. In an in-class critique, reviewer, Steve Hollinger, interpreted Falling Objects as a comment on post-modern society, and our belief that we can put everything back together again.

Other comments that I heard multiple times were:

- It's fun/satisfying to break plates
- It's fun/satisfying to put them back together
- It's like dance dance revolution

Axiom Gallery, May 30 through June 21

Overview: The second time I showed *Falling Up*, it was as part of a group show at the Axiom Gallery that was up for a number of weeks. In this installation, I put greater effort into presentation. Among the changes I made were the placement of the projector. Where at the Doran Gallery I rear-projected the video, this time I hung the video camera up from the ceiling of the gallery.

An example of how I estoned the video, wen I showed at teh Axiom gallery

Another change I made was to make the interface more complex. I added two more arrows to the interface giving users more control of the speed of the video. In programming I connected all the input of the switches, so adding two more switches created six more options. For example, if a visitor stepped on both the forward buttons at the same time the video moved the fastest.

Participation: Although I was pleased with my programming and the number of possibilities it offered, it was clear from observing people interacting with the installation that they didn't grasp these possibilities.

Creating multiple possibilities, didn't necessarily affect the installation's usability, but the way I designed the graphics for the controls, and the fact that I used a computer was less powerful than the one I used in my previous installation did.

In terms of graphics, instead of simply having a forward and reverse arrow

as I did before, I placed the words "slower" and "faster" between the arrows. Naturally many people using the video stepped on the words, which had no effect on the video, instead of the arrows.

Using a computer with less processing power meant that people using the installation didn't consistently get precise feedback from their actions like they did from the installation at the Doran Gallery. This problem was at times subtle, but compared to the previous installation I thought of the interface in this installation as being a bit "broken".

Despite the problems with the interface, people still enjoyed the piece, including a fourteen-year old boy who spent most of his time at the exhibit, breaking the plate over and over again.

Feedback: Although I observed people interacting with *Falling Up* at Axiom Gallery, I didn't collect feedback at the opening. Also, the set-up of the gallery wasn't conductive to videotaping. I do remember one's person response to the installation was that I was angry, especially with men.

Doran Gallery, November 30, 2008

The third time I showed the piece, I made a number of changes that brought it closer to my original concept. I changed the interface so that the video was controlled by the direction and speed of visitors walking. I installed two interactive videos instead of one, so I was finally able to express my idea of multi-user interaction.

I also made the projections larger, so interaction was closer to an immersive experience.

I was able to create the interaction by using two infrared sensors for each of

the projections. A person walking by the projected image would trigger one sensor and then the other. I used MaxMSP to measure the time between one sensor being hit compared to the other, as well as the direction.

Although, this installation of the project came closest to my original conception of the interface, it was also the roughest installation of the three. The infrared sensors didn't have as long of a range as I would liked, so people had to walk closely to them. Ideally the space of the exhibit should have been a corridor, so that people's movements would be guided down a hall. As a rough approximation I used a long black box to guides peoples' path through the exhibit, but without my direction I assume it would of taken people awhile to figure out how to interact with the exhibit.

Also the interface for the projection of the plate on the right seemed at times to have a mind of its own. If I was showing Falling Up in a more professional setting this probably would of bothered me, but in this instance I found the added randomness, even if it wasn't intended by me, interesting.

Participation: I was pleased with how people interacted with the third version of Falling Up. The people at the installation walked, ran, and hopped in using the interface. At times more than one person interacted with the projections at once.

Similarly to the two previous showings, from watching the video it's clear that some people at the exhibit enjoyed playing with Falling Up, given their level of engagement and time spent with the exhibit.

I also was heartened to note the reaction when one of the plates fell particularly slowly, producing what sounded like deep notes as it broke.

Feedback: "It was fun to play with. What is interesting is hearing the notes come out of it. it's like bass notes"

"I like the violence and the power in it. I'd love to be in a room full of dishes I could break. It would be even better if I could reverse the action so that it never happened. For me it is about appearances and control. Plus it is just fun to play with. I especially enjoyed attempting to make the plate on the left 'bounce'."

"When you break the fine china it's kind of upsetting, but then you can just put it back together. There is nothing unique anymore, everything can be replaced."

"This was more like the randomness of life, you're walking along and everything could fall apart or everything could come together. Or things could fall apart or come together at the same time."

5. CONCLUSIONS

The most satisfying part of creating Falling Up was seeing it become a reality, and watching other people interact with it. On a fundamental level, I was simply pleased that it worked.

Although Falling Up isn't an exhibit that everybody was interested in interacting with, or even that most people became engaged in for a prolonged period of time, I'm satisfied that I created a bridge between the digital and physical world, and to a certain extent from my mind to the minds of other people.

Because my thoughts on the project evolved as I worked on it and from other people's reaction to it, I suspect that I had some circular thinking in analyzing my intentions for Falling Up in terms of the feedback that I received about the work. That being said, I found it encouraging that some of the ways people interacted with or commented on Falling Up reflected my personal interpretations.

For example, when people commented on their enjoyment of breaking plates and putting them back together again I felt that it fits with my intention to give people the experience of controlling time in a physical and external environment.

Two people made comments about the work as a reflection of modern society. One said that the work expresses society's belief that everything can be put back together again. Another said that the work reflects our belief that everything can be replaced. Those sentiment don't exactly match mine, but as I continued working on Falling Up, and watched others interact with the piece, it struck me that although the image can be put back together, the plates I smashed remained broken. In fact, I still had the pieces. The

second time I showed the work, I included the shards during a critique to emphasize the difference between media, our thoughts, and reality.

My third interpretation of Falling Up was that it created an experience demonstrating that there is more information in the world than we can perceive with our senses. It was this interpretation on which I based my argument that Falling Up could be seen as a science exhibit.

The last time I showed Falling Up, people were impressed when the video played super-slowly and they could examine how far the shards of the plate flew. However, in general people didn't interpret Falling Up through the lens of science. One of the reasons is context: The exhibit isn't in a science museum environment. I also found I wasn't interested in creating a context for the exhibit in order to justify it in terms of science. The subject matter of plates breaking also didn't contribute to the scientific interpretations. People viewed the plates as a metaphor, but not of scientific content. Finally, the physical action of the interaction itself, either stepping on a switch or walking, didn't make a connection to scientific content.

Despite the limitations I encountered in communicating scientific content with Falling Up, I think the project points to ways that interactive environments can be powerful communication tools; Not by designing interactions that virtually recreate the world, but by creating interactions that reflect the landscape and actions of our minds.

Areas for future research include incorporating active metaphors into interfaces, thereby tapping into our natural ability to think through abstract ideas using metaphors, and using mirroring to connect the physical body to the digital world.

6. PROCESS

Creating an interactive exhibit requires the skill sets of many fields. Although I focused on creating a satisfying interaction, I found it necessary to wear many hats, and to learn many new skills in the process of transferring my idea for an exhibit from a sketch to a prototype. Those skills include programming, electronics, exhibit lighting, woodworking, sound recording, and using a high-speed camera. The one skill I felt relatively comfortable with was photography, and by extension video.

Conceptually creating an exhibit required a shift in my thinking from 2D to 3D space - a space that people can physically move around and interact in. For almost my whole life I've concentrated on creating 2D surfaces. I'd left the world of building behind when I stopped playing with blocks and constructing teepees. On a technical level working with 3D space requires creating, or appropriating structures to define space.

One of the hardest challenges for me was finding out how to create an interaction that didn't depend on a keyboard and mouse for input. Phidgets came to the rescue at the very end of fall semester in Brian Lucid's Elements of Media Class.

Using a phidget accelerometer that could measure tilt – connected to a string and a stick - I was able to move a stick up and down and control video of a ball dropping. The stick dropped, the ball dropped – the stick raised, the ball raised. I enjoyed playing with video in Final Cut – slowing the action down, reversing the playback, and listening to how the pitch of the sound shifted depending on how fast the video played. I had found a way to bring the same experience outside the computer. I was ecstatic.

The next semester I was determined to complete an interactive exhibit

project. I was fairly convinced that, although I had many challenges to overcome, I could make an exhibit where users controlled the video of projected objects falling a reality. I knew from my previous filming that I needed a high-speed camera. With standard cameras only 12 or 15 frames of an object falling would be captured, and often the moment of impact was missed. I had to find a way to project the video so that bottom of image met the floor. Yet I also wanted people standing in front of the video not to cast a shadow over it, this was actually my biggest concern. I also had to find a way to create a satisfying interaction. Moving a stick wasn't going to cut it.

Working through the animation department I was able to use a camera with a high-speed function that took more frames per second, but at the expense of resolution, so the images were fuzzy. By mid-semester I was able to show a fuzzy projection of a plate crashing that was controlled by a phidget infrared sensor and ActionScript.

At this point I had already realized that I had to find a better, meaning a real, high-speed camera. The infrared phidget sensor technically worked – if you had the skill of a Theremin player. But my goal was for people to interact without effort. I also felt the need to upgrade the physical set-up of the piece, which at midterm was a sheet hanging from a pole.

I tracked down a specialized video company in New Hampshire that let me rent one of their outdated high-speed cameras. Just as importantly, they spent the time showing me how to use it. I still needed to get lens and a PC to work with the machine. It turned out to be almost as much of a challenge (and more expensive) to find a PC that was compatible with the camera as it was to get the camera itself.

The video and sound was recorded over the course of one weekend in my backyard with the help of my friend, John Beaudoin. I set up the shoot outdoors because I was warned that the alternating current of studio lighting may appear to flicker if I shoot the video at too high of a speed. We filmed multiple plates breaking, as well as a couple of cups of tea and milk spilling.

Shooting outdoors had an unintended consequence. I was accustomed to recording at a studio at school where the floors are concrete. At school all I had to do was drop a plate and it would shatter. In the backyard I used a wood platform as the floor. It turned out that the plates were just as likely to bounce off of the wood as break. I tried dropping the plates from a greater height, and then throwing them with some force to get them to break. Throwing the plates worked, but when thrown the plates were

also less likely to hit their mark where it could be captured by the camera. When the plates did break they were less likely to break into many pieces – sometimes breaking just into two or three. At the end of two days I was disappointed in the number of decent shoots I had.

For the interactivity I switched from using a phidget sensor and Flash to an arduino board and MaxMSP. At first, I again, tried to use an infrared sensor as an input to the arduino board, thinking that the video could be controlled by people's distance to the sensor. This way to playback could be controlled by people walking, like I originally imagined. However, I found that, as with the phidget infrared sensor, I wasn't able to control the video very precisely with infrared, so I switched to making foot pressure pads as the input control.

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