Tangible Interfaces for Interactive Point-of-View Narratives

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June 1999

Submitted to the Program in Media Arts and Sciences,
School of Architecture and Planning,
in partial fulfillment of the requirements for the degree of
Master of Science in Media Arts and Sciences at the
Massachusetts Institute of Technology
September 2001

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Abstract

This thesis presents three storytelling systems for interactive point-of-view narratives using tangible interface technology. The focus is the design and development of computational story models and interfaces that enable users to experience new forms of interaction with stories in the digital medium.

Specifically, I propose that having multiple tightly related character viewpoints can be used as a means of structuring comprehensive and coherent interactive story experiences. Furthermore, I also claim that by using tangible interfaces that are tightly integrated into the narrative model and story content, users can have rich interactive story experiences in which the interaction/interface does not distract from their engagement in the story.

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Acknowledgments

This research was completed with the help of a number of different people—friends, colleagues and professors who have provided me with support and inspiration over the course of the past several years. In particular, I would like to thank the following people.

My advisor, Hiroshi Ishii, for his guidance, vision and encouragement, and for providing me with the resources to pursue my work.

My readers, Glorianna Davenport, Kevin Brooks and Ron Baecker for their insights and support along the way.

All of my friends and colleagues in the Tangible Media Group. Especially Alison Wood for all the great brainstorming sessions and her wonderful stories, Brygg Ullmer for his help and advice on the *Tangible Viewpoints* interface construction, and James Patten and Jason Alonso for their help with the Zowie sensing system.

Laura Packer, Kevin Brooks, Raelinda Woad, Stacey Resnikoff, Ben Vigoda, and Nyssim Lefford for their help with content creation for the *genieBottles* and *It May All End in Aleppo*.

Egon Pasztor for his amazing coding skills and help with the *Tangible Viewpoints* graphics. And for being there through many late nights!

Dan Overholt for all his hardware expertise and for being there whenever I needed it most. And for putting up with me through the last few hectic months!

Erica Bouhenic for pointing me to multiple viewpoint stories in English literature, and Jean-Claude Bouhenic and Bill Thomson for all the great discussions up at the cottage.

And most of all my parents, Bohumil and Dora Mazalek, for their love, support, and for always being there to help me think things through.

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Introduction

Storytelling is an important part of human culture. We all listen to other people's stories, but we also all tell stories of our own. We find great pleasure in experiencing good stories. They touch us emotionally, and help fulfill our artistic and aesthetic desires. Extending across generations and cultures, stories can also be extremely instructive. They teach us about the world and about our history, and they inform us about the major themes that have affected both individuals and societies for millennia, helping us put our own lives into perspective. And by creating our own stories, we can structure and express our own experiences, understandings and opinions about the world in a form that can be passed on to others.

In the fast-paced and technologically advanced society of today, storytelling is no less important than it has been in the past. Whether in the form of myths, plays, novels, or films, our stories as well as those of our predecessors can help guide us forward. But, inundated by the television shows and videogames of our mass media culture, we can sometimes feel we have lost all real sense of time. Although contemporary media can give us the illusion that we are always in touch

with the world, we still seem to be losing the stories of our past, the stories that give us a sense of who we are and how we fit in. In his book *The Power of Myth*, Joseph Campbell comments: "We are not well acquainted with the literature of the spirit. We're interested in the news of the day and the problems of the hour." [11, p.1] He suggests that our myths have not been able to keep up with our technology, and that in our schools we learn only technologies rather than great stories that impart the wisdom of life experienced.

Yet the computational age provides many opportunities for us to communicate our stories – text, graphics, sound, and video can all be combined together using the digital medium. Desktop moviemaking, hypertext pages on the Internet, and even simple word processing are all powerful means by which people can create and distribute their stories. Perhaps we can make use of these technologies to tell meaningful stories that might fulfill the human need for storytelling, and become the myths of our contemporary society.

In this thesis, I will examine some of the new forms of storytelling made possible by digital technologies. But before beginning our exploration of storytelling in the computational age, let us look back at how storytelling has evolved across the centuries.

1.1 A Brief History of Storytelling

There are many theories on the origins of storytelling. Anne Pellowski provides an analysis of its history in her book *The World of Storytelling*, and suggests that it originated in the play activities through which people entertained their particular social group informally [31]. She also describes evidence to support a variety of other theories. For instance, storytelling might have stemmed from a human need to explain and understand our surrounding physical world, or from a religious need to honor supernatural forces. Or perhaps storytelling evolved from an aesthetic need for beauty and form through expressive language, or from an inherent desire to communicate and record our experiences.

There is probably some amount of truth to all of these theories. According to Joseph Campbell, early people enacted rituals and created myths to help them cope with the certainties of life, such as the passage from childhood to adulthood, and death [12]. He explains that the earliest evidence of mythological thinking can in fact be associated with graves and ritualized burials anywhere from 150,000 to 50,000 BC. Cave paintings dating from 40,000 to 10,000 BC are also early evidence of mythological thinking and storytelling. Early artists tried to tell their stories by painting pictures on cave walls or rocks – they told of encounters with animals, sacred rituals, and the experience of life and death.

Figure 1: The drawing shows a dancing shaman from *Les Trois Frères* cave (above). "The Scene of the Dean Man" from the *Lascaux* cave is famous for its narrative possibilities (right).

Long before the development of written language, stories were passed down the generations through a tradition of oral storytelling [4]. They took the form of myths and legends, and helped people understand and explain the world around them. Around campfires and water holes, the wisdom of the elders was passed on to young children. Ideas, ideals, values and standards of behavior were all handed down from one generation to the next. Early oral tales from many cultures have been preserved for us, and are still told or read today. Some examples include creation myths, such as the *Book of Genesis* in the Bible, handed down by the ancient Hebrews, or stories of heroes, such as the Sumerian *Epic of Gilgamesh*. Other notable examples are the works of Homer such as the *Iliad* and *Odyssey*. Homer created his stories around 1200 BC, long

before the Greeks developed a credible, lasting alphabet, and his works were then passed orally from generation to generation for hundreds of years.

Theatre evolved as another form of storytelling, in which actors take on the role of characters in a story that is performed in front of a live audience [41]. Generally believed to have originated in religious rituals, theatre eventually grew to be an independent art form in ancient Greece, where it was first used to celebrate the rejuvenation of the earth, and later drew on Homeric legends for its subject matter. Greek playwrights such as Thespis and Aeschylus developed dramatic conventions that would influence theatrical arts across the centuries to come. For instance, according to Greek tradition, Thespis invented the drama when he augmented the dithyramb (a form of choral song) to have a single actor who wore different masks to portray several characters. With the possibility of dialogue between the actor and chorus members, more complex themes and modes of storytelling could be developed.

Figure 2: The first Greek plays were performed at the *Theatre of Dionysus* in Athens (left). The vase fragment depicts actors from ancient Greek theatre (above).

Over the years, theatre evolved around different parts of the world. For instance, between the classical and medieval periods in Europe, it was kept alive by popular entertainers – mimes, minstrels and storytellers – who wandered the country alone or in small groups. During the late Middle Ages, these popular entertainers found a more secure place at

royal courts and in the households of nobility, where they acted, sang, and played music for their masters. In Japan, dances had been common in religious rituals since prehistoric times. Japanese No theatre is a fusion of dance, drama, and song that was developed in the 14th century, and draws influences from theatrical and musical arts in China, Korea and India.

The development of stable writing systems around the world allowed people to start recording their stories [45]. For instance, the works of Homer were finally written around 700 BC, and they became the textbooks in the schools of Greece, and the cornerstone of Western literature. During the Middle Ages in Europe, Christian scribal monks recorded many of the great sagas and heroic epics from the oral tradition. Examples include the Anglo-Saxon *Beowulf*, and the German *Song of Hildebrand*. The invention of the printing press by Johannes Gutenberg in Germany around 1450 drew on earlier inventions from China (paper, block printing, and moveable clay type), and marked the Western world's first practical means of disseminating ideas, information, and stories from a single source to a large and distributed audience [19]. From that point on, printed books rapidly became a widespread storytelling medium.

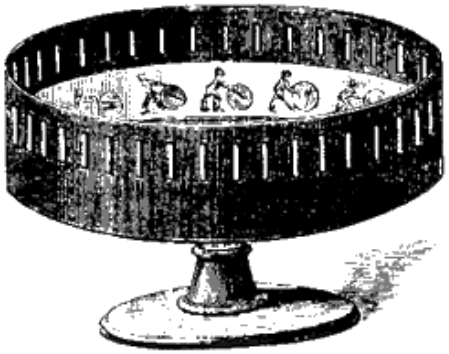

Figure 3: The Zoetrope consisted of a revolving drum with many small slits. A series of pictures that changed slightly from one to the next were arranged on the inside. By spinning the drum, one could trick the eye into seeing a single moving picture.

Near the end of the 19th century, technological innovations such as the Kinetoscope and Kinetograph by Thomas Edison, and the Cinématograph by the Lumière brothers enabled storytelling in the form of motion pictures. These technologies were based on earlier devices such as the Zoetrope that used persistence of vision to create the illusion of motion

from still images (see figure 3). As motion picture machines evolved, a cinematic grammar or language of storytelling was devised, and many stories were adapted to fit this new medium. The storytelling language is now known as the cinematic "montage" (editing), which can build time and space not out of sentences and paragraphs, but out of sequences of shots separated by cuts. In this way, sequences of film are structured into coherent narratives that can be communicated to an audience. The first example of this cinematic structure is generally considered to be D.W. Griffith's 1915 film, "Birth of a Nation" [33]. The film's development of plot and dramatic use of editing became integral to the structure of Hollywood and mainstream filmmaking.

Over the course of the 20th century, innovations such as the transmission of sound and motion pictures over radio and television provided new means of distributing information and stories to wide-ranging audiences. At last in 1945 came the invention of the first electronic computing machine. Since then, the rapid development of personal computers and digital formats for audio and video has opened up many possibilities for the expansion and development of the art of storytelling.

1.2 Technology and Storytelling

Across the centuries, technological innovations have enabled new mediums for creative expression, and storytelling has evolved to fit each one. In his Master's thesis, Phillip Tiongson describes three stages in the development of an expressive medium: first a medium is invented through advances in technology; next an expressive language is defined through experimentation, an understanding of past conventions, and a vision for the future; and finally, as the medium matures and stabilizes, the tools for working within it become increasingly accessible, allowing both professional and amateur artists across the world to tell new kinds of stories [42]. For instance, the invention of motion picture cameras enabled a cinematic form of expression. Certain early films captured scenes from real life, such as the first film by the Lumière brothers, *La sortie des ouvriers de l'usine Lumière* (Workers leaving the Lumière factory, 1895). Many other early films were simple translations of the theatrical form of storytelling: stage plays acted in front of a camera.

Certain films also played with the illusion of cinema: in the "trick" films of Georges Méliès, people appeared and disappeared at the will of the filmmaker. His most well known work, *A Trip to the Moon* (Le Voyage dans la Lune) was created in 1902. Through this sort of creative experimentation, cinematic storytelling conventions were defined, allowing today's filmmakers to tell their stories using a language unique to the cinematic medium.

The development of personal computers over the past twenty years has allowed people to begin adapting storytelling as an interactive digital medium. In 1989, Brenda Laurel reminded us how difficult it is for people to imagine what has not yet been invented, and that extrapolating from the state of interactive entertainment at any point in time risks incorporating the limitations of the past into the future of interactive storytelling [26]. Early digital stories range from hypertext novels, to adventure games and multimedia CD-ROMs. The first computational narrative model that comes to mind is generally the branching story structure, which is based on the choose-your-own-adventure books of the 1970s. In this model, stories branch out into multiple different pathways, and the author provides preset branch points at which the user (or reader) must choose which one to follow. It is clear that in these early interactive systems, the grammar to guide and help structure storytelling within the digital medium is still rather limited. There remains a vast world of creative opportunities to be explored and exploited, and with the increasing stability and accessibility of digital technology today, storytellers worldwide are able to free themselves from the cinematic and literary traditions of the past in search of novel approaches to computational storytelling.

1.3 Interactive Narratives Meet Tangible Interfaces

In 1998, I attended my first CHI (Computer-Human Interaction) conference. There, a presentation by two graduate students from the Tangible Media and Hyperinstruments Groups at the MIT Media Lab caught my attention. They were using plastic triangular pieces that could be snapped together as a means of navigating through non-linear stories [24]. This was my introduction to the concept of "tangible interfaces",

and I was fascinated! I had been creating stories using digital video and conventional GUIs (Graphical User Interfaces), and I immediately saw the potential of tangible interfaces for communicating digital stories to audiences in a rich physical form.

Figure 4:
Triangles is a tangible interface in the form of a physical/digital construction kit of plastic triangular pieces.

Over the past two years as a student in the Tangible Media Group, I have created three separate storytelling systems that use tangible interface technology. This thesis thus contributes to the field of interactive storytelling through the design of computational story models and tangible interfaces that enable users to experience new forms of storytelling. In particular, the computational models I have explored use multiple points-of-view as an approach for structuring narrative interaction, and the tangible interfaces have served as a means of communicating the stories to audiences.

Storytelling is a vast field that is continuously expanding as new mediums and forms of expression are developed. I chose to focus on three key points in digital storytelling: interactivity in narratives, multiple points-of-view, and the design of tangible interfaces to communicate stories. It is important to ask how these three points work together to form the focus of my research, and the next few subsections address this question.

Why Interactive?

Many people believe there is an inherent conflict between interactivity and immersive or engaging narrative experiences. When a user is immersed in a story, they are less inclined to interrupt the experience

through some form of interaction. Furthermore, from the perspective of creating a story, interactivity risks greatly increasing the complexity of the narrative structure. For instance, instead of a single defined narrative path, the branching story model must provide many paths, all of which must make sense in view of the story being told. Despite these problems, storytellers have enjoyed experimenting with interactivity over twenty years. They have been attempting to overcome the problems of complexity and immersion by exploring different narrative models for their stories. The benefit of interactivity for authors and viewers alike is that a given story can take on a variety of meanings through alternative tellings. Furthermore, as Michael Murtaugh explains in his Master's thesis, relinquishing certain aspects of authorial control can allow viewers to form a personal connection to the story [29]. In this sense, interactive narratives offer the potential to tell more complex and personally meaningful stories than those delivered to a mass audience. Interactivity may serve to increase viewer engagement by incorporating their specific knowledge and preferences. For instance, a computational system can gather the viewer's knowledge about story events as they navigate, and then direct the course of the story accordingly. Interactivity also creates the possibility of "reviewable" stories in which each telling can reveal different perspectives and insights. The digital medium allows us to tell stories in a new way, and although it might sometimes be difficult to see from the interactive storytelling landscape of today, it should be possible to create immersive stories in which users are driven to interact.

Why Multiple Points-of-View?

In character-driven narratives, different characters with distinct personalities and unique points-of-view are used as a basis for creating a story. As Maureen Thomas, creative director of the Cambridge University Moving Image Studio, explained to me at a Narrative Workshop run by Glorianna Davenport at the MediaLabEurope in Dublin, "if you start from character, the story simply writes itself." In contrast to the character approach, creating a story from plot-points can be much more difficult. With a framework of actions and events in place, finding the right set of characters to fit them can be a tricky task. It may even be the

case that for a given set of plot-points, there may not exist a believable set of character personalities to enact them. Furthermore, while plot-driven stories can incorporate interactivity by branching out into different narrative paths, character-driven stories can use multiple points-of-view to incorporate interactivity into a single story space, allowing for decreased complexity in the creation of the story. Also, branching structures can sometimes fragment the plot, leaving viewers unsatisfied with the story experience. Giving viewers the choice between multiple character viewpoints on a given story is one possible strategy for structuring interactions into coherent story experiences. This approach will be explored in greater detail in Chapter 2.

Why Tangible?

When creating a story, it is important to consider the form and environment in which it will be conveyed to its audience. This environment needs to provide an atmosphere for immersion in the story. In theatre, we experience a story together with other audience members as it unfolds on a stage in front of us. In film, the frame that is projected onto a large screen in a dark theatre provides a window into a story world that draws us in with ease. When reading a novel, our imagination is free to "see" the story in our own way, and we become immersed in the words written on each page. In contrast to these forms, traditional computer interfaces seem static and clunky. All day long I sit in front of a computer screen, clicking on a mouse, and typing on a keyboard. I am reminded of Professor Hiroshi Ishii's words: this form of interaction "impoverishes the senses". This is the last thing I want when experiencing a story. Tangible interfaces provide interactive narratives with a means of escaping from the computer box into our physical environment. They enable us to go beyond visual/auditory senses and make better use of our sense of touch.

1.4 Thesis Structure

This thesis chronicles my explorations in the design and implementation of interactive narratives with tangible interfaces, and describes the theoretical principles I have identified along the way. The process was

one of iterative design across three separate storytelling systems, in which the ideas and limitations of each contributed to the development of the next.

In Chapter 2, I examine the concept of multiple viewpoint narratives from a theoretical perspective, and describe past work in the fields of point-of-view and tangible narratives. I also identify two main hypotheses for the design of my systems.

Chapters 3, 4 and 5 are devoted to the design, development and analysis of the three storytelling systems I have built: the *genieBottles* system, a narrative installation entitled *It May All End in Aleppo*, and the *Tangible Viewpoints* system.

Chapter 6 concludes the thesis by summarizing the lessons learned and discussing possible extensions to the *Tangible Viewpoints* system.

Chapter 2

Laying Down the Foundations

I have examined the human need for storytelling, and how it has evolved over the ages. I have also hinted at how interactivity can be structured using multiple character viewpoints, and how tangible interfaces can provide a rich means for interaction with stories.

At this point, it is time to lay down specific foundations for the design of tangible interactive point-of-view storytelling systems. In this chapter, I look at past work in two related fields: multiple viewpoint stories and tangible narratives. I then go on to discuss the principles and hypotheses that led to the design of three interactive storytelling systems: an audio-based "bottled" story entitled *genieBottles*, a narrative video installation entitled *It May All End in Aleppo*, and finally the interactive *Tangible Viewpoints* system.

But first, I begin by examining the term point-of-view in narrative theory. Since the term covers a vast range of functions in the English language, it is important to clarify the meaning in the context of this thesis, and to look more closely at how it can be used in the creation of interactive stories.

2.1 Defining Point-of-View

How is the term *point-of-view* used differently in the following two sentences?

1) From my point of view at the top of the building, the cars below looked like little toys.
2) John told me that from his point of view it had been a mistake to sell the house.

The first sentence uses point-of-view to denote the physical position from which something is viewed, while the second uses it to mean an opinion or mental attitude toward a question. Although these sentences demonstrate how the term is used in everyday language, neither one provides a definition that can be applied directly and precisely to the concept of point-of-view in narrative theory and storytelling.

In his book *A Theory of Narrative*, F.K. Stanzel quickly casts aside these ordinary uses of the term point-of-view, and instead identifies a meaning that is specific to narrative terminology. He writes that point-of-view is the "standpoint from which a story is narrated or from which an event is perceived by a character in the narrative." [37, p.9] This definition in fact reveals two distinct contexts in which the term point-of-view has been used in narrative theory: (1) to narrate or communicate to an audience, and (2) to perceive or experience as a character in the fictional space. Since applying the term point-of-view to both contexts can lead to confusion, Seymour Chatman refers to the first using the term *narrative voice*. He defines point-of-view and narrative voice as follows:

> "Point of view is the physical place or ideological situation or practical life orientation to which narrative events stand in relation. Voice, on the contrary, refers to the speech or other overt means through which events and existents are communicated." [13, p.153]

So narrative voice is the expression, while point-of-view is only the perspective in terms of which the expression is made. Seymour Chatman explains that the perspective and expression need not be lodged in the same person, and that different combinations are possible [13]. For example, narrative voice and point-of-view coincide in stories where the narrator both perceives events and recounts them in the first person. On the other hand, point-of-view is frequently assigned to a character that is

not the narrator, and the narrator recounts events in the third person. Chatman hence writes: "point of view is in the story (when it is the character's), but voice is always outside, in the discourse." [13, p.154]

Looking at the Stanzel and Chatman's theories has helped identify a definition of the term point-of-view appropriate to storytelling. But how can the concept be extended to multiple characters, each with their own point-of-view? And how does interactivity fit into the picture?

2.2 From Point-of-View to Interactivity

In Chapter 1, I briefly mentioned the difference between plot-driven and character-driven narratives. Although both character and plot are necessary for a story to exist, narrative theorists have long argued over which is subordinate to the other. In his *Poetics*, Aristotle repeatedly underlines the primacy of action, of which the characters are mere agents [2]. Similar to Aristotle, the Formalists argue that character is a functional product of plot. They avoid analyzing the psychological essence of characters, and instead concentrate only on their actions [13]. For instance, theorist Vladimir Propp studied over a hundred Russian folktales and concluded that they were all constructed from a certain set of plot components. For him, the characters in the folktales were simply products of what the stories required them to do [32, p.20]. In modern art narratives on the other hand, the contemplation of character seems to be predominate. According to Seymour Chatman, modern characters like Leopold Bloom in James Joyce's *Ulysses* cannot be reduced to any single aspect or pattern [13, p.112]. Their traits are numerous and complicated, and cannot be considered mere consequences of the story's plot. It is the character's personalities that seem to determine their actions.

In reality, applying a generalized statement about the importance of plot over character or vice versa to all stories is impossible to do. The question should be one of emphasis. This seems to be what Tzvetan Todorov is getting at when he distinguishes two broad categories of narratives: those that are plot-centered (or *apsychological*) and those that are character-centered (or *psychological*) [43]. To quote Henry

James, "What is character but the determination of incident? What is incident but the illustration of character?" Where the chief emphasis falls in a given story is more a matter of the changing tastes of authors and their publics [13].

For me, the interesting question lies in how the emphasis on either character or plot can be used to structure interactivity in digital storytelling systems, and the advantages or disadvantages of each approach. In Chapter 1, I mentioned a typical method of using plot to guide interactivity by creating stories that can branch out into different paths (the "choose-your-own-adventure" model). Users interact by deciding which path to take at the preset branch points. One downfall of this method is generally acknowledged to be the increased complexity of the writer's task, given that they have to provide many different believable plot lines for a given set of characters. The personalities of the characters are not used to guide the narrative. Instead, their actions are frequently left as a choice for the user at the story's branch points. As in Vladimir Propp's folktales, the focus is more on providing a variety of interesting plot lines than on the contemplation of complex characters. While it can sometimes be interesting to follow characters along a variety of diverging narrative threads, I have generally found it difficult to immerse myself fully into such stories. As Seymour Chatman has underlined, modern narratives have tended to lean toward psychologically complex characters, whose traits and actions do not necessarily add up to a single goal-oriented behavior [13]. Perhaps this is what I have been missing in plot-driven interactive narratives.

In the previous section, we examined point-of-view as the concept of seeing a story from a particular character's perspective. Psychological narratives frequently give us access to a character's thoughts and consciousness, which serves as a typical means of entering his or her point-of-view. The distribution of inside views among different characters in a story can lead us to identify with certain characters over others. Seymour Chatman writes that "despite close physical proximity and the thinness of characters' skins and membranes, wholely different mental universes exist only inches apart." [13, p.216] In traditional narratives, these widely differing "mental universes" generally fit into a

master plot. Over the course of the story, the focus often narrows to a single main character's viewpoint with which we are lead to sympathize. We can call this the "hero model." In contrast, certain modern storytellers have explored the possibility of constructing narratives by using several character viewpoints consistently over the course of the story. For instance, multiple viewpoints can allow the construction of a story from several partial and sometimes conflicting opinions of the past, as in Akira Kurosawa's film *Rashomon* (1950). Alternatively, the author can shift viewpoints as the story moves forward in time – an approach that is often used in "whodunit" mysteries such as the play *Shear Madness* (adapted from the Paul Pörtner's 1963 play *Scherenschnitt* by Marilyn Abrams and Bruce Jordan). In either case, moving from a single character viewpoint to several different viewpoints can provide a means for structuring interactivity in a computational narrative by allowing viewers to select the viewpoint as they move forward through the story.

One of the advantages of the multiple viewpoint approach is that it leaves greater possibility for different viewers/readers to relate to different characters depending on their own personalities and preferences. Furthermore, events can take on a variety of meanings depending on whose perspective they are viewed from. When choosing point-of-view is left to the viewer, a single story space can turn into a myriad of story experiences, each one tailored to the preferences of a particular individual or audience. Janet Murray captures our desire for such experiences when she writes:

> "The kaleidoscopic power of the computer allows us to tell stories that more truly reflect our turn of the century sensibility. We no longer believe in a single reality, a single integrating view of the world, or even the reliability of a single angle of perception… The solution is the kaleidoscopic canvas that can capture the world as it looks from many perspectives—complex and perhaps ultimately unknowable but still coherent." [28, p.161]

2.3 Point-of-View Narratives

Multiple viewpoint narratives have been explored in both non-interactive and interactive forms by many different writers, filmmakers

and artists. This section gives an overview of some of the more notable examples.

Non-Interactive Works

I include examples of point-of-view stories from the following three non-interactive categories: (1) literature, (2) cinema, and (3) theatre.

(1) Literature

Examples of multiple viewpoint narratives from literature include William Faulkner's *As I Lay Dying* and *The Sound and the Fury*. In *As I Lay Dying*, each chapter begins with a name caption, and the text that follows is seen from that character's perspective. In total there are fifteen different character points-of-view that emerge over the course of the story. *The Sound and the Fury* on the other hand is told through three different narrators, each with an idiosyncratic and partial perception of the story. The novel is divided into four parts: the first is the direct interior monologue of a mentally disabled character, the second and third are each narrated by different characters, and finally the fourth is in third person omniscient viewpoint. William Faulkner originally asked his publisher to use different colors for the print in the novel, hoping it would make the time-jumping stream of consciousness style of the first section more comprehensible [28].

(2) Cinema

In cinema, multiple point-of-view narratives have been explored in a variety of ways. One of the most widely acknowledged examples is the 1950 film *Rashomon* directed by Akira Kurosawa. The film is a careful observation of a single event (rape and murder) looked at from four different points-of-view one after the other. The stories of the four witnesses are wildly at variance, and as such the film questions the existence of a single unified reality. Kurosawa's approach works well in that the entire story is centered around a single event linking together the four points-of-view.

Another cinematic approach to treating multiple viewpoints is to follow each character around with the camera as their part of the story unfolds.

An example of this is Robert Altman's *Short Cuts* (1993). Unlike *Rashomon* with its single central event, *Short Cuts* has many different stories with a total of 22 main characters. As such, the film can be overwhelming on first viewing.

Jim Jarmusch's film *Mystery Train* (1989) illustrates yet another approach to changing character perspectives in cinema. The film presents, one after the other, three separate episodes that are gradually revealed to be taking place simultaneously. Each episode in fact offers a different character perspective on the same period in time. Compared to *Rashomon*, there is relatively little that links together the different points-of-view. Although certain events are seen over again in the different episodes, there is no single central event. A similar approach is used in Brigitte Rouan's 1991 film *Overseas* that tells the intersecting stories of three French sisters one after the other. As the sisters' paths cross, we see certain events depicted more than once, each time from a different sister's point-of-view. As in *Mystery Train*, the events in which the stories intersect become reference points for the viewer, and the importance of certain events changes from one sister's account to the next.

Figure 5: Production stills from Akira Kurosawa's *Rashomon* (left) and Jim Jarmusch's *Mystery Train*

(3) Theatre

In Theatre, stories often have many equally weighted characters, which can sometimes give the audience a feeling of witnessing multiple character perspectives of the given events. In Anton Chekhov's *The Seagull*, for instance, the 10 different principal characters come on stage

trailing pieces of their seemingly complex personal histories. Furthermore, they have complicated relationships with one another, and our perspective of them keeps shifting as we see them through different characters' eyes.

Figure 6:
Photo from a performance of Anton Chekhov's play *The Seagull*.

In an entirely different documentary theatrical piece called *Fires in the Mirror*, Anna Deviere Smith delves into the conflict between African Americans and Hassidic Jews in Crown Heights, New York. After having interviewed a wide range of people, she performs selected portions of the interviews on stage, imitating the look, voice and mannerisms of each person, and speaking their actual words. Through this approach, the audience can gain deep insights into the personal stories of the real-life characters, as well as into the collective story they wove together through their separate viewpoints. Overall, Smith's performance shows the audience that there is no single answer or truth that can encompass the complex reality of the conflict.

Interactive Works

Examples of multiple viewpoint interactive works fall roughly into three different categories: (1) non-computer-based works, (2) hypermedia, and (3) digital storytelling systems. In the first two categories, the story structures are static and lack the capacity to store knowledge. In contrast, digital storytelling systems have the ability to remember viewer interactions, and can thus construct dynamically responsive narratives based on accumulated knowledge and the content/procedures provided by the author.

(1) Non-computer-based systems

The first of these categories includes storytelling forms such as interactive live theatre, radio plays, and television.

A notable example for this category is *Tamara*, an interactive dinner play by John Krizanc that takes place in the rooms of a large mansion. The audience members are free to follow actors from room to room, observing their performances, and slowly piecing together the story. The play is structured in such a way that each audience member sees only a portion of the total story depending on the rooms they decide to visit. Audience members' sympathies toward the characters in the play thus differ based on which scenes and whose point-of-view they witness during their wanderings throughout the house.

Another example is a new BBC radio play to be aired in September 2001. *The Wheel of Fortune*, written by Nick Fisher, is actually a collection of three plays that will be broadcast on different channels simultaneously. Each of the three plays focuses on the story of a different character, and listeners will be able to switch between the channels at key points, effectively creating their own plays.

(2) Hypermedia

Hypermedia systems allow authors to create links between pieces of story content, including text, images, audio and video, thereby forming a graph structure or story-web that the viewer can navigate.

In her book *Hamlet on the Holodeck*, Janet Murray describes a story format that is used frequently by students in her interactive writing classes [28]. She calls it the *violence hub*. Authors of such stories place an account of a violent event (for example a newspaper article) at the center of a web of stories that explore it from different viewpoints. Helicopter accidents, robberies and canoeing fatalities are all examples of violent incidents that have formed the center of such hypermedia narratives in Murray's classes.

Another hypermedia example is the online story *DarkZOO*, which is a multiple viewpoint narrative that can be viewed from six different

characters perspectives [20]. Unlike most hypertext stories on the Internet, *DarkZOO* is structured in an almost completely linear fashion. When users first enter the story system, they are introduced to the characters and asked to select one of their points-of-view. The story then moves forward in a linear fashion from one chapter to the next. At each page, users have the ability to stay with the current point-of-view or select a different one (with the restriction that not all character viewpoints are necessarily available at every chapter). Users can also view images from the story, or read an integrated version of the novel. As with most hypertext systems, I felt I was gaining very little from the way the interactivity was structured since the story was in no way dynamic or adaptive, and for the most part I felt compelled to read all available points-of-view at every chapter.

Figure 7: The navigation bar in the *DarkZOO* online hypertext story. Joshua's point-of-view is currently selected (indicated by the red border). White text indicates the points-of-view that are currently available.

(3) Digital Storytelling Systems

An early example that fits into this category is Carol Strohecker's 1986 computer controlled videodisc *A Different Train of Thought* [38]. It consists of a single story in which different characters see events in different ways both literally and symbolically, and viewers interact with the story by accessing representations of the characters' thoughts. The video screen is divided in two: the bottom of the screen displays still pictures of the characters in the movie, while the upper part displays the actual moving image. As the story unfolds, viewers can click one of the still images along the bottom of the screen to gain insight into that character's thoughts. What works well in Strohecker's story is that it keeps moving forward regardless of whether or not the viewer decides to interact. Also, when a viewer accesses a given character's thoughts, they can elect to return to the main story at any time, or let the "thought"

segment play itself out, after which return to the main story is automatic. Both these features are beyond the basic ability of hypermedia, which is why *A Different Train of Thought* can be placed in the storytelling systems category.

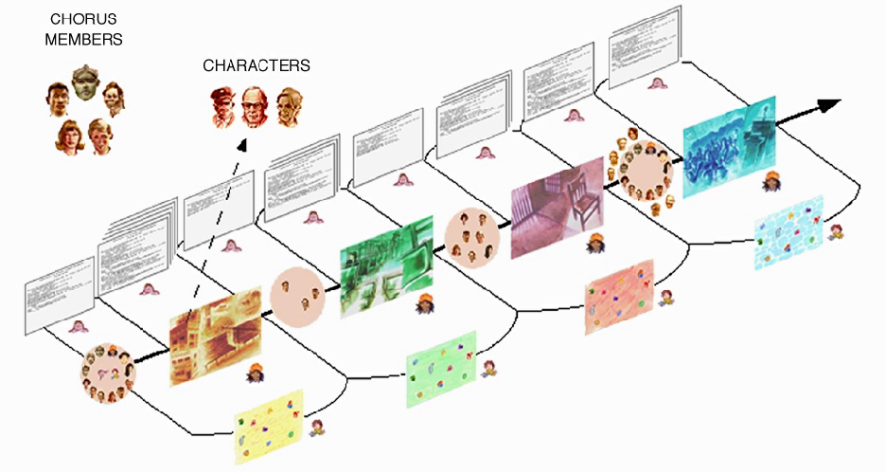

Figure 8: This diagram illustrates the different "folds" in *Tired of Giving In*. By clicking on parts of the screen, users can bring up an associated set of characters and chorus members that engage in a pre-recorded dialog.

Over 10 years later, between 1996 and 1999, Carol Strohecker worked on another point-of-view storytelling system together with Kevin Brooks and Larry Friedlander. Like *A Different Train of Thought*, *Tired of Giving In* also maintains a particular storyline. Viewers explore the story through the multiple perspectives of the different characters and a three-part chorus similar to that in ancient Greek theatre [39, 40]. The authors call their system an experiment in *narrative unfolding*, as the story is revealed not only through varying perspectives, but also at varying levels of detail that can be "unfolded" by the user. The system presents a point-of-view model for structuring computer-based narratives so that viewers can interact without actually changing the course of the story.

Another example of a point-of-view digital storytelling system is the evolving documentary *New Orleans: A City in Transition* [14]. Shot by Glorianna Davenport and Richard Leacock, the piece is a case study of

urban change along the historic waterfront of New Orleans before, during and after the 1984 Louisiana World Exposition. Presenting 5 major stories, and 50 major characters over 3 years of development, the interactive presentation was first realized in 1987 on a networked Unix-based system. It was later re-written in Hypercard. The original system incorporated a free-form associative query mode for browsing the information, and viewers could orchestrate which character's point-of-view they wanted watch the action from.

A final example for this category is Philip Tiongson's *Hindsight*, a java-based web interface for multiple viewpoint interactive narratives [42]. The plot is based on the idea that our actions seem different to us when we look back at them. We tell different stories about our lives depending on our audience and on how we have changed since the actual events took place. In *Hindsight*, the narrative always progresses forward, and the user can switch between the different threads at any time. In this sense, it is similar to Nick Fisher's *The Wheel of Fortune*.

2.4 Tangible Narratives

The idea of using tangible components in storytelling is not new. For instance, children have been telling (and participating in) tangible stories for centuries, using their dolls and other toys as props. In the field of digital storytelling, a number of people have also sought to go beyond traditional computer interfaces for interacting with narratives. Their work can be placed roughly into two different categories: (1) tangible interfaces, and (2) transformational environments and installations.

As human beings, we have developed sophisticated skills for sensing and manipulating our physical environment. Most of these skills are not employed by traditional GUIs (graphical user interfaces). When we interact with a story using a keyboard or mouse, we focus on the screen and the scale of the screen, often losing sight of the architecture and environment around us. In contrast, tangible interfaces and transformational environments are rooted in our physical surroundings. They employ physical objects, surfaces and spaces as tangible embodiments of digital information, thus coupling the dual worlds of

bits and atoms. As such, they can afford natural physical interactions with digital stories.

(1) Tangible interfaces

As mentioned in Chapter 1, the Triangles project was my introduction to the idea of using tangible interfaces as a means of interacting with stories. The Triangles creators, Matt Gorbet and Maggie Orth, worked on two separate storytelling systems using the Triangles [23, 24]. The first was a web-based narrative called *Galapagos*. Partial images of characters, events and locations were placed along the faces of the Triangles in such a way that connecting them would complete the images and trigger a story in the form of web pages. The second system, *Cinderella 2000*, was an interactive version of the Cinderella fairy tale. The *Cinderella 2000* story was entirely audio-based, since the authors had learned from the *Galapagos* system that users were not sure how to handle the split visual focus between computer screen and triangular tiles.

The *StoryBeads* project by Barbara Barry illustrates how a tangible/wearable interface can be used for creating and sharing stories [5, 6]. Stories are created by sequencing digital images and text that can be stored inside the beads. The beads also act as a computer network that can trade content with other beads.

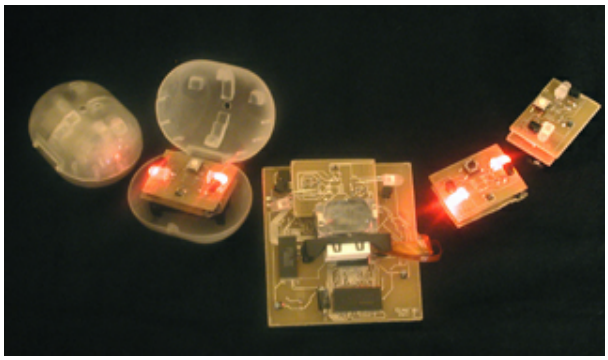

Figure 9: Photo of a digital *StoryBeads* necklace.

Much of the work in the Gesture and Narrative Language group uses digital technology to link children's stories to physical toys. Some examples include Kimiko Ryokai's work on *STORYMAT*, a physical play

mat that stores children's storytelling play by recording their voices and the movements of the toys they play with [35, 36]. These stories later revive on the mat as other children play and tell stories with the same toys. In a similar vein, the *Rosebud* project links children's stories to their stuffed animals [21, 22].

The *PETS* project at the University of Maryland is another form of tangible interface storytelling for children [18]. Robotic toy pets are used as electronic storytellers for children. The basic idea is that children can build their own pet by snapping together the modular animal parts of the *PETS* robot. Once the pet is built, children can use a special computer application to tell their stories. These stories can later be acted out by their robotic pet.

Figure 10: A robot pet acting out a child's story.

Finally, together with Professor Hiroshi Ishii and graduate student Jay Lee, I worked on a first project using physical bottles as a tangible interface for storytelling. In *bottlogues,* the voices of three fictional characters (a stag, man and eagle) are contained in a set of three bottles. As each bottle is opened, the corresponding character begins to speak a monologue. If multiple bottles are opened at once, the character's voices overlap. The three voices are placed left, center and right in the stereo field to help users in distinguishing them from one another.

Aside from the *bottlogues* piece, no one seems to have explored tangible interfaces specifically for creating point-of-view interactive narratives.

(2) Transformational Environments and Installations

Although transformational environments and installations are less "tangible" than the example works described in the previous category, they frequently employ tangible objects within the space. Sometimes they even use similar sensing technologies and/or interaction techniques.

The *StoryRooms* project at the University of Maryland creates room-sized interactive storytelling spaces for children [1]. Using a combination of low-tech and high-tech storytelling elements, children are able to author physical storytelling experiences that can be shared with other children. A similar project entitled *KidsRoom* from the Media Lab's Vision and Modeling group guides children through an interactive, imaginative adventure [3]. During the playout of the story, children interact with objects in the room, with one another, and with virtual creatures projected on the wall. The main difference between the *KidsRoom* and *StoryRooms* projects is that in the latter, children create their own immersive story environments instead of simply experiencing them.

Another example is the transformation environment *Wheel of Life* from the Interactive Cinema group [15]. Three mythical sets and scenarios (Water, Earth and Air) were implemented as a theatrical installation in which members of the audience can participate as either "users" or "guides." While "users" move around and explore the space, "guides" must give them clues to help them unlock the secrets of the story.

Figure 11: A character from Toni Dove's *Artificial Changeling* installation piece

A final example is the narrative installation *Artificial Changeling* (1993-1998) by artist Toni Dove. It is presented as a responsive cinematic installation in which one person at a time can interact with film characters and impact the course of the story. Information about the

movements of a viewer standing in front of a rear projection screen is used to alter the direction the story takes.

2.5 Lessons Learned

There are a number of lessons to be learned from all this past work. To begin with, looking at different point-of-view narratives showed us how certain ones center on a specific incident, thereby creating a tight relationship between the different character points-of-view (think of *Rashomon*), while others simply follow different characters around on their separate stories (think of *Short Cuts*). While both approaches can work well in some cases, the latter can be more complex and confusing, leaving viewers feeling lost or wondering how the different story pieces connect. Ensuring story coherency is an important factor in the design of interactive stories in particular, since the complexity of many systems seems to take away from the immersive and transparent quality of the story experience. Creating tight character relationships can thus be used as an approach to ensure coherency in interactive point-of-view stories.

The differences between hypermedia and storytelling systems taught us that making use of the computational power of the computer can serve to create more successful interactive stories. Computational systems have the ability to gather knowledge about user interactions and use the information to adjust the viewer's story experience. Giving users complete freedom in navigation and too many navigable options can be dangerous. Stories like *DarkZOO* can make users feel that in order to get the "full picture" they must exhaust all of the options, which can be distracting from the flow of the story. This problem can be avoided if a story system is made to adapt dynamically as the user moves through it, presenting only relevant options at any given time and narrowing or broadening the scope of these as the story progresses.

A key factor in the design of tangible narratives is the design of the interface/interaction, and the way in which it relates to the story content. In *bottlogues*, the characters did not interact with one another, even when released from their bottles at the same time. Instead, they gave separate monologues with overlapping voices. Although this had a

nice audio effect, it distracted from the story experience because it was difficult to understand the characters' words. Furthermore, this multi-monologue narrative model is at odds with the interface being used. The characters were being released into the same space, and it would have seemed more natural for them to converse with each other. This demonstrates how important it is to tailor the narrative model/story content to the interface/interaction and vice versa.

2.6 The Hypotheses

These lessons can be used as the basis for formulating two main hypotheses for the design of tangible point-of-view storytelling systems:

(1) By using point-of-view narratives to structure the interaction in a storytelling system, we can avoid the complexity and fragmented nature of branching structures and provide viewers with a single consistent story space. Furthermore, by ensuring tight relationships between characters, or by structuring the story around a main central event rather than many small intersecting stories, viewers can be given a comprehensive and coherent interactive story experience.

(2) Using tangible interfaces for communicating digital stories provides a rich means of interaction in which the interface can become a part of the story world rather than distracting users away from it. Simply put, the computer interface should not distract or separate us from the digital story content/narrative model. Ideally, there should be a tight relationship between the two in order to ensure a transparent and fulfilling story viewing experience.

2.7 Three Storytelling Systems

Drawing on lessons learned from the past work of others and in the hopes of confirming my hypotheses, I have created three separate interactive storytelling systems that focus on multiple viewpoint narratives using tangible interface technology. The process was one of iterative design across the three systems—a sort of journey of discovery,

with the limitations of each design contributing to the ideas and development of the next. For each system, an appropriate tangible interface and narrative model was first identified and then developed. Sample content was created in order to test the system with users.

The next three chapters follow a parallel structure, each describing the design, development and analysis of one storytelling system. For each system, the following five topics are covered: (1) the design and development of the interface, (2) the narrative and computational structure, (3) sample story content used for testing, (4) user feedback, and (5) reflections. A very brief introduction to each system is given below.

The genieBottles

The goal was to create an interactive story in bottles that would address the limitations identified in the *bottlogues* project. In the *genieBottles* storytelling system, there is a tight relationship between story content and interface, and the narrative model supports dialog between characters if they are released from their bottles simultaneously.

It May All End in Aleppo

The goal of the interactive narrative installation *It May All End in Aleppo* was to build a system (interface and narrative model) that would allow for a more highly defined narrative progression than in the *genieBottles*. The core concept was to design a story in which two characters would each tell their own perspective on a series of past events that involved both of them. I decided to realize this in the form of a responsive narrative installation in which the two characters respond to viewer presence by confiding their perspective on the story's events.

Tangible Viewpoints

The goal was to create a dynamic and adaptive system that could support interaction between the characters (as in the *genieBottles* system) and still maintain a highly defined sense of narrative progression (as in the installation *It May All End in Aleppo*). The basic approach was to organize the pieces of a multiple point-of-view story according to the

character viewpoint they represent, as well as their place in the overall narrative. The interface uses graspable pawns as physical handles on the different character viewpoints in the story.

Chapter 3

A Story in Bottles

In September 1999, I joined a small team of students working under the supervision of Professor Hiroshi Ishii on a project called *musicBottles*, in which sets of bottles are filled with the sounds of classical, jazz and techno music. Physical manipulation of the bottles—opening and closing—is the primary mode of interaction with these digital contents [25].

Glass bottles have been a part of human culture for thousands of years, serving both practical and aesthetic functions both in our homes and in our workplaces. By introducing a tangible interface that deploys glass bottles as containers and controls for digital information, the *musicBottles* project explores the transparency of an interface that weaves itself into the fabric of everyday life. The seamless extension of physical affordances and metaphors into the digital domain is a key principle for its design. I was immediately taken with the beauty and simplicity of the bottle interface—its magical nature captured the interest of anyone who passed by—and I was very excited by the prospect by filling the bottles with my own form of expression: stories.

I soon began working with Professor Ishii and graduate student Jay Lee on a project called *bottlogues*, mentioned in the previous chapter. The idea was simple: instead of filling the bottles with different musical instruments, each bottle would contain one character in a fictional story. The result was three separate character monologues contained in three different bottles. As each of the characters—a stag, a man and an eagle—was released from their bottle, they would tell their story to the user. We showed the *bottlogues* piece at the spring 2000 sponsor meetings at the Media Laboratory, and although people admired the poetic sound of overlapping voices, they found the story difficult to follow. This was not what I had hoped for, and I began to wonder whether it was possible for the system to support dialogue between the different characters if they were released from their bottles simultaneously. My theory was that this could be done without interfering with or destroying the flow and progression of the narrative. In this chapter, I describe the *genieBottles* project, which grew out of this idea. I discuss the design and development of the interface, the story structure, sample story contents, and user feedback.

3.1 Interface Design and Development

The *genieBottles* system presents a story that is told by three genies that live in glass bottles. The story is stored in the form of digital audio, and physical bottles provide an interface for interacting with it. When a bottle is opened, the genie contained inside is released and begins to talk to the user. If several genies are released at once, they converse with each other. The physical bottles can be seen as graspable containers and controls for the interactive story.

Technical Design: Physical Setup and Sensing

The physical setup for the *genieBottles* system is based on the *musicBottles* and *bottlogues* installations. The glass bottles sit on top of a custom designed triangular table, custom designed by graduate student Seungho Choo, with a distinct central "stage" area where they can be wirelessly sensed. The middle shelf of table houses three Color Kinetics lights, and the stage area acts as a rear-projection surface for the display

of light compositions. Placing a bottle on the stage area produces a colored visual aura under the bottle as feedback that the bottle is "digitally active." Opening one of the bottles causes audio to be played through speakers concealed on the bottom shelf.

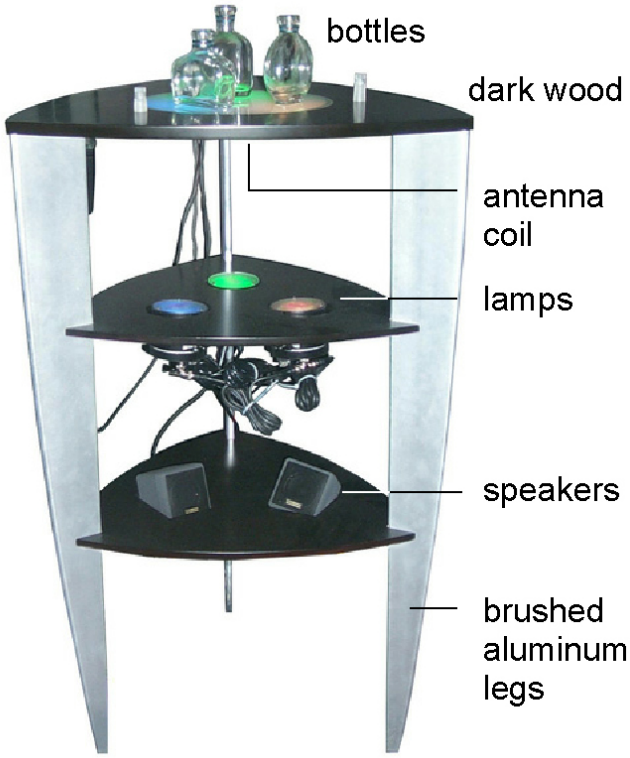

Figure 12: Table setup with the jazz bottles on top. The table was custom designed by graduate student Seungho Choo.

The bottles interface incorporates wireless sensing technology designed by Professor Joe Paradiso [30]. Sensing the manipulation of the bottles is made possible through the use of small electromagnetic resonator tags placed around the opening of each bottle, and pieces of ferrite embedded in the corks. These tags consist of a wire inductance coil in parallel with a film capacitor. The resonant frequency of the tag is simply a function of the inductance of the coil and the value of the capacitance. When the cork is placed inside the mouth of the bottle, the high magnetic permeability of the ferrite increases the inductance of the coil, which in

turn lowers the resonant frequency of the tag. Every bottle thus has two resonant frequencies associated with it: one when the bottle is open, and another when it is closed.

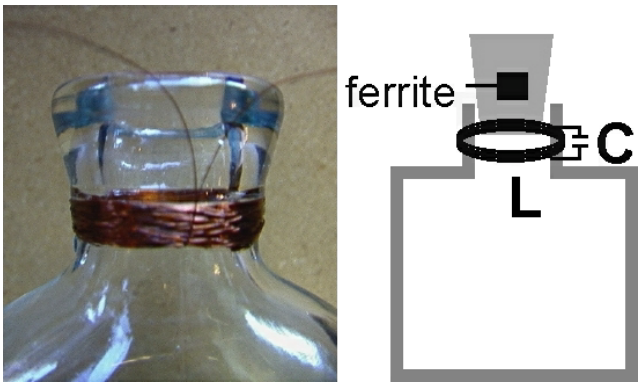

Figure 13: An electromagnetic resonator tag is wrapped around the neck of each bottle.

The resonant frequencies of the different tags are detected through the use of a custom designed tag reader board and sent to the computer via the serial port. There, a master control program written in Java is responsible for interpreting the tag reader data and generating the appropriate sound and light output.

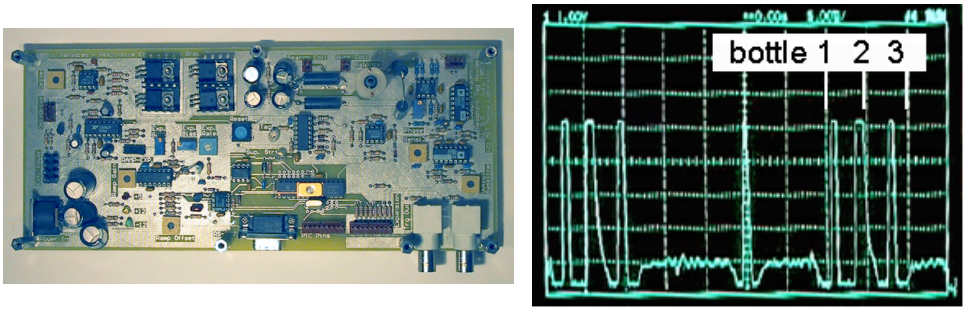

Figure 14: Professor Joe Paradiso's optimized tag reader board (left), and an oscilloscope showing three spikes corresponding to the resonant frequencies of three different bottles (right).

Artistic Design: Bottles and Lighting

In order to strengthen the relationship between the bottle interface and the story content, we decided to design a set of bottles for a specific genie story written by undergraduate student Alison Wood. The story is about three genies named Seala, Junar, and Opo, and their bottles were hand blown at the MIT Glass Lab by Peter Houk.

Figure 15: Sketches for the bottles and final photographs. The first row shows preliminary sketches done by Alison Wood. At first we wanted Junar's bottle to have sharp angles reflecting her abrasive personality. After discussions with glass blower Peter Houk, we discovered that this was difficult to accomplish, and we instead opted for a bottle with crackled glass and moon-like craters. The revised sketches are shown on the second row. The third row shows the final three hand-blown bottles.

In order for users to be able to associate each bottle with the correct genie character, the bottles needed to be easy to differentiate from one another, and their form and lighting needed to reflect the distinct personalities of the three genies. Seala, the "water genie," lives in a tall, smooth and fluid looking bottle, which is illuminated by a deep blue

light when closed, and a soft purple light when open. Junar, the "moon genie," lives in a slightly rounded bottle made of crackled glass. The craters on the bottle remind us that Junar's true home is the moon. Her bottle is illuminated by a bright orange light when closed, and a pinkish light when open. And finally Opo, the "baseball genie," lives in a short round bottle, with a matte finish that reflects his dull and depressive personality. The light projected underneath Opo's bottle is light yellowish-green when closed, and soft turquoise when open.

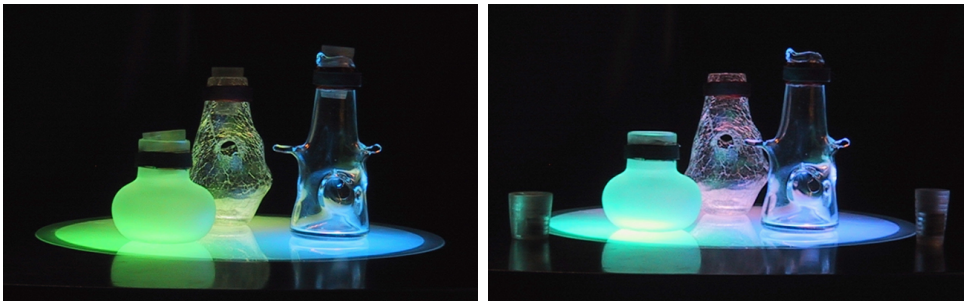

Figure 16: The three genie bottles with colored lighting. On the left, all the bottles are closed, while on the right they are all open.

3.2 Narrative and Computational Structure

In the *musicBottles* installation, each bottle represents a singular voice or instrument in a musical piece. The model for interaction can be represented as multiple pre-synchronized audio streams running in parallel. Instead of music, each bottle in the *genieBottles* system contains the voice of one character in an interactive story. Unlike in the *musicBottles* system however, the audio streams in *genieBottles* are no longer pre-synchronized. Instead, each bottle needs to be aware of the open/closed state of the other two bottles to ensure that the appropriate audio will be played back. If only one genie has been released from its bottle, it will give a monologue. If several genies have been released at once, they will converse with each other.

The State-Transition Narrative Model

The genie story is based on a state-transition model for interactive storytelling, in which the system plays back the appropriate segment of audio depending on the state it is in, as well as the appropriate segment(s) of audio to transition from one state to another. Since the story contains 3 characters (genies G1, G2, and G3), there are a total of 8 (or 2^3) states that the system can be in. The states are: G1 bottle open, G2 bottle open, G3 bottle open, G1 and G2 bottles open, G1 and G3 bottles open, G2 and G3 bottles open, all genie bottles open, and no genie bottles open.

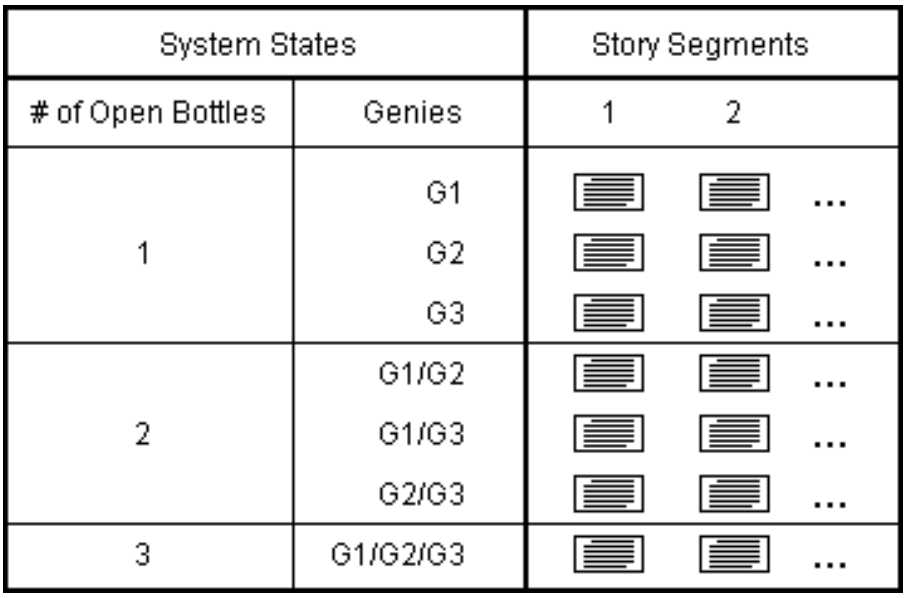

Figure 17: Relationship between the system states and story segments in the *genieBottles* system.

In order for the state transition narrative model to work smoothly, the story is organized into multiple short segments of story text for each of the 7 system states in which at least one genie bottle is open. For each state, the story segments are ordered according to a narrative progression. Every time the user interacts with the system by opening or closing a bottle, the system transitions into a new state causing the first unused story segment for the new state to be played back. This ensures that even if the same sequence of interactions is repeated multiple times,

a new portion of the story will be played back each time, allowing the story to maintain narrative progression.

In Alison's genie story, there are only two short segments of story text for each state. A longer story with a stronger narrative progression might require a dozen or more segments of story text for each state. The table above shows the relationship between system states and segments of story text.

Transitions from one system state to another happen when a bottle is opened or closed, and are accomplished at the level of the story using short connecting segments of audio. The following example shows how the system can smoothly transition from a monologue by G3 to a dialogue between G1 and G3 using two short lines of text. G1 interrupts G3's monologue at an arbitrary point in the story segment with the sentence "Well, well, well." G3 then reacts to G1's interruption by saying "Hello." These two sentences ensure a smooth transition to the dialogue that follows between G1 and G3.

[G3 monologue]	***Seala*:** Shhhh. I'm Seala. Hi. I can't talk for long because I'm in the middle of trying to conjure the water spirits. I owe everything to…
[G1 interrupter line]	***Junar*:** Well, well, well…
[G3 interruptee line]	***Seala*:** Hello!
[G1/G3 dialogue]	***Junar*:** What are you doing? ***Seala*:** I am meditating. I'm calling the water spirits to come and help us. ***Junar*:** Brilliant. Your answer to everything…

By using very generic connecting lines for each character, the same lines can be re-used at different points in the story. The connecting lines of audio are divided according to two types of state transition: up in state and down in state. In the *genieBottles* system, an array of several connecting lines is stored for each character and type of state transition. Whenever a state transition takes place, the system selects randomly from the appropriate array and plays back the connecting audio lines between the segments of story text for the old and new states. The two

types of state transition and connecting audio lines are described below. The diagram illustrates the two types of transition between system states.

(a) Moving up in state:

In this type of transition, the user is opening a second or third bottle. This means that a new genie is being brought into the conversation, and is causing an "interruption." The appropriate way to handle this is to play two short segments of audio: an "interrupter line" (from the genie that is causing the interruption) and an "interruptee line" from (one of) the genie(s) that is being interrupted. Some examples of "interrupter lines" are "I'm here" or "What's going on?" and some examples of "interruptee lines" are "Hey, you interrupted!" or "Hi there!"

(b) Moving down in state:

In this type of transition, the user is closing one of the bottles that are open. This means that one of the genies is leaving the conversation, and the genie that remains is being "cut off." The appropriate way to handle this is to play a short "cut-off line" from (one of) the remaining genie(s). Some examples of "cut-off lines" might be "Good riddance!" or "See you later!"

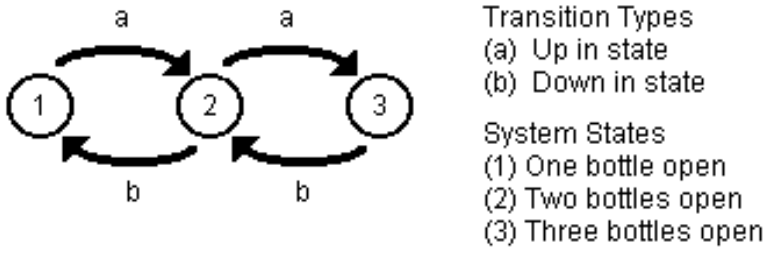

Figure 18: The two types of state transition in the *genieBottles* system.

Handling the End of a Story Segment

In the *genieBottles* system, the story segments for each state are quite short (generally somewhere between 30 seconds and 1 minute). This

means that if the user does not interact with the system for a while, the story segment for the current system state will run out. The story structure of the *genieBottles* system needs to account for this in some way, otherwise the user might get confused if some of the bottles are open but there is no audio playing. Each genie is thus associated with a specific background audio track that will start to play after the genies stop talking. The idea is that if the user is not interacting with the system, the genies will eventually get bored with talking to them and return to their bottles. However, since the bottles are still open, each genie's background audio sounds will be heard coming from the open bottles. The background sounds for the different genies are: wind sounds for Junar, water sounds for Seala and baseball stadium sounds for Opo.

Handling the Story Conclusion

The final important aspect of the story structure is how the *genieBottles* system handles the conclusion of the story. In technical terms, the story reaches its conclusion when there are no longer any story segments left to play back. However if the user keeps interacting with the system, it still needs to give appropriate feedback. For this reason, there are several "end segments" for each genie that are played back when there are no remaining story segments. As with the transition lines, the "end segments" for each genie are stored in an array and selected at random. They are designed to give users the idea that the story is finished and that the genies no longer want to talk. Here are some examples of "end segments" for the three genies:

Junar: I don't want to talk now. I'm too busy sulking over the injustice of it all…

Opo: Are you aware that if an outfielder jumps high on the back wall in attempt to catch a long ball that appears to be going over said wall, then he may steal a homerun from the batter? And if he jumps too tall, catches said ball, and falls over said wall, the umpire will call – homerun.

Seala: Among the silence of the waves
I spent my days calmly breathing
watching the silver line of the sea
rise and fall upon my walls of glass.

If a given play-out of the story reaches the "end segments", the system will re-start from the beginning after 5 minutes of no interaction.

3.3 Story Content

The genie story can be loosely described as a multiple point-of-view narrative, since depending on which genie(s) a user listens to most, they will get a slightly different story, tailored to that genie's particular history, desires and beliefs. Each genie has a distinct personality and background that defines the way in which he or she talks or interacts with other genies. The overall form of the story is not highly structured, and it does not have a strongly defined narrative progression or plot. This is because the physical interaction tightly constrains the flow and progression of the story. When a user interacts with the system, they capture the genies at a particular moment in time, during which they are talking about their state of being in bottles, about their pasts, and about their expectations or desires for the future. Similar to the distinction in cinema between *plot time* and *story time* (i.e. a plot can select certain portions of story's duration to present to the user), there is a distinction in the genie story between *interaction time* (i.e. play-out time) and *story time*. The diagram below shows the overall form of the genie story.

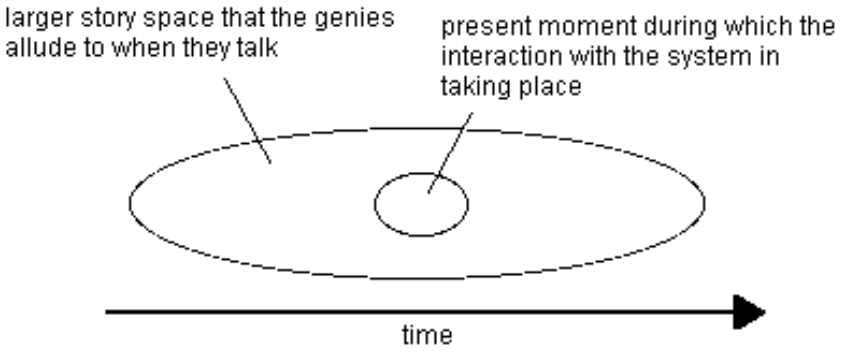

Figure 19: The overall form of the genie story and the distinction between "interaction time" and "story time."

The Genie Characters

The three genies are equally weighted principal characters in the story, however each one has their own individual perspective on life. Through interacting with the system, users can decide which genie(s) they relate to best, and listen to the story from the perspective of one or more genies. If a user listens to only one genie, the story will be heavily weighted to that genie's particular views and beliefs. On the other hand, if a user listens to the story mainly through the dialog segments between all three genies, the story will be more balanced between their individual views. The genie's personalities and goals are described below.

Junar

Junar is an angry and resentful genie. She is not happy in her bottle and would like to escape. When she is caught alone, she likes to talk about her past. Junar used to live on the moon, where at night she carved beautiful pictures on the surface of craters. She was expelled from the moon and placed into a bottle as punishment for this vandalism. She talks about coming up with a plan for escaping from her bottle, and when she interacts with the other genies, she tends to get frustrated with them since they don't seem capable of coming up with a good escape plan.

Opo

Opo is a very depressed genie. His master placed him behind a commentator's booth in a baseball stadium when he was a child, and now he talks too much and drones like a bad baseball commentator. He is very aware of this and is self-conscious about boring the other genies. On the other hand, he cannot seem to help taking everything like a game and providing commentary for it. As such, he doesn't really care whether he is in a bottle or not.

Seala

Seala is a calm and peaceful genie. She was once a small piece of blue tourmaline resting in the earth, but was blasted out by a hot spring and fell into the ocean, where her outsides hardened into a bottle with a

vapory genie inside. Seala spends a great deal of time thinking and meditating. She knows that the other two genies are unhappy, and hopes to call the water spirits to come help them. Although she would not mind escaping from her bottle, Seala is a fatalist and is content doing whatever the Great Ocean has planned for her.

Story Form and Progression

Over the course of storytelling history, many narrative theorists have tried to understand and formulate the important components that form a story. Tzvetan Todorov, for instance, wrote about the structure of narratives in his book *Genres of Discourse* [44]. He proposed that narratives are fictional environments that go through a number of stages or transformations, beginning at a state of equilibrium, suffering a disruption, moving through an attempt at repair, and finally on to a new equilibrium at the end. Film theorist Edward Branigan, in his book *Narrative Comprehension and Film*, articulates a similar outline for how a narrative will work [7]. His "narrative schema" consists of the following elements:

(1) Introduction of setting and characters
(2) Explanation of a state of affairs
(3) Initiating event
(4) Emotional response or statement of a goal by the protagonist
(5) Complicating actions
(6) Outcome
(7) Reactions to the outcome

We have already discussed that the genie story does not have a highly defined narrative progression since it is constrained by the physical interaction with the bottles. It is nevertheless interesting to examine how well its segments fit into Branigan's very traditional and rigid narrative form. How close does the *genieBottles* system come to supporting an archetypical narrative?

The order of Branigan's seven narrative elements is important, as they progress through the stages of the story from beginning to end. The characters and initial situation are first introduced. The "initiating event" is similar to Todorov's "disruption." It offsets the balance in the fictional world, and moves the story forward into a series of events linked by a

causal relationship. The fourth element gives the story a direction or goal to look forward to, and the narrative then moves forward through various events and actions to a final outcome. The following table (figure 20) gives an overview of how these narrative elements fit into the segments of the genie story. The full text of the genie story can be found in Appendix A.

When a user first approaches the system, they will begin by choosing which one of the three bottles to open first. This means that the first segment played back will be one of the genie monologues. The narrative elements that correspond to this are the character introduction and current state elements, found in (row 1, column 1) of the table. From this point on, the narrative progresses down the table as more genies are introduced into the conversation, and to the right onto new segments in each state. We can see from the table that this movement does in fact result in a rough progression through the seven narrative elements, though not necessarily in the exact order outlined by Branigan. Since the current genie story only has two segments per state, it is not long enough to allow for a real conclusion to the story. A story containing more segments could be written to move slowly toward the conclusive elements of the narrative (6 and 7), shown by the imaginary "Segment n" in the table.

	Segment 1	**Segment 2**	**...**	**(Segment n)**
Any one genie	(1) (2)	(1) (2) (3) (4)	...	(6)(7)
Any two genies	(3) (4) (5)	(4) (5)	...	(6)(7)
All genies	(5)	(5)	...	(7)

Figure 20: Overview of the narrative progression in the genie story. The numbers refer to the seven narrative elements in Branigan's schema.

While the above table gives a rough overview of how the genie story progresses through the seven different narrative elements, the following

table (figure 21) gives a detailed analysis of each story segment and how it fits into Branigan's schema. Again we notice that by introducing more genies and by moving forward through the segments, the genie story will move forward through the seven narrative elements. This table also provides a summary of the important pieces of story information, such as the introduction to the different genie characters, their state of being in bottles, the conjuring of water spirits to save them (initiating event), and the coming of the rain storm (complicating actions resulting from the conjuring of water spirits).

	(1) Character introduction	(2) Current state	(3) Initiating event	(4) Emotional response or goal	(5) Complicating actions	(6) Outcome	(7) Reactions to outcome
Junar Segment 1	She was a graffiti artist on the moon	She is not happy in her bottle					
Opo Segment 1	He was placed behind a commentator's booth when he was young	He talks like a commentator and is depressed					
Seala Segment 1	She was a piece of tourmaline that lived in the earth	She wants to help the other genies					
Junar Segment 2	She was put into bottle as punishment	Seala is waiting for the water spirits	Seala is conjuring the water spirits	She wants to get back to the moon			
Opo Segment 2		They are trying to get out of their bottles	Seala is conjuring water spirits	He doesn't care if he gets out			
Seala Segment 2	She got her power from water spirits			She wants to find the water spirits			
Junar/Opo Segment 1				They give opinions about water spirits			
Junar/Seala Segment 1			Seala is calling the water spirits				
Opo/Seala Segment 1				They wonder when the water spirits will come	It begins to rain		
Junar/Opo Segment 2				Junar is confident she will free them			
Junar/Seala Segment 2				Junar wants to break bottle	Junar is trying to break her bottles		

Continued from previous page...

Opo/Seala Segment 2					The water is flowing in		
All genies Segment 1					Junar is trying to jump and it is starting to rain		
All genies Segment 2					It is raining harder		

Figure 21: Detailed analysis of the narrative progression in the genie story based on Branigan's articulation of traditional narrative form.

Since the genieBottles story is not a highly structured narrative progression, there is no real conclusion or denouement in the traditional sense. Although the genies talk about escaping from their bottles, they do not succeed in doing so during the time of the interaction (i.e. the playout of the story). In a sense, the genie story is reminiscent of some of the works of Franz Kafka, such as *The Castle*. Like Kafka's hero, the genies never reach their goal, and at the end of story we leave them still trying to escape from their bottles.

3.4 User Feedback

The *genieBottles* system has been shown at several major sponsor events at the Media Laboratory, and has received a good deal of positive feedback. It has also been presented in the *Sketches and Applications* category of *SIGGRAPH 2001* [27]. Although I did not conduct controlled experiments, I was able to observe a variety of users and receive their comments. This helped me understand the strengths and issues of the system design, as well as gather users' responses to the physical bottle interface and the genie story content.

In particular, during the fall 2000 Media Laboratory sponsor events, the *genieBottles* were shown to around 50 visitors in an "open house" environment. People approached the installation alone or in small groups, and were given the opportunity to interact with the bottles. The level of computer experience varied greatly from one user to the next, ranging from computer programmers and expert users, to novice users with little more than basic word processing skills. My observations and findings are summarized below.

Physical Bottle Interface

The artistic appeal of the *genieBottles* interactive interface—the colorful lights and beautifully crafted bottles—captured the interest of users immediately. Most of them understood the bottle interface with little or no instruction, and quickly grasped the concept of genies trapped in bottles. In fact, some users even approached the system with prior knowledge and expectations about characters in bottles, and as a result they were able to guess that the bottles would contain genies before even opening them. For example, one man's first comment upon spotting the bottles from afar was, "Oh, look! They've got genies in bottles here!" In general, users' comments demonstrated that the bottle interface and genie concept went well together, and that at the level of the interface, the system behaved in accordance with user expectations.

The magical nature of the *genieBottles* interactive interface evoked the curiosity of many users, and as a result a large number of questions concerned the underlying sensing technologies of the system. Since no wires or tags were immediately visible on the bottles, users enjoyed guessing at how the opening/closing and presence on the table were detected. Some users tested the technological limitations of the system by opening and closing the bottles very quickly one after the other. This would frequently cause the audio playback to lag and have trouble catching up to the current system state, a glitch that could be fixed in future versions of the code.

Narrative Model and Story Content

Some users had already seen the *musicBottles* and/or *bottlogues* installations, and were thus primarily interested in the new story contents and in how the narrative structure of the *genieBottles* system differed from previous work. In general, they found that the state transition narrative model was a clean and simple way to resolve the question of how to support dialogue between the genies.

Most user questions were centered around three main points. First all of, they were almost all curious about how the system was able to maintain narrative progression. Many of them expected the system to repeat the same audio when the same sequence of interactions was repeated over

again, and were surprised to see that this was not the case. Secondly, they were curious to know how long the genies would talk and whether the audio segments were pre-recorded or generated on the fly. When told that the segments were pre-recorded, most users would wait to see what happened when a segment finished. Some of them liked the idea of having different background sounds when the genies returned to their bottles, but most users wished that the segments were longer, or that the story would automatically move on to the next segment from the current system state. This sort of "auto-playback" would allow users to open one bottle and listen to the story from beginning to end without interacting any further. This model would be interesting to consider for a longer story that would have more than just two segments per state. Lastly, users were curious about the story's conclusion and how long they could play with the system before exhausting the story content. Some of them even expected the story to continue endlessly like *An Endless Conversation* by Mark Halliday and Ryan Evans of the Interactive Cinema group (1992-1998).

Figure 22: A user interacting with the *genieBottles*.

The overall reaction of users to the genie narrative was very enthusiastic. Users could follow the narrative with much more ease than in the *bottlogues* piece, and many commented on how much they liked Alison's genie characters.

3.5 Reflections

In order to conclude the discussion of the *genieBottles* project, this section provides a summary of what I learned about the strengths and limitations of the system from three different angles: the computational narrative structure, the story content, and the interface.

How effective is the computational story structure?

The state transition narrative model used in the *genieBottles* system proved to be a simple and effective means of creating a interactive story for the bottle interface that supports both conversations between characters and at least some story progression. While this simplicity allows users to grasp the way in which the system works with ease, it precludes certain sophisticated narrative forms and devices, described below.

The narrative structure in the *genieBottles* system is strictly governed by the physical bottle interface, the number of bottles, and the means of interaction available to users (i.e. opening and closing the bottles). This has a number of limiting consequences on the computational structure. First of all, since the play-out time of the story is constrained by the user interaction, the system can support only a serial story progression. Narrative devices such as the flashback are thus not supported. Secondly, since the number of story segments is determined by the number of system states or characters (i.e. bottles), the computational structure is not adaptive and cannot support the introduction of new pieces of content. Also, since the story is told entirely through the conversations and monologues of genies, inner thoughts and emotions of the genies are difficult to communicate to users.

In the *genieBottles* system, the numbers of open/closed bottles are used as the story states in the computational state transition model. The result is a highly character driven narrative. To create a more plot-driven narrative, the seven elements in of the "narrative schema" discussed earlier could be used as states, and the story would move from one to the next as users opened and closed bottles.

The *genieBottles* software could easily be extended to support more characters, however this would increase the number of states exponentially, making the writer's task of creating a coherent story for the system more difficult. With three characters, the computational structure is limited to 7 active states (i.e. states where at least one genie is talking). With four characters, the writer would need to provide 15 active states, and with five characters 31 active states!

Is the system capable of telling a good story?

As mentioned in section 3.4, users who played with the system seemed to enjoy listening to the story told by the genies in bottles a great deal. While this demonstrates that the *genieBottles* system has the potential to tell good stories that users will take pleasure in experiencing, the quality of stories in bottles is by no means guaranteed. As with any storytelling medium, the immersive quality of the story will depend on the writer's ability to create a rich story world and to communicate it to his or her audience in a way that arouses their interest. In the *genieBottles* system the success of the story depends moreover on the writer's ability to think in terms of the computational state transition model and to see their story on different levels, through the monologues and dialogues of the different genie characters.

How effective is the tangible interface?

As mentioned already, the simplicity of the physical bottle interface strictly governs the computational structure of the story. And while this limits the narrative possibilities a great deal, it ensures that people immediately know what to do even when approaching the system for the first time. The system affordances are clear, and the presence of genies in the bottles fulfills people's expectations of what type of character would

normally be found inside a beautiful bottle. There is thus a strong connection between the interface and the story.

Overall, while the interface worked well for a short story such as Alison's genie story (an interaction time of about five minutes), it is difficult to imagine that users might be able use the bottle interface to navigate through the interactive equivalent of a 500 page novel or a 2 hour film.

Chapter 4

A Narrative Installation

In the fall of 2000, I took a class entitled *Interactive Expression* at the MIT Center for Advanced Visual Studies (CAVS). Taught by Professor Stephen Benton, Glorianna Davenport, and Hisham Bizri, the class featured a series of lectures by visiting artists, and looked at contemporary issues in the field of interactive digital art. As a final project for this class, I decided to create a narrative video installation that would attempt to overcome some of the limitations identified in the narrative structure and interface of the *genieBottles* system. The last chapter discussed how the physical interface and interaction style in the *genieBottles* imposed very tight constraints on the narrative form and progression of the story. I hoped to address this limitation in the creation of my next interactive narrative system.

In creating the interactive narrative installation titled *It May All End in Aleppo*, my goal was to build a system (interface and narrative model) that would allow for a more highly defined narrative progression than in the *genieBottles*. The core concept was to design a story in which two characters would each tell their perspective of a series of past events involving both of them, thus keeping the character-driven approach to

storytelling used in the *genieBottles*. In this chapter, I describe the design and development of *It May All End in Aleppo*, including the interface, story structure, story contents and user feedback.

4.1 Interface Design and Development

The installation *It May All End in Aleppo* presents the story of two characters who experience a series of somewhat traumatic events together. Each character interprets these events in a different way when they reflect on them from a later date. The interface uses sensor mats to activate each of the two characters. When a viewer approaches one of the characters, the character becomes activated and confides in the viewer, relating their perspective of the story.

Technical Design: Physical Setup and Sensing

The experience of *It May All End in Aleppo* is designed to be very personal. The characters in the story are activated by the physical proximity of viewers. In order to accomplish this, two sensor mats are placed on the floor in front of two monitors placed at average human height. When no viewers are present, each monitors loops a series of images relevant to one of the character points-of-view. As a viewer approaches one of the two monitors, they step on a sensor mat, which causes the character to appear on the monitor screen and tell the viewer their story. When the viewer steps back again, the character disappears.

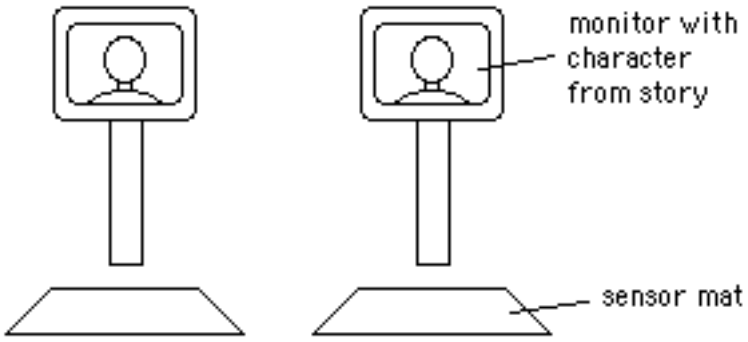

Figure 23: The physical setup of *It May All End in Aleppo*.

The interface allows for several viewers to interact with the installation at once. For instance, each viewer can approach a different monitor, activating both characters simultaneously. Or both viewers can approach the same monitor, causing one character to speak to both of them.

The sensor mats used in the installation are made by Tapeswitch Corporation. They act as momentary switches that can detect the presence of pressure. Both sensor mats are connected to a small circuit with a PIC microcontroller that sends serial data to two computers, informing them about the state of the two mats. On each computer, a master control program written in Java is responsible for interpreting the serial data and generating the appropriate audio/video output on its monitor. The program uses the QuickTime for Java API to control the video playback.

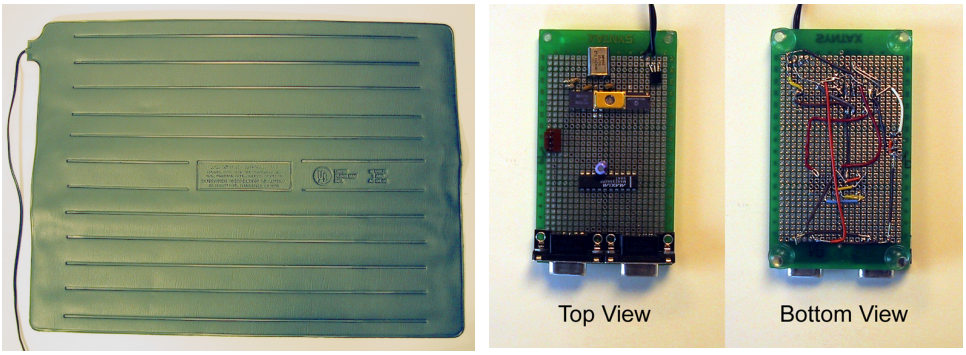

Figure 24: A Tapeswitch sensor mat (left) and top and bottom views of the soldered protoboard implementation of the circuit (right).

Artistic Design: Video and Images

The artistic design for *It May All End in Aleppo* involved two main components: the two character videos, and the two sequences of still images that play back on the monitors when no viewers are present.

The character segments were recorded with relatively little rehearsal. The actors each read over the story once, and together we established the correct tone of voice, inflections, and pacing for their respective parts. The actors were videotaped in a close-up "talking-head" shot, with an

unmoving camera. I wanted to capture each character from the shoulders up so that when seen on the monitors, they would seem to be standing in front of the viewer. Once the videotaping was finished, I digitized the video segments and applied "hue and saturation" and "solarize" filters to the video clips. I wanted to achieve a somewhat abstracted look for the characters. I chose an orange coloring for the female character, and a purple coloring for the male character. The abstraction of the faces made them seem less like news broadcasters and more like fictional characters from a story world. It also provided a nice means of distracting viewers from the low quality of the production and the fact that the actors were reading their parts from a teleprompter placed below the camera.

Figure 25: The video segments of the two characters from *It May All End in Aleppo* were abstracted using the "hue and saturation" and "solarize" filters in Adobe Premiere..

When no one is interacting with the installation, each monitor plays a unique sequence of images that are relevant to that character's perspective on the story events. The effect I hoped to achieve was a sort of moving collage of evocative images that give a sense of the story content and the differences between the two character viewpoints. In each moving collages, images overlap and fade from one to the next, roughly following the course of the story from beginning to end. The collages were created in Adobe Premiere, and are both designed to play in a continuous loop (so the first and last frames are the same). Since the story takes place in the early 1940s, I chose to make the moving collages in black and white.

Figure 26: Still frames from the two "moving collages" that play on the monitor screens in a continuous loop when the characters are not activated. The images for the male character are on the left (including views of the Statue of Liberty and large ships), and the images for the female character are on the right (including views of a chateau, soldiers, and a girl with her dog).

4.2 Narrative and Computational Structure

In *It May All End in Aleppo*, each monitor represents one of the two characters in an interactive story: a husband and wife. When activated by a user, each character speaks a monologue that relates their perspective on a series of past events that involved both of them. This section describes the multithreaded story structure used to support this form of interaction.

The Multithreaded Narrative Model

The narrative system consists of two character monologues (narrative threads), and two moving collages of images, all in the form of QuickTime movies, controlled by two separate computers and sensor mats. When no users are present to activate the characters, the images run in an infinite loop on both monitors. When one of the characters is being activated by the presence of a user, its narrative threads plays back on the screen, while the other computer continues to loop the image sequence. When both characters are active simultaneously, both threads of the story play at once. The following two diagrams illustrate the effects of user interaction and the four possible states of the system.

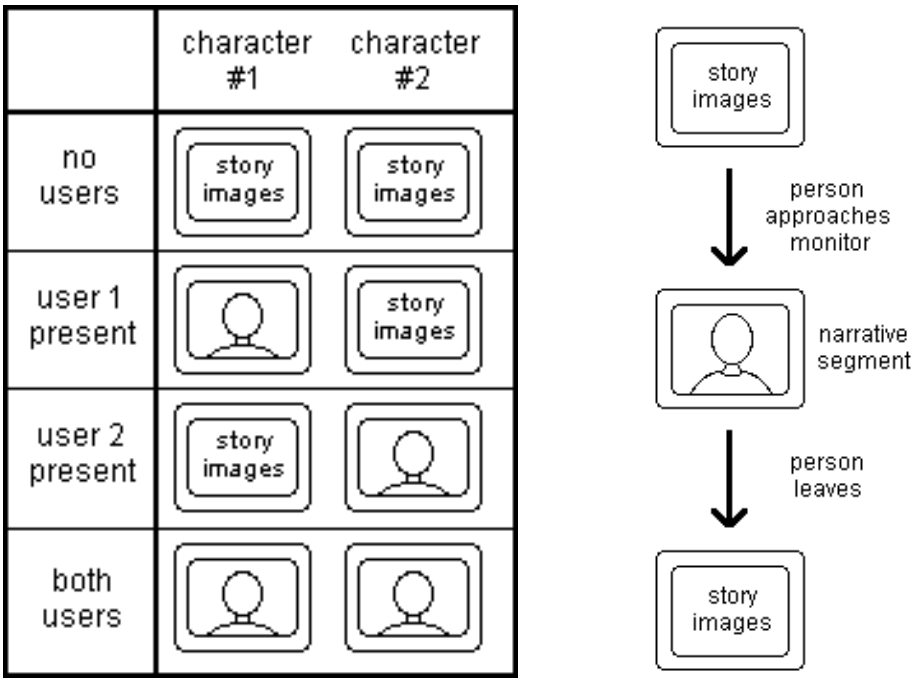

Figure 27: The table on the left illustrates the four states of the narrative system: no characters active, one character active, the other character active, or both characters active at once. The diagram on the right illustrates how the narrative segments are activated by user interaction.

Each character's narrative thread is divided into twelve story segments, each describing a particular event in the story. The two narrative threads are parallel in the sense that they move through roughly the same twelve events in the same order, but provide differing points-of-view. The flow of the story will be discussed in greater detail in section 4.3. The following diagram illustrates the narrative structure of the story as it is divided into small story segments for the two different character points-of-view. The beginnings of the story segments provide nice starting points for when a character is activated.

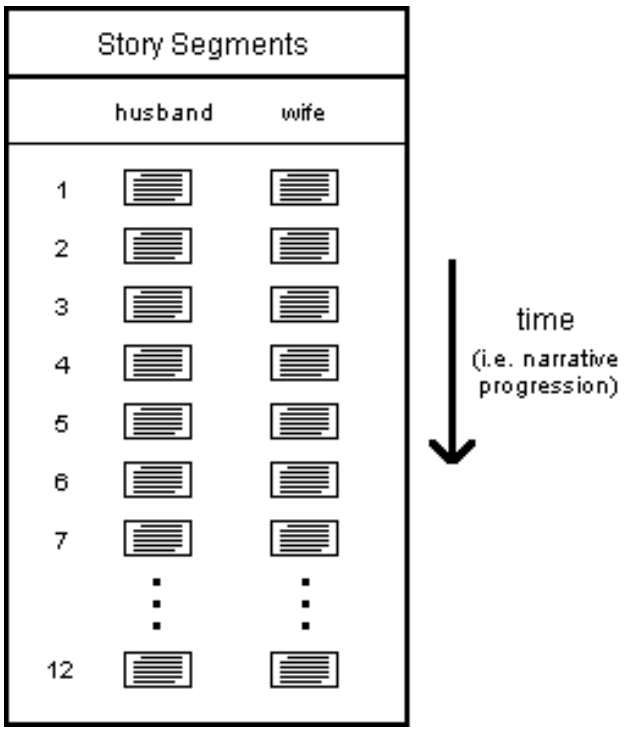

Figure 28: The narrative structure of *It May All End in Aleppo* consists of two character viewpoint threads, each divided into twelve smaller story segments.

Looping the Story

An important aspect of the story structure concerns how the narrative system handles the conclusion of the story. Since *It May All End in Aleppo* was designed as an installation piece that could be run continuously in a gallery space where viewers would interact with it on and off over long periods of time, there needed to be some way for the system to restart automatically whenever it reached the end of the story. The simplest method of solving this was to run the two narrative threads in an infinite loop. In order to avoid having a distinct break in the narrative flow whenever the threads restarted, I decided to create a circular story structure that would support looping. The narrative begins in the story world present (segment 1), which corresponds to the time when the story ends (segment 12). In segment 1, the characters speak from separate locations in the narrative present, indicating that they

have a story to tell. Their telling of the story begins in segment 2 when they both reflect back to the time when the series of events they are describing began – just before the German invasion of Paris at the beginning of the Second World War. From that point on, the characters both move forward in time, recounting the major events in order, until they again reach the present time in the story world in segment 12. Back in the present again, the story loops back and characters begin their tale over again.

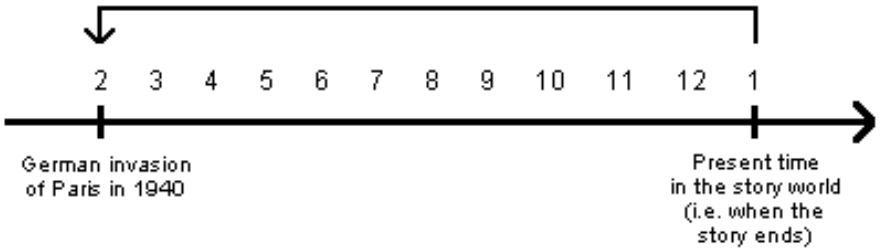

Figure 29: This diagram illustrates the circular story structure of *It May All End in Aleppo*.

Synchronization

A final important question in the design of the narrative system concerned the synchronization of the two story threads. The first tests of the system used completely unsynchronized threads. This meant that when a character was activated, only their portion of the story would move forward, while the other character's portion of the story would stay at the current segment. If the second character became activated later on, its narrative thread would have fallen behind the other character's narrative thread. The result of this unsynchronized approach to multithreaded storytelling was that when both characters were active at once, they would rarely be speaking about the same narrative event. The diagram below illustrates this approach.

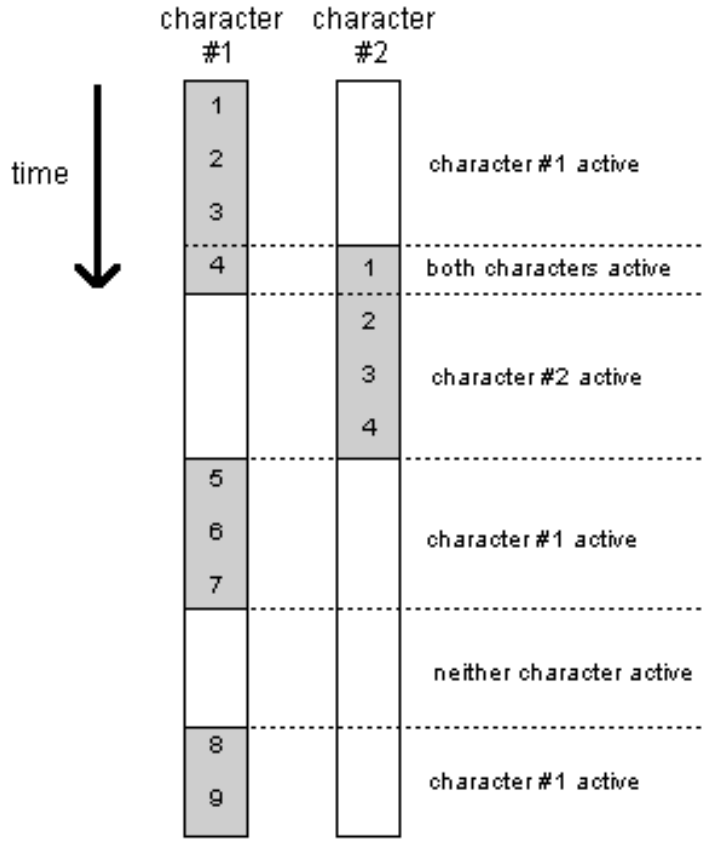

Figure 30: Unsynchronized approach to the multithreaded narrative model. The vertical columns represent the two character threads, the numbering indicates the narrative segments, and the shaded areas show when each character is active. In this example, character #2 is activated at a later time than character #1. This means that by the time character #1 has already reached narrative segment 4, character #2 will be starting its monologue at narrative segment 1.

The final version of *It May All End in Aleppo* uses completely synchronized narrative threads. This means that whenever a character is activated and moves forward through the narrative segments, the other character's narrative thread is moved forward as well in order to keep up. If the second character becomes activated later on, its narrative thread will thus not have fallen behind and will remain in sync with the first character. This synchronized approach to multithreaded storytelling works well with the *It May All End in Aleppo* narrative, since the twelve story segments are specially designed to parallel one another in narrative events, while providing two different (sometimes contradictory)

perspectives. The differences between the two character viewpoints are rendered a great deal more obvious to viewers in the synchronized approach. When both characters are active, they will be speaking about the same thing, and many of their statements will reflect each other. If a user is listening to the wife character for instance, they might hear a statement by the husband in the background that contradicts what the wife is telling them. At this point, they have to make a decision about which character they should believe. For example, in segment 4 the wife's statement "And so the poor dog was left whining behind a locked door,..." is echoed a short while later by the husband's "We had never had any dog."

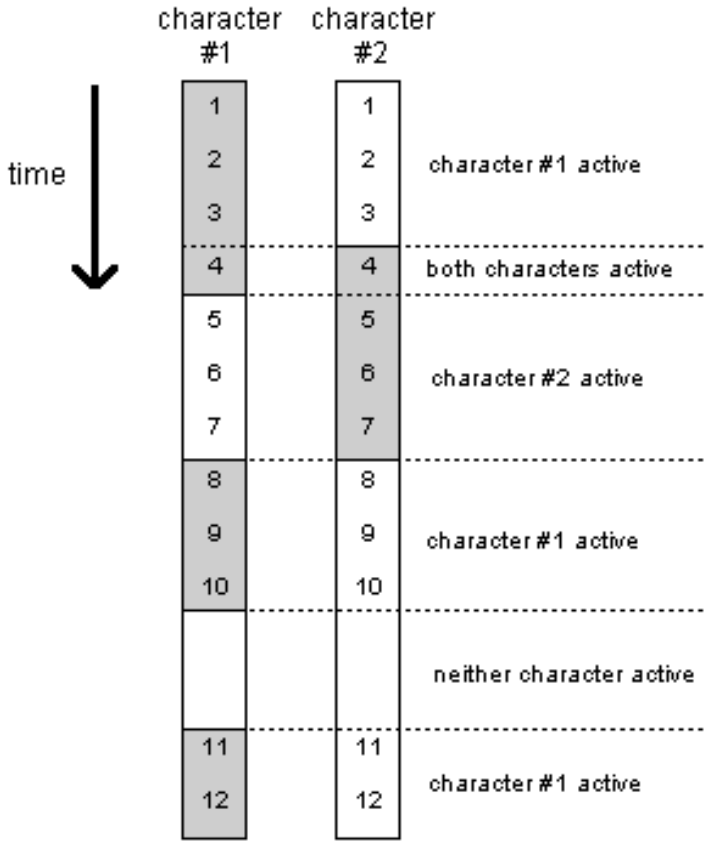

Figure 31: Synchronized approach to the multithreaded narrative model. The vertical columns represent the two character threads, the numbering indicates the narrative segments, and the shaded areas show when each character is active. In this example, character #2 is activated at a later time than character #1. However character #2's thread has been advancing even while only character #1 was active, and so the two threads will remain in sync at segment 4 when character #2 begins to speak.

4.3 Story Content

As we have seen, the narrative installation piece *It May All End in Aleppo* allows viewers to explore two different character points-of-view on a story. The lack of an explicit unifying reality is abandoned in favor of competing inconsistent ones. The story told is based on the short story *That in Aleppo Once...* by Vladimir Nabokov. Depending on which character they decide to listen to most, viewers develop a slightly different understanding of the events that occurred to a young married couple around the beginning of the Second World War. If viewers choose to listen to both versions of the story, they are faced with the problem of deciding whose account of events is correct, or whether there is a correct account at all. As in Kurosawa's *Rashomon*, viewers are made aware of the subjectivity of truth—different people interpret events in different ways, and through the telling and retelling of events they often reveal more about themselves than about what actually happened. Simply put, the husband and wife in this story have a different understanding of what reality consists of.

The Characters

The husband and wife are equally weighted principal characters in the story, although each one has their own individual perspective on story events. Through interacting with the system, users can decide which character they relate to best, and can choose to listen to the story from the perspective of one or both of the characters. As mentioned already, listening to both characters reveals inconsistencies in their stories, leading viewers to question their validity and the honesty of the two characters. This aspect of the narrative is not revealed if viewers decide to listen only to a single character's account.

Husband

The husband is a poet who lives in Paris until the German invasion begins in 1940. He marries a young girl quite impulsively not long before the invasion, and then hopes to escape to New York with her. Although he recounts his version of the story eloquently and calmly, he gives some indication that he can be quite emotional at times. He slowly

discovers that he does not really know the girl he married, and this torments him a great deal, especially after she leaves him. By the end of the story, the miserable husband has managed to convince himself that his wife had never existed at all.

Wife

The wife is an emotional young girl who marries an older man—a poet—not long before the German invasion of Paris in 1940. She finds herself lured by his beautiful verse, but then realizes that he is in fact a stranger to her. Her manner of dealing with this situation is impulsive. Her emotions and views seem to sway easily, and she is quick to fall for another man. By the end of the story, she finds herself alone and feels that she has the strength to take her life into her own hands.

Story Form and Progression

In the previous chapter, I examined how well the *genieBottles* story fits into Edward Branigan's articulation of a "narrative schema," a sequence of seven major elements that together form a narrative [7]. This schema is based on a very rigid and traditional understanding of narrative structure. The elements are as follows:

(1) Introduction of setting and characters
(2) Explanation of a state of affairs
(3) Initiating event
(4) Emotional response or statement of a goal by the protagonist
(5) Complicating actions
(6) Outcome
(7) Reactions to the outcome

Looking at how well *It May All End in Aleppo* supports this type of narrative structure will provide a basis for comparing it to the *genieBottles* system. The following table gives an overview of how the seven narrative elements above fit in with the story segments of the *It May All End in Aleppo* story. The full text of the story can be found in Appendix B.

	(1) Character introduction	(2) Current state	(3) Initiating event	(4) Emotional response or goal	(5) Complicating actions	(6) Outcome	(7) Reactions to outcome
Husband Segment 1	He is a poet	He has arrived in America with a story to tell					
Wife Segment 1		She is back in Paris and will tell her story					
Husband Segment 2			They marry her in Paris and the war begins				
Wife Segment 2	She is still young. He is a poet.		They marry and the war begins				
Husband Segment 3				They plan to go to NYC			
Wife Segment 3				They want to go to NYC and leave Paris suddenly			
Husband Segment 4				They flee together			
Wife Segment 4				They flee by train			
Husband Segment 5					He loses his wife on the way to Nice		
Wife Segment 5					She is abandoned on the train by her husband		
Husband Segment 6					He decides to continue on to Nice		
Wife Segment 6					She looks for her husband		
Husband Segment 7					The police are no help		
Wife Segment 7					She meets a Frenchman in Marseilles and falls in love with him		
Husband Segment 8					He finds his wife by chance		
Wife Segment 8					She finds her husband by chance		
Husband Segment 9					His wife lies about her absence		

Continued from previous page...

Wife Segment 9					She feels she cannot stay with her husband and asks for a divorce		
Husband Segment 10						He tries to arrange for them to escape but his wife leaves him	
Wife Segment 10						She meets the Frenchman in secret and escapes with him	
Husband Segment 11						He cannot find his wife and leaves for NYC	
Wife Segment 11						She leaves the Frenchman	She misses her husband
Husband Segment 12							He is unhappy in NYC without her
Wife Segment 12							She wants to start a new life

Figure 32: Detailed analysis of the narrative progression in the *It May All End in Aleppo* story based on Branigan's articulation of traditional narrative form.

The multithreaded narrative model used in *It May All End in Aleppo* ensures that the story will always progress from beginning to end in a linear fashion. Users are merely given the choice of which character's perspective to view the narrative events from. The fact that both threads of the story progress linearly allows for a more highly defined narrative progression than in the state transition model used in the *genieBottles*. From the table above we see that the story does in fact progress almost exactly according to the "narrative schema" outlined by Branigan. The table also provides a summary of the important pieces of information as they unfold in the story. The story begins in segment 1 as the characters introduce themselves, covering the character introduction and explanation of current state of affairs. The story then moves to segment 2 in which the characters get married and the German invasion takes place, forming the initiating events of the story. In segments 3 and 4, the characters respond to the invasion by fleeing Paris, and also discuss their

goals of going to America. Segments 5 through 9 summarize the various complications that arise, and finally segments 10 through 12 bring the story to its conclusion as the characters separate and find themselves in different parts of the world.

4.4 User Feedback

It May All End in Aleppo was shown at *Inter.Flux—Exhibition 2000 of Art & Technology*, an exhibition of student work hosted by the Center for Advanced Visual Studies at MIT. Although I did not conduct controlled experiments, this event and my preliminary tests at the Media Laboratory allowed me to observe a variety of users and receive their feedback. This helped me understand the strengths and issues of the system design, as well as gather users' responses to the interaction and story content.

In particular, at the *InterFlux* exhibition, *It May All End in Aleppo* was shown to several dozen visitors in an art gallery environment. People approached the installation alone or in small groups, and were free to interact with it as desired. Sometimes several people would interact with the installation at once, while a larger group would stand and watch from the side. The level of computer experience varied greatly from one visitor to the next, ranging from computer programmers and expert users, to novice users with little more than basic word processing skills. My observations and findings are summarized below.

The Human Proximity Interface

Observing people interacting with the installation for the first time was a very rewarding experience, since their actions corresponded almost exactly to my expectations. Users who had not yet seen the way in which the system worked would generally begin by approaching the monitor in order to get a closer look at the black and white looping image sequences. As soon as they got close enough to step on one of the mats (hidden underneath a carpet), a character would appear on the screen. Surprised by the sudden change, they would immediately step back and the screen would return to the image sequence. Realizing what was going on, they would then step forward again to listen to the character's

story. Having listened to one character's perspective for a while, most users would then proceed to listen to what the other character had to say. It was nice to see in this way that the interface was simple enough for most people grasp without any guidance at all.

Most people quickly understood that the sensing technology was located underneath the carpet and was weight activated. Some users commented that they would have preferred a different sensing technology that did not require them to be exactly in front of the character to activate it, but would allow them to stand slightly to one side of the monitor. Standing to the side did not work with the sensor mats due to their relatively small size. Certain users experimented with the interface in new ways, such as standing with one foot on each sensor mat in order to activate both characters simultaneously. Sometimes groups of visitors would approach the installation at once, and would interact with it together. For some pairs, it became almost a game as they tried to coordinate their actions with each other—taking turns stepping on and off the mats, activating one or both characters at a time, and listening to different possible combinations of the character's stories.

Figure 33: Observing a user interacting with *It May All End in Aleppo* at the Center for Advanced Visual Studies. The user has activated the husband character on the right monitor.

Overall, the interface seemed to work well for presenting a point-of-view narrative in a gallery environment. Users comments were generally quite positive, and small number even suggested expanding the story to

include more characters. Many users also commented on how much they liked the aesthetics of both the character videos and image sequences.

Narrative Model and Story Content

Users who experimented with the first unsynchronized version of the system found that while it was relatively easy to follow one character's perspective, it sometimes got confusing if they tried to follow both threads. This was due to the fact that the characters would rarely be talking about the same event if the user tried to listen to one immediately followed by the other. The one positive effect of this was that occasionally one of the character's words would parallel the other's in an unexpected way, highlighting relationships between different parts of the narrative that would not have be so obvious to users if the threads were always in sync with one another. For example, at one point a user was listening to the husband say "I tried in vain to find her…" (segment 11), just as another user activated the wife character who began with "So I must tell you that I am back in Paris now." (segment 1). In this remarkable coincidence, the wife literally provided a reply to her husband who was wondering about her whereabouts. Despite these interesting coincidences, the preliminary tests confirmed my initial suspicion that tighter synchronization would be needed between the two threads. This lead me create the second synchronized version of the system.

Users who later tried the synchronized version of the system generally found that the story was much easier to follow across the two threads than it had been in the unsynchronized version. Some users contented themselves with capturing the essence of the narrative from only one character's perspective. Others tried to piece together the story by listening to short sections from each character's point-of-view one after the other. One user decided that he wanted to hear the entire story from both characters' perspectives. Instead of simply listening to the entire story from one character and then the other, he alternated between the characters until he had looped through the story several times and listened to all of the story segments at least once. Watching people interact with the system in these different ways made very happy, because it made me feel that I had accomplished my goal as an artist to

create an interactive storytelling system in which people would feel compelled to interact and experiment with the interface, all the while being captivated by the actual story itself.

4.5 Reflections

In order to conclude the discussion of the narrative installation *It May All End in Aleppo*, this section provides a summary of what I learned about the strengths and limitations of the system from three different angles: the computational narrative structure, the story content, and the interface.

How effective is the computational story structure?

In *It May All End in Aleppo*, users are told a story about events in the characters' lives that have already passed. By situating user interactions with the story world at a later time than the events in the story, I was able to create an interactive system in which the interaction time is kept separate from the plot time. The result was a story with a strong narrative progression, which addresses one of the limitations of the *genieBottles* system. On the other, the system had lost the *genieBottles*' capability of supporting interaction and conversations between the characters. In this sense the multithreaded narrative model used in *It May All End in Aleppo* is similar to the structure of the *bottlogues* piece, and seems like a step backwards. However, unlike in the *bottlogues* piece, the character threads in *It May All End in Aleppo* are kept on separate computers, emanate from separate sets of speakers, and are separated by a certain distance in space. In this way, when a user is standing in front of one character, the voice of the other character remains in the background, allowing the user to focus on a single audio stream. Furthermore, the two sets of twelve parallel narrative segments create a strong link between the separate threads, and the special looping structure of the story allows users to revisit certain segments over again, or try different combinations of character activation. So although the multithreaded model of *It May All End in Aleppo* is similar to that of *bottlogues*, when combined with a different interface and a looping story structure it makes the story easier for users to follow.

The software that drives the installation is very flexible and can easily be extended to support more characters. Unlike the *genieBottles*, this would not cause a large increase in the number of story segments in the system. While the narrative system is not adaptive and does not support the addition of new content on the fly, the number of story segments is not governed by the number of characters as in the *genieBottles*, it is possible to create longer or shorter stories at the writer's will. Finally, the multithreaded structure used in the installation supports only a serial story progression that loops back to the beginning whenever it reaches the end. Complex plot structures that jump around in time are not supported.

Is the system capable of telling a good story?

Users seemed to enjoy not only the interactive component of the installation, but also the story content itself. Writing a story for an interactive system such as the *genieBottles* can be a real challenge for writers of traditional non-interactive stories. It allows them to test their ability to think in an interactive form on many levels at once. The multithreaded structure used in *It May All End in Aleppo* is closer to traditional narrative works than the *genieBottles*, and thus provides an easier way for writers to work their way into interactive storytelling. But once again, the quality of the final story in this multithreaded system (as in any other interactive piece) still depends on the creativity and communication skills of the writer!

How effective is the interface?

While the affordances of the interface in the *It May All End in Aleppo* installation are not as immediately obvious as in the *genieBottles*, the interface nevertheless proved to be very easy for users to grasp. Users generally only needed to step on and off the sensor mat once before understanding the consequences of their actions and the functionality of the system. There was a close relationship between the physical interface and the story content. By stepping on the sensor mats, users were drawn into the story world and the characters would speak to them directly in a very personal way.

Fundamentally, the human proximity interface with its sensor mat implementation is very similar to the bottle interface—it provides a sort of switch to activate story content. The main difference is the way in which the two types of "switch" are packaged and presented to the user. The bottles provide a very tactile interface that users can touch with their hands. In contrast, the human proximity interface provides a full-body interaction in which users have to approach the monitors and step on the sensor mats in order to experience the story. Based on the categorization of tangible narratives proposed in Section 2.4, the bottle interface can be considered a "tangible interface," while the human proximity interface is a "transformational environment or installation."

Finally, the human proximity interface worked well in the gallery environment and atmosphere. The interface lent itself to short interaction sessions by many different people, and users could approach the installation much the same way they would approach another person for conversation, and immediately see the results of their actions. Given the physical movement required to activate the characters, the interface would not be appropriate for longer story content that demands more lengthy and involved periods of interaction.

Chapter 5

Tangible Viewpoints

While developing *It May All End in Aleppo*, my goal had been to create an interactive narrative with a greater sense of narrative progression than in the *genieBottles*. I had succeeded in this by situating the user interaction with the characters at a later time than the story events. The side effect was that the system was not designed to support interaction and conversations between the two characters. The following table summarizes some of the differences between the *genieBottles* and *It May All End in Aleppo* narrative systems that contributed to my goals and ideas for a third system: *Tangible Viewpoints*.

genieBottles	***It May All End in Aleppo***
- Has a strong tangible component to the interface - The story is conveyed entirely through pre-recorded audio segments - The genies can interact and converse with each other - The narrative progression is limited over the course of the story	- The physical interface lacks a real tactile component - While there is both audio and video in the installation, the story is still conveyed primarily through the audio portion - There are no conversations between the characters - There is a strong narrative progression throughout the story

Figure 34: Some differences between the *genieBottles* and *It May All End in Aleppo*.

The core concept for *Tangible Viewpoints* was to create another character-driven storytelling system (comprised of a new narrative model and tangible interface) that could support interaction between characters without forgoing a highly defined sense of narrative progression. I also hoped that to design a narrative system that, unlike the previous two systems, would not constrain individual story segments to a specific form and method of delivery (e.g. monologue by a "talking head" or audio-only conversations). In this chapter, I describe the design and development of *Tangible Viewpoints*, including the interface, story structure, story contents and user feedback.

5.1 Interface Design and Development

Tangible Viewpoints is a system for interacting with a character driven narrative. The different segments of a multiple point-of-view story are organized according to the character viewpoint they represent, as well as their place in the overall narrative. These segments can consist of various types of media (video, audio, images, text), and can present character development, action, and location with as much complexity as any scene of a film or chapter in a book.

Technical Design: Physical Setup and Sensing

The interface uses wirelessly sensed graspable pawns to navigate through the multiple viewpoint story. When a pawn is placed on the interaction surface, the story segments associated with its character's point-of-view are projected around it. Users select segments to be displayed on a nearby monitor, causing the narrative to advance and new segments to become available. An aura is also projected around each pawn to give a visual representation of the prominence of that viewpoint in the current telling of the story. Changes in the story space are reflected by dynamic changes in the projected graphics.

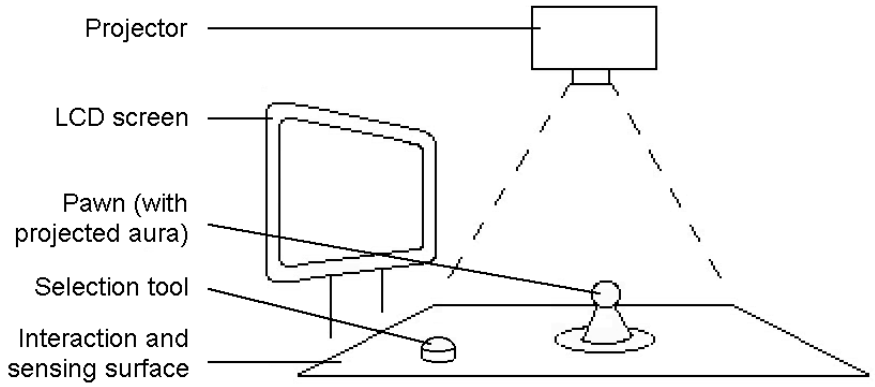

Figure 35: The *Tangible Viewpoints* physical setup.

The *Tangible Viewpoints* interface incorporates wireless sensing technology from the former company Zowie Intertainment Incorporated. A small electromagnetic resonator tag is place in the base of each pawn and the selection tool, allowing their movements be tracked when placed on the sensing surface. Each tag consists of a wire inductance coil in parallel with a film capacitor, and the sensing surface is made up of eight antenna loops. For the *Tangible Viewpoints* system, two tag sensing surfaces are tiled together in order to provide a larger interaction and projection surface. The movements of the pawns are sent two the computer via the serial port, where a master control program written in Java is responsible for decoding the data and generating the appropriate audio/visual output.

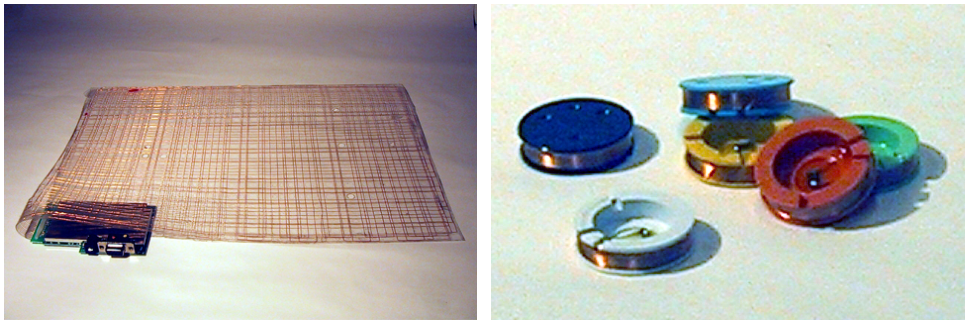

Figure 36: The tag-reading surface consists of eight antenna loops arranged in a flat plastic cover (left). The tags consist of a wire wrapped around the outside of a small plastic holder, in parallel with a capacitor concealed inside the holder (right).

The Java program consists of four main modules. The first module is responsible for reading the serial data and decoding the (x, y) positions of the pawns and selection tool on the interaction surface. The second module drives the projection of graphics onto the interaction surface. The third module controls the display of story segments in the form of QuickTime videos on the flat panel screen. The fourth module is the narrative engine (discussed in section 5.2) that contains all the story information and content. It interprets the incoming serial data from the first module, and generates the appropriate response in the graphics and video modules. In short, it is responsible for moving the story forward based on user interactions.

Artistic Design: Interaction Surface, Pawns, Graphics and Videos

The design of the interaction surface was centered around a number of basic needs. First of all, I wanted the antenna coils and the circuit boards to be concealed from view. Secondly, the setup needed to provide a clean surface on which the pawns could be moved and graphics projected. Finally, it needed to be robust in order to withstand repeated use over a long period of time.

I decided to build the interaction surface on the Media Lab's Lasercutter using a combination of white, clear and translucent acrylic layers held together by screws. The designs for the layers were done in an application called Corel Draw and can be found in Appendix D.

The interaction surface stands on four acrylic legs that form the bottom layer. The circuit boards are mounted on a layer of acrylic immediately above the legs. The next few layers up are used to sandwich the two sets of antenna coils in place, immediately underneath the white acrylic projection surface. Finally, the topmost layer is used to create a raised border around the projection and sensing area of the interaction surface. This border gives users both a tactile and visual indication of where the movement of the pawns can be sensed. This top layer also includes eight circular indentations around two sides of the sensing area. These can be used to hold the pawns when they are not being manipulated on the sensing area.

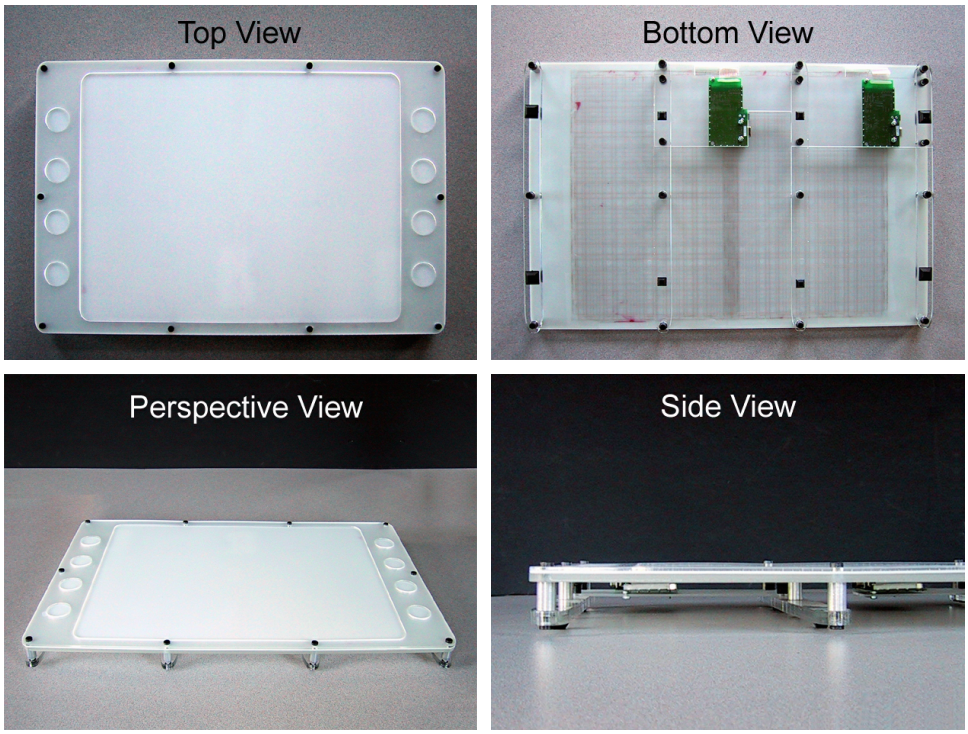

Figure 37: Four different views of the interaction surface.

The second step in physical creation of the *Tangible Viewpoints* system was the design and construction of the pawns and selection tool. Since the pawns are used to represent the character viewpoints in the story rather than the actual characters themselves, I wanted the figures to evoke the human form in a somewhat abstract manner, similar to pawns in a chess set. Although inspired by chess pawns, I deliberately avoided using black and white colors in order to avoid a direct connection to the game of chess. I instead chose to fabricate the top part of the pawns out of clear acrylic rods using the Media Lab's NC Lathe. The base of each pawn consists of a colored acrylic ring that serves to distinguish it from the others. The three colors used to differentiate the viewpoints are red, green and yellow. The ring around the base of each pawn also serves to conceal the small tags that allow them to be sensed.

The selection tool was also fabricated out of clear acrylic using the Media Lab's NC Lathe. It is designed to look somewhat like a small looking glass

or lens. Like the pawns, it also has a colored acrylic base used to conceal the small tag.

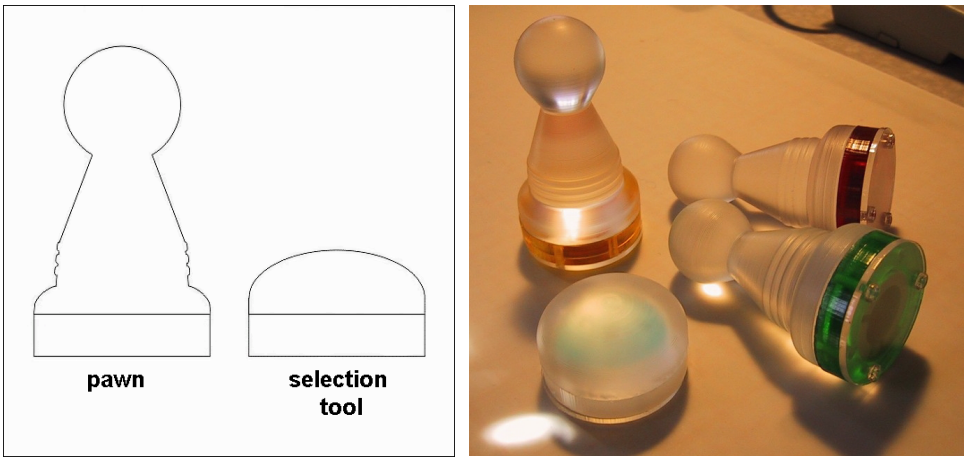

Figure 38: Designs for the pawns and selection tool (left). Completed pawns and selection tool (right).

Another important aspect of the *Tangible Viewpoints* design was the aesthetics of the graphics that are projected around the pawns. I wanted them to be clean and simple, and to follow the pawns fluidly as they were moved around the sensing area. The graphics include two components: the character auras and the story segments.

The auras are used to give a visual representation of the prominence of each character's viewpoint in the current telling of the story. The colors of the auras match the colors of the pawns: red, green, and yellow. They are designed to look somewhat like a halo. The color is stronger near the center (close to the pawn) and fades out slowly toward the edges.

Each pawn is a handle on a character viewpoint of the story. The story segments projected around it thus represent the pieces of narrative told from that character's perspective. A difficult design question was how to represent the story segments in graphical form. In the current implementation, they are presented as pieces of text (i.e. scene titles). In future versions of the system, they might be better presented as small images or even video clips.

In order to avoid having story segments overlap as the pawns move around, the graphics were implemented as a physical simulation of a solar system. The pawns and auras act as suns, and the story segments act as their planets. The planets are attracted to their own sun by a certain force, but repel all other planets as well as other suns. The implementation of the graphics and physical simulation were done with the help of graduate student Egon Pasztor.

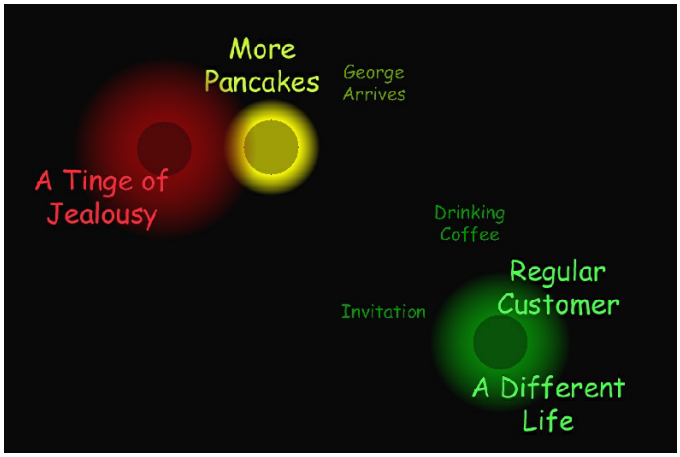

Figure 39: Screenshot of the graphics projected around each pawn. These include an aura, and story segments associated with each character viewpoint.

The final step was the design of the content of the story segments. Users can select story segments on the interaction surface, causing them to playback on the nearby flat panel display. The story segments are in the form of QuickTime videos, and can consist of video, audio, still images, and text. The first set of content that has been tested with the system is entirely text based. That is, the videos consist of portions of the story script that fade in and out on the screen. The script uses two fonts: a plain font for the conversational portions, and a cursive font to represent the character's inner thoughts and observations. The color of the text matches the color of the corresponding character viewpoint on the interaction surface.

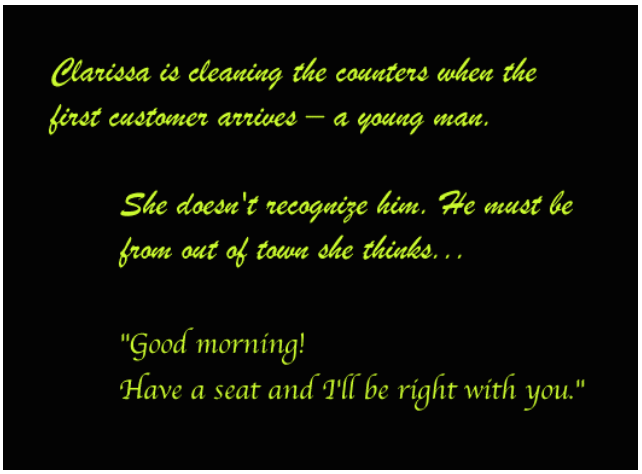

Figure 40: Still frame from one of the text based videos used to test the first version of the *Tangible Viewpoints* system. The story segment is from Clarissa's point-of-view, represented by the color yellow.

Eventually, the content of story segments might consist of full motion video. An interesting question is how these videos could visually distinguish between the different character viewpoints. One option would be to start each story segment's video clip with a title displaying the character's name, the way William Faulkner does in the chapters of *As I Lay Dying*. The story segments could also use different textures, lighting, editing style, and camera movement as a means of visually identifying the different character points-of-view. One example of how this has been used in cinema is the film *Calendar* (1993), directed by Atom Egoyan. Certain portions are shot on film with a static camera and relatively little lighting, other portions are shot on video with a constantly moving handheld camera and a washed-out image, and finally other portions consist of brightly colored still images. In Egoyan's film, these stylistic differences serve to distinguish between the different times, locations, events and moods in the film. Similar types of stylistic differences could be used to distinguish between the different character viewpoints in future content designed for the *Tangible Viewpoints* system.

5.2 Narrative and Computational Structure

In the *Tangible Viewpoints* system, each physical pawn represents a handle on a character viewpoint of the story. When the pawn is placed

on the sensing area of the interaction surface, the segments corresponding to its viewpoint are projected around it. Using a special selection tool, users can choose segments to be played back on a nearby display, causing the story to move forward and the projected graphics to change accordingly. This section describes the story structure used to support this form of interaction.

Three Characters, Three Acts

The *Tangible Viewpoints* narrative structure supports multiple viewpoints stories, in which the story pieces are organized according to the character viewpoints they represent, as well as their place in the overall narrative. The current implementation of the system consists of three main character perspectives (corresponding to the red, green, and yellow pawns), and also three acts that provide a structure for the narrative events.

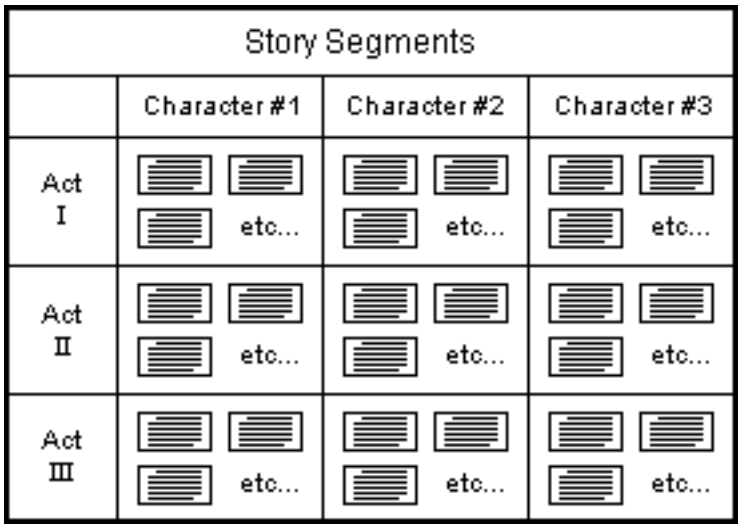

Figure 41: Organization of the story segments in the *Tangible Viewpoints* system.

The three-act structure is a basic dramatic form that has evolved from ancient Greek theater, the ancestor of modern drama. Most dramatic films and plays follow the three-act form. Act I is used to set up the story, the past events, the characters, and the conflict. Act II builds through a cause and effect chain of events and crises that often frustrate the main characters. It generally concludes with a setback for them. Act III

contains the climax and resolution of the story. The three-act structure is described in detail in *A Director's Method for Film and Television* [34].

Moving Forward

User interactions cause the story to move forward through the three acts. The system determines when to move onto the next act based on two conditions:

(1) If a user has exhausted the story segments from a certain character's perspective in the current act, the system moves on to the next act.

(2) Otherwise, if the viewer has seen at least half of the total number of story segments in the current act, the system moves onto the next act.

As the story moves forward through the three acts, the system gathers information about which characters a user has been interacting with, and makes decisions about what segments to present based on this knowledge. Imagine for instance that a user has been viewing segments from character A's viewpoint (indicated by a large aura around the corresponding pawn), and that those segments have revealed story information about character B but not character C. In this case, as the story moves forward to the next act, only the segments that involve either characters A or B are presented. In this way, the system eliminates segments that do not contain information that is relevant to the current viewing of the story. So if a user seems to be interested mainly in a particular character's point-of-view (condition (1) above), the scope of the story becomes narrower as it progresses. On the other hand, if the user interacts equally with the three pawns (condition (2) above), the result will be a much broader story.

The Weighted Story Network

The idea of using a spreading activation network as a narrative engine was pioneered by Michael Murtaugh in his work on the *Contour* and *Dexter* systems in the Interactive Cinema group [16, 17, 29]. Previous systems used rule-based algorithms and a complicated annotation system as the underlying computational structure for interactive narratives.

Murtaugh created a clip selection algorithm based on thematic continuity. All the clips in Murtaugh's database are annotated with an arbitrary number of keywords grouped into classes, and thematic continuity between two clips is defined as the number of keywords they have in common. This annotated database is combined with a spreading activation network of agents that monitor clips selected by the user. When a clip is selected, related clips activate themselves, increasing the likelihood that they will be played in the future. In Murtaugh's system, users are given access to the entire database of content. While this works very well for the documentary material of *Elastic Boston*, the system is not tailored to convey a highly defined sense of narrative progression when navigating through a story space.

Some of the functionality of the *Tangible Viewpoints* system is loosely based on this idea of a spreading activation network. However instead of giving users access to the entire database of story material, this weighted network is combined with the three-act story form (described in above sections) that allows the system to maintain narrative progression and eliminate non-relevant story segments from the viewable possibilities.

In addition to being annotated based on viewpoint and act, each story segment in *Tangible Viewpoints* is further annotated with the names of other characters that figure in that piece of the story. For example, a story segment in Act I that is from character A's viewpoint, and that tells about a conversation between characters A and B will be annotated as follows: viewpoint = A, Act = I, characters involved = A, B. In addition to these annotations, every story segment is given an overall weight, similar to the activation values in Murtaugh's system. The story segments with higher weights figure more prominently on the projection surface, indicating that they hold greater relevance to the current telling of the story, and increasing the likelihood that they will be selected. If the weight of a story segment becomes negative, it will disappear from view altogether. As the user interacts with the system, the weights of the different story segments adjust themselves according to two rules:

(1) When user selects a story segment, the weights of all other story segments from that viewpoint and involving the same characters are increased. For instance, if a users selects a story segment from character A's viewpoint that tells of a conversation between

character A and B, the weights of all other clips that are seen from A's viewpoints and involve character B are increased.

(2) As the story moves forward through the three acts, the weights of all story segments in the current act are increased, while the weights of story segments in previous acts are decreased. The story segments from past acts thus become less prominent on the screen. This serves to give users a sense of the narrative progression and the passing of time. Future versions of the system could be made to support a more refined structuring of narrative events than the three-act form, allowing story segments that became too far in the past to eventually fade away.

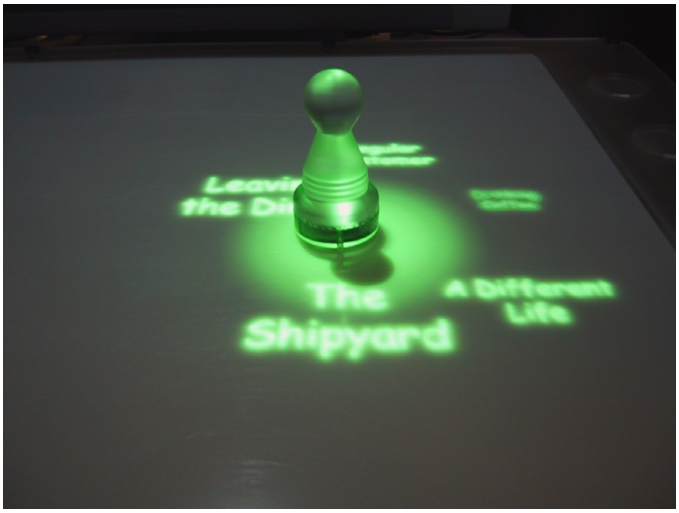

Figure 42: Story segments with larger weights are bigger in size and brighter, while those with smaller weights are smaller in size and faded.

Narrative Queries

The last important aspect of the *Tangible Viewpoints* computational narrative structure is its capability to support character-based narrative queries. By touching the auras of different pawns together in different ways, users can query the database of story segments according to different character-based criteria. For instance, it the user touches the auras of two pawns together, the system will display only the story segments that are relevant to both of those characters. On the other hand, if the user touches the auras of all three pawns together, the system will display only the story segments that are relevant to all three at once.

These narrative queries enable users to explore the story with respect to only the characters they are interested in by narrowing its scope as desired. For instance, if users are interested only in the particular story thread involving the relationship between characters A and B, they can touch pawns A and B together. In this case, only story segments relevant to both characters A and B will remain visible. The following diagram illustrates four possible pawn configurations, each presenting different portions of the story to the user.

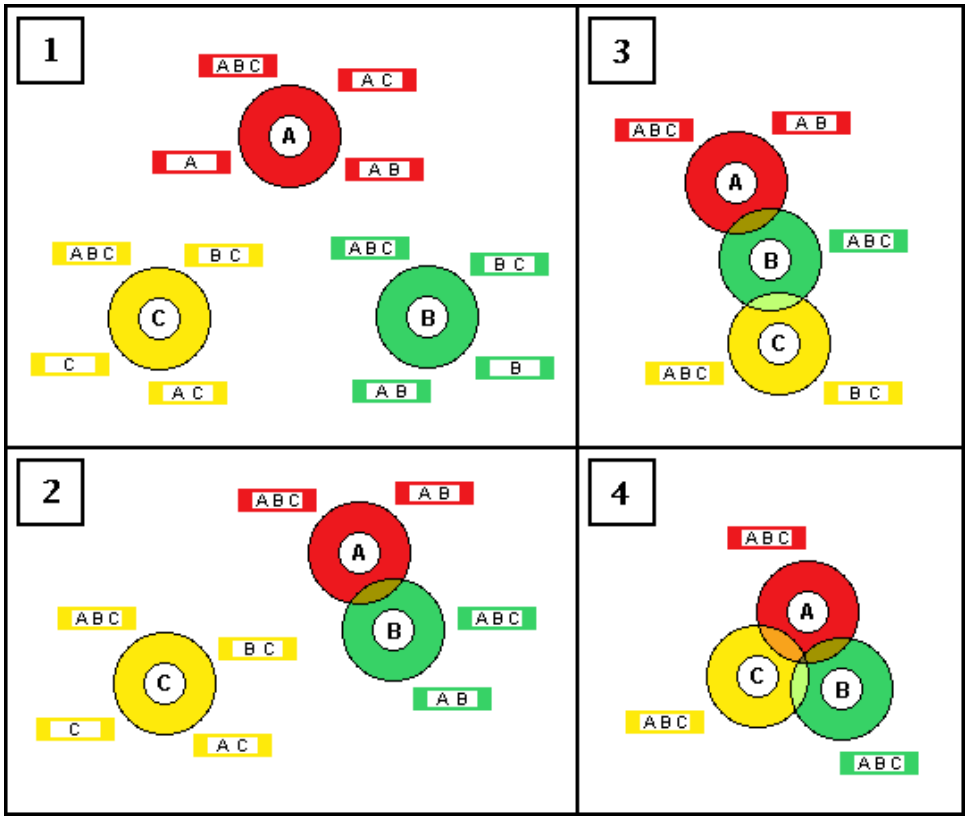

Figure 43: Quadrant 1 shows the story segments that are visible for each viewpoint when no auras are overlapping. In quadrant 2, the auras of pawns A and B are overlapping, so for viewpoints A and B, only the segments relevant to both characters A and B are visible. For viewpoint C, all segments remain visible. In quadrant 3, auras A and B are overlapping, and auras B and C are overlapping. This means that the story segments visible for viewpoint B must involve all of A, B and C. Finally, in quadrant 4, all three auras are overlapping, so only the story segments relevant to all three characters at once are visible.

5.3 Story Content

To date, the *Tangible Viewpoints* system has been tested with only a preliminary set of content—a short multiple viewpoint narrative piece entitled *The Diner*, which tells the story of three characters who meet at a diner in a small East Coast town early one morning. Each character's experience of the meeting is somewhat different. By exploring the three viewpoints, users can gain access to the thoughts and feelings of the different characters, effectively seeing the story events through each one's eyes. If a user centers more and more on a particular character's point-of-view, they will get a more focused story centered around that character's particular feelings and desires. On the other hand, if a user spreads their interest equally between the three viewpoints, the result will be a much broader story, with more information about the inner feelings of all three characters.

The Characters

The three characters, Clarissa, George and Gavin, are equally weighted principal characters when the story begins. Since the system is not initially biased toward any particular viewpoint, it is up to the user to decide whether or not they relate to one character more than the others. The personalities and goals of the three characters are described below.

Clarissa

Clarissa is a waitress at the diner. She works her shift early in the morning, serving coffee and breakfast to the customers who come in. She is young and pretty, and the customers always like her. She is polite and friendly with them, and enjoys casual conversation. She never complains about her job, but nevertheless she often wonders whether she will one day find something better. She daydreams of what other possibilities might be out there for her, and hopes that one day she will find a more exciting life in a big city.

George

George is a rigger at the shipyards. Although not a man of great intelligence, he is happy and enjoys the rigors of outdoor life and work. He is talkative and can sometimes be quite loud and boisterous. The only thing he misses in his life is a family. He is in his late thirties and has never been married. He would love to have children someday, and cannot help feeling that he might never find the right woman. George is a regular customer at the diner, and goes there mainly to see Clarissa.

Gavin

Gavin is a businessman from Boston. He lives alone and works long hours. He dresses in expensive clothes, and can be arrogant and flirtatious. His relationships with women never seem to last long, but he doesn't really mind. His life is hectic, and he doesn't feel he has time for anyone else. Gavin comes to the diner by chance when he driving to New York early one morning.

Story Form and Progression

In the previous two chapters, we looked at Edward Branigan's articulation of a "narrative schema." It is based on seven major elements that together form a relatively rigid and traditional structure for stories. Once again, the elements are as follows:

(1) Introduction of setting and characters
(2) Explanation of a state of affairs
(3) Initiating event
(4) Emotional response or statement of a goal by the protagonist
(5) Complicating actions
(6) Outcome
(7) Reactions to the outcome

As with *genieBottles* and *It May All End in Aleppo*, we can use these seven elements as a means of analyzing the narrative progression of the story content used in the *Tangible Viewpoints* system. The following table gives a detailed analysis of how the story segments of *The Diner* fit in with the seven narrative elements. The full text of the story can be found in Appendix C.

	(1) Character introduction	(2) Current state	(3) Initiating event	(4) Emotional response or goal	(5) Complicating actions	(6) Outcome	(7) Reactions to outcome
Intro Clarissa	Clarissa is a waitress at a diner	Arrives to work at diner					
Intro George	George is a rigger at a shipyard	Looking forward to eating at the diner					
Intro Gavin	Gavin is a big-city business man	Looking for place to eat					
Act I Clarissa 1		Clarissa is working at diner when Gavin arrives					
Act I George 1		George arrives at diner					
Act I Gavin 1		Gavin arrives at the diner					
Act I Clarissa 2		Clarissa serves the customers					
Act I George 2		George orders breakfast					
Act I Gavin 2		Gavin orders breakfast					
Act I Clarissa 3			Clarissa sees George invite Gavin to join him				
Act I George 3			George invites Gavin to join him				
Act I Gavin 3			Gavin decides to join George at the counter				
Act II Clarissa 1				Clarissa is intrigued by Gavin			
Act II George 1				George is envious of Gavin			
Act II Gavin 1				Gavin hopes to chat with Clarissa			
Act II Clarissa 2					Clarissa is attracted to Gavin		
Act II George 2					George secretly loves Clarissa		

Continued from previous page...

Act II Gavin 2					Gavin flirts with Clarissa and invites her to Boston		
Act II Clarissa 3					Clarissa watches the fight brew		
Act II George 3					George flares up and threatens Gavin		
Act II Gavin 3					Gavin insults George when threatened by him		
Act III Clarissa 1						Clarissa tries to calm the situation	
Act III George 1						George is ready to fight	
Act III Gavin 1						Gavin tries to avoid fighting	
Act III Clarissa 2						Clarissa tries to calm George as Gavin leaves	
Act III George 2						George is still angry with Gavin	
Act III Gavin 2						Gavin pays the check	
Act III Clarissa 3							Clarissa goes back to work
Act III George 3							George calms down
Act III Gavin 3							Gavin leaves the diner

Figure 44: Detailed analysis of the narrative progression in the *The Diner* based on Branigan's articulation of traditional narrative form.

As we can see from the above table, *The Diner* follows the three-act structure that was outlined in section 5.2. The first three rows of the table represent the introductory sequence of the story. This sequence is played at the beginning of each interaction session, and serves to introduce the three different characters and their perspectives on the story. From the introductory sequence, the story moves into Act I, in which the current state of affairs is revealed, and an initiating event takes place (George invites Gavin, the stranger, to join him for a coffee). In Act II, the goals of the two men are revealed to conflict with each other, which results in tension and complicating actions. The events are resolved in Act III, and the story world regains equilibrium.

This sequence of narrative events follows Branigan's schema quite closely. However, since users are given some choice as to the order in which they can view the story segments, the narrative is not necessarily followed linearly from beginning to end. If users view certain segments out of chronological order, they must mentally piece them together in order to make sense of the story. This technique has been used certain novels and films—a notable example is Quentin Tarantino's 1994 film *Pulp Fiction* which deliberately shuffles the chronology when presenting narrative events to the viewers. For example, a man that is killed in one scene is then seen alive in the next, and viewers are left to infer that the events have been presented to them out of chronological order.

5.4 User Feedback

To date, the *Tangible Viewpoints* system has undergone only preliminary testing stages. It has been used by a number of people around the Media Lab, and has been shown at two open houses during the spring 2001 Media Lab sponsor meetings. Watching users interact with the system has helped me understand the strengths and issues in the current system design, and has pointed me toward a number of necessary revisions.

In particular, during the spring 2001 Media Laboratory sponsor events, the *Tangible Viewpoints* system was shown to around two dozen visitors in an "open house" environment. People approached the system alone or in small groups, and were free to interact with it as desired. The level of computer experience varied greatly from one user to the next, ranging from computer programmers and expert users, to novice users with little more than basic word processing skills. My observations and findings are summarized below.

Tangible Viewpoints Interface

In general, users found that the *Tangible Viewpoints* interface provided an innovative means for navigating through an interactive story. Most of them commented on how much they liked the dynamic and fluid nature of the graphics, as well as the aesthetics of the pawns and interaction surface.

The system turned out to be considerably less intuitive than either the *genieBottles* or *It May All End in Aleppo*. When they first approached the interface, users were often uncertain of what to do. They would place a pawn on the interaction surface, and its associated story segments would appear around it. At this point, I frequently needed to show them how to use the selection tool in order to choose segments to play back on the nearby display. However, once users had understood this basic interaction, they generally found the story easy to navigate, and enjoyed exploring the additional interactions afforded by the system on their own (such as placing several pawns on the interaction surface at once, and touching them together).

Figure 45: User interacting with the *Tangible Viewpoints* system.

The fact that users needed this initial prompting in order to be able to use the system effectively indicates that the system should provide better tangible clues about the possible interactions. One user suggested that the interaction surface could have tactile qualities indicating where to place and how to move the pawns. For instance, recessed portions in the

sensing area (similar to the "pawn holders" around the edges) might be used to indicate how the pawns could be placed. In this case, different portions of the sensing area could be used for different navigational purposes (e.g. viewing a character's flashbacks, memories, or dreams).

Many users also suggested that the playback of story segments could be integrated into the graphics on the interaction surface rather than displayed on a separate screen. They felt that this would make the overall system slightly more seamless, since both navigation and playback would be taking place in the same physical space. This is an important design revision to consider for future versions of the system.

Narrative Model and Story Content

The narrative model and story content was difficult to evaluate due to the preliminary nature of the content. For the most part, users seemed to like the idea of being able to view the story from different character perspectives, and had no trouble grasping the idea that each pawn served as a handle on a particular character's point-of-view. With that said, most users wanted stronger clues as to which character's viewpoint they were seeing when they played back the segments. One way of doing this would be to begin the playback of each segment with an intertitle displaying the character's name, so that viewers would always be aware of the current viewpoint.

Several users commented that they liked being able to view the story multiple times over, each time taking a different path through the story segments and discovering new information about the characters. They found that the narrative model was well suited to free exploration of the story space, and suggested that it would work well for stories with many characters whose lives were more or less intertwined. One user commented that the narrative queries would prove to be useful in such complex stories, since they would enable viewers to easily select one particular story thread that they wished to follow.

One of the most important points that users brought up with respect to the narrative structure was the need for the system to give viewers a stronger sense of time. While they liked the ability to explore the story

space freely, many of them felt that the chronology of the narrative would become difficult to follow if the story were more complex. In the current system, story segments become smaller in size and fade out as they move further into the past. One possible way of conveying a stronger sense of time would be to organize the story segments along rings around the pawns. Time could be made to move outward from the center. Current events in the story time would be placed on the inner rings first, and would then move to the outer rings as the story moved forward and they moved into the past.

The overall reaction of users was very enthusiastic, and many of them said they looked forward to seeing future versions of the system.

5.5 Reflections

In order to conclude the discussion of the *Tangible Viewpoints* project, this section provides a summary of what I learned about the strengths and limitations of the system from three different angles: the computational narrative structure, the story content, and the interface.

How effective is the computational structure?

The computational structure of the *Tangible Viewpoints* system displays more flexibility than the ones used in *genieBottles* and *It May All End in Aleppo*. Since it is based on a network of weighted story segments combined together with an algorithm for advancing the story forward, the software implementation could easily be extended to support more characters and more acts.

In the *genieBottles* system, the number of story segments is strictly governed by the number of characters in the story. In the *Tangible Viewpoints* system, this is not the case. Each character viewpoint can have a different number of story segments associated with it, allowing for greater flexibility in the content. For this reason, the system could be easily modified to support adaptive stories, in which users could provide content for the system during interaction sessions. Moreover, since users have some flexibility over the order in which they view the segments, the

system is better suited to handling a non-serial progression and sophisticated narrative devices such as flashbacks.

On the other hand, while the *Tangible Viewpoints* narrative structure is capable of supporting richer and more complex stories than the previous two, its flexibility can sometimes make it difficult for users to follow the story. The three-act form used to organize story events is the system's only means of maintaining narrative progression and giving users some sense of the story time. Without it, users would effectively have access to all story segments at once, with no indication of which ones precede others in the narrative.

Overall, the computational structure in *Tangible Viewpoints* strives to give the interactive story experience a combination of flexibility and structure, so that users will feel they have the freedom to explore without feeling lost or confused. This has proved to be a difficult balance to achieve, and the system will have to undergo many more iterations before it gets there.

Is the system capable of telling a good story?

When creating content for the *Tangible Viewpoints* system, writers are asked to work within a highly structured three-act narrative form, but still anticipate that many of their story pieces will be shuffled around when viewed. Given the preliminary nature of the content that has been tested with the system, it is difficult to say at this point whether or not this combination of structure and flexibility will in general permit writers to tell a good story.

When working with traditional narrative forms, the quality of a story depends mostly on the writer's creative abilities. In this case however, it also depends heavily on what tools the writer has to guide him through the creation process. Still today, most writers and filmmakers are unaccustomed to thinking about their works on the many levels and in the many configurations required by interactive narrative forms. As new types of interactive narrative models are developed, it will be necessary to provide tools that can aid content creators in working with them.

How effective is the tangible interface?

The interface for *Tangible Viewpoints* was specifically designed to support multiple viewpoint stories in which the different viewpoints could be presented to users in a variety of formats such as video, audio, images, and text. The main tangible components of the interface are the pawns that are used as handles on the different character viewpoints. By manipulating the pawns, users can see the story segments associated with the different viewpoints, and can play them back on a nearby monitor.

The affordances of the *Tangible Viewpoints* interface are not as immediately obvious as in the previous two systems, and as such, the interface is not as effective initially. However, users generally only needed to be shown how to use the selection tool once in order to grasp the concept of the interface. From that point on, they were able to explore the story on their own, and the interface proved to be an effective means of navigating through the multiple viewpoint story space. Since the interaction is comfortable and not physically tiring, the interface lends itself quite well to long periods of interaction (e.g. over half an hour).

The relationship between interface and story content in the *Tangible Viewpoints* system is not as strong as in the previous two systems. In the *genieBottles*, the genies in the story actually "live" in the glass bottles that serve as an interface. In *It May All End in Aleppo*, the monitors actually represent the characters in the story, and they confide in you when you approach them. None of the interface components in *Tangible Viewpoints* are directly a part of the story world. Although this allows for greater flexibility in the story content, it sometimes seems to distract users from the story experience. In future versions of the system, tighter mappings between the story and the interface might provide more seamless interactive story experiences for users.

Finally, the physical layout of the interaction surface and the system's ability to support the manipulation of multiple pawns at once makes the system well suited for collaborative story exploration.

Chapter 6

From Now On

This thesis has chronicled my explorations in the design and implementation of interactive point-of-view narratives with tangible interfaces. The process has been one of iterative design across the three systems described in the past chapters. For each system, the ideas and limitations that were identified through testing and user feedback contributed to the design decisions and development of the next.

In this chapter, I attempt to summarize what was learned from the development of these three systems, and how it has contributed to the field of character-driven "tangible narratives."

To conclude the thesis I present some ideas for future work on the *Tangible Viewpoints* system.

The table on the following page summarizes some of the important differences between the three systems in relation to the three key themes outlined in Chapter 1: interactivity in narratives, multiple points-of-view, and tangible interfaces. The column on future work for the *Tangible Viewpoints* system gives an overview of some of the ideas presented in section 6.2 of this chapter.

	genieBottles	*It May All End in Aleppo*	*Tangible Viewpoints*	**Future Work (*Tangible Viewpoints*)**
Interactive Narrative Structure	- Uses a state transition interactive narrative model that is quite rigid - The narrative progression is limited over the course of the story	- Uses a multithreaded interactive narrative model that is relatively flexible - There is a strong narrative progression throughout the story	- Uses a very flexible narrative model that consists of a weighted network of story pieces combined with a three act story structure - There is a strong narrative progression throughout the story	- Explore adaptive narrative structures in which users could provide additional content for the system in order to create evolving stories
Multiple Points-of-View	- The different character viewpoints provide a way of structuring both the interface and interactivity - A different bottle is used for each character	- The different character viewpoints provide a way of structuring both the interface and interactivity - A different monitor (with sensor mat) was used for each character	- The different character viewpoints provides a way of structuring both the interface and interactivity - Pawns were used as handles on the character viewpoints in the story	- Explore having different levels of depth for each character viewpoint - Extend the story to a greater number of character viewpoints
Tangible Interface	- Has a strong tangible component to the interface - Uses real world objects with clear physical affordances - The interface is closely mapped to the story content	- The physical interface lacks a real tactile component - The affordances of the interface are not immediately obvious but are easy to understand - The interface is closely mapped to the story content	- Has a strong tangible component to the interface - The affordances of the interface are not immediately obvious and are conceptually more complex - The interface is flexible and not as tightly mapped to the story content as the other systems	- Provide tighter mappings between the interface and story content - Provide more tangible components for the user to interact with

Figure 46: Overview of the important differences between the three systems in relation to the three key themes of this thesis.

6.1 Looking Back

Based on the related research in point-of-view and tangible narratives presented in Chapter 2, two main hypotheses were identified for this thesis.

The first hypothesis had to do with the structuring of interactive narratives. It proposed that having multiple tightly related character viewpoints could be used as a means of structuring comprehensive and coherent interactive story experiences.

The second hypothesis had to do with the interface and presentation of story content. It proposed that by using tangible interfaces that are designed to be tightly integrated into the narrative model and story content, users would be able to experience rich interactive story experiences in which the interaction/interface would not distract from their engagement in the story.

Three separate tangible storytelling systems were developed to support these hypotheses. Each system was constructed based on a different narrative model for point-of-view stories. Each system also used a different interface for structuring user interactions with the story.

The first system was the *genieBottles*, which used glass bottles as a physical interface to access the story content. Genies contained inside the bottles would tell a story to users through their monologues and dialogues. The system used a state-transition model for interactive storytelling.

The second system was a narrative installation entitled *It May All End in Aleppo*. Two characters were displayed on separate monitors. When approached by a user, each character would confide their perspective on story events. The system used a multithreaded approach to interactive storytelling.

The third system was called *Tangible Viewpoints* and used graspable pawns as a means of navigating through an interactive story from three different characters' points-of-view. The story pieces were projected around the pawns and could be viewed on a nearby screen when

selected by a user. The system used a weighted network of story pieces as the computational structure for the narrative.

Each system was evaluated through informal user testing, described in previous chapters. In the first two systems, the interface tightly constrained the way in which users could interact with the story, and hence also the way in which the computational story model could work. The story structures were neither adaptive, nor capable of supporting certain sophisticated narrative devices (e.g. flashbacks) that have evolved in other storytelling mediums such as literature and film. On the positive side, the rigid narrative structures used in these systems, as well as their simple interfaces with clear affordances, made the stories easy for users to follow. The third system displayed more flexibility in both the interface/interaction and the underlying narrative model. While this system was capable of supporting richer and more complex story structures, as well as adaptive stories, it compromised on some of the ease-of-use of the other two systems. Faced with a greater number of interaction options, and a more complex relationship between actions and results, users were sometimes unsure of what to do.

In all three systems, the multiple tightly related character viewpoints proved to be an effective way of structuring interactivity, thus confirming the first hypothesis. The character viewpoints allowed interactivity to be seamlessly integrated into the stories, without destroying their flow or adding unnecessary complexity to the narrative or computational structure. It also provided a means of reflecting the narrative structure in the interface. In each system, the different characters were clearly identifiable in the physical components of the interface: glass bottles in the first system, monitors in the second, and pawns in the third.

In the first two systems, the interfaces were tightly related to the narrative, and became a part of the story world when users interacted with them. The users' physical space, the interface and the story were all seamlessly integrated, allowing for an engaging story experience and confirming the second hypothesis. However, while these interfaces worked for relatively short interaction sessions (e.g. in a gallery environment), it was difficult for users to imagine interacting with them

and maintaining engagement in the story over extended periods of time. In the third system, the relationship between interface and story was slightly more abstract. None of the interface components were directly a part of the story world, which sometimes distracted users from the story experience. On the other hand, this system seemed much more capable of supporting longer and more indepth stories, and also longer periods of user interaction.

Overall, this thesis has hopefully shown that interactivity and viewer engagement in a story are not mutually exclusive, and that by developing tangible interfaces to support interactive storytelling, we might be able to provide viewers with new types of story experiences in which the interface and interaction can be seamlessly integrated into the story world.

But there is still much to be done to bring the field of interactive digital storytelling to the level of maturity of other narrative mediums such as film and literature. Through exploration and experimentation, we are slowly searching for ways to change the narrative experience, inheriting from the legacies of traditional storytelling forms, and making use of the new technologies that are becoming available today. One of the interesting questions brought forth by this research is one of balance. How can we balance between a simplicity in the interface and narrative model that allows viewers to have comprehensive interactive story experiences, and a complexity in the narrative form and story content that allows us to tell richer and more meaningful stories? The following section looks at future directions for the *Tangible Viewpoints* project in light of this question.

6.2 Looking Ahead

The question to ask now is: where does one go from here? The third system discussed in this thesis, *Tangible Viewpoints,* can provide some possible directions. As the most flexible of the three systems, it might be capable of bridging the gap between simplicity and coherency in the interaction, and richness and complexity in the story form and content. The ideas for further research and developments on the system are

divided into two subsections: improvements to the interface, and improvements to the narrative structure.

Interface

In her book *Hamlet on the Holodeck*, Janet Murray discusses threshold objects (interface components or controllers that lead one into and out of a story experience) and explains that they are most effective when closely tied to an object in the fictional world [28, p.108]. In *genieBottles* and *It May All End in Aleppo*, the physical components of the interface represented something from the story world (the bottles contained the genies in the story, and the monitors actually represented the characters). In *Tangible Viewpoints* however, the pawns are not a part of the story world, but rather handles on a particular character viewpoint on the events in the story.

The relationship between the interface and the story in *Tangible Viewpoints* could be made stronger in a number of ways. First of all, the pawns could be given a stronger meaning in the story world through the interactions that they support. For instance, bringing two pawns close together might bring up story segments that involve conversations between the characters. The system could provide a greater selection of tangible objects that might have an existence in the story and evoke memories for different characters, the way the sled Rosebud did for Charles Foster Kane in the film *Citizen Kane*. The interaction space (currently flat and empty) could also be structured based on components of the story world. For example, different parts of the surface might have different tangible qualities, afford different interactions, or represent different elements in the narrative (such as locations or times).

Other possible interface improvements involve the navigation through the narrative. It would be useful to provide a history of viewed story segments, so that users could see the path they had taken through the story thus far in addition to the available options ahead. This history could be provided in the form of a timeline integrated into the interaction space. Story segments would line themselves up in the timeline as they were first played back, and users would be able to review the segments as desired.

Another interesting idea would be to hide the story segments from the user altogether. For instance, if the interaction surface was divided according to narrative elements such as location and time, segments could be selected automatically depending on where the user placed their pawns. In the current system, allowing users to see all the available story segments makes the mechanisms of the narrative construction highly conspicuous, which can leave some users wondering what to do and can work against providing narrative immersion. Hiding the story segments and allowing the narrative to advance automatically based on user interactions could potentially eliminate this problem.

An important consideration for the future is the social context in which the system could be used. I occasionally found that several users would try to interact with the system at once, however since there is only a single selection tool, only one user at a time could make decisions about which story segments to play back. By eliminating the selection tool, it would be easier for the interface to support collaborative story exploration. In addition to the pawns, other tangible components such as physical objects from the story world could be used to navigate through the story space. It might also be interesting to synchronize two *Tangible Viewpoints* systems in different locations. This would allow for remote collaborative story experiences between users.

Finally, the system could provide better integration between the viewing screen and the interaction surface in order to minimize the necessity for users to split their focus between the two. Perhaps the screen could be eliminated altogether, and the playback of story segments could take place somewhere on the interaction surface.

Narrative Structure

The story segments in *Tangible Viewpoints* are organized according to the character viewpoint they represent, as well as their place in the overall narrative (which is a three-act structure). As the story moves forward through the three acts, the system gathers information about which characters a user has been interacting with, and makes decisions about what segments to present based on this knowledge. This dynamic model of the viewer's knowledge could be extended to incorporate other

information as well, such as locations, times, and events. This would allow the story to make use of concepts such as suspense and surprise, which are important in narrative genres like the mystery.

Another interesting enhancement to the narrative model would be to explore how it could support multiple levels of depth in the characters' individual perspectives. Currently, the character auras serve mainly as a means of giving users an idea of how much of the story has been viewed from each character's perspective. If the narrative were instead structured into multiple levels of character depth, the growth of a character's aura might be used as a means of giving a viewer access to more personal or indepth information about that character. For instance, if a character had a very small aura, the system would only reveal things the character expressed openly to others. As the character's aura grew larger, the system would begin to reveal their inner thoughts, and eventually even their subconscious sentiments. While this multilayered narrative structure could be very interesting in terms of the story's development, it would definitely be a challenge to find a clear way of expressing it in the interface.

Finally, given the flexibility of the *Tangible Viewpoints* platform, it would be interesting to explore how it could be used to support entirely different narrative structures than the one discussed in this thesis. An example is the evolving story, in which users would be allowed to provide new content for the different character perspectives. For instance, the story segments could be in the form of memories or dreams. Over the course of time, the web of memories for each character would grow, as new users would interact with the system and provide new memories for each character. Such a system could be presented as an installation piece. The result would be a slowly evolving collective story fabric, in which every visitor would have an opportunity to leave a piece of themselves behind in the installation.

Appendix A

The genieBottles Story

The full text of the genie story discussed in Chapter 3 is included in this appendix. The story was written by undergraduate student Alison Wood.

Genie Story

	-- 1 --	-- 2 --
Junar	I don't know what you people out there expect but I can tell you that I am NOT happy about what's going on right now. They have me trapped in here! My name is Junar. I used to live on the moon—I loved it there! [Reminiscing] During the day the sunlight is piercing—there are no clouds on the moon—so I'd sleep then in soft moon dust, under the lip of a crater the size of the oceans on your planet. At night was when I did my work. I would hike across my crater by starlight and carve pictures, [Arrogantly] the most intricate images you've ever seen, on its surface. [Now bitter] "Vandalism" they called it.	So they sent a solar wind, snatched me up in mid-drawing and shot me into this vile bottle as 'punishment' for my moon graffiti. Hah. I'll show them vandalism. You're maybe wondering what we're all doing now. Well, according to Seala, we're "waiting for the water spirits" to come free us. [Conspiratorially, maybe a whisper] Do you want to know what I'm *really* doing? I'm trying to come up with my OWN plan to get out of this bottle and back onto the moon. [Normal voice] There are no such things as water spirits, Seala is a space cadet. [Sarcastic] But its kind of hard to concentrate with all of this CONJURING going on around here... [Accusingly] and Bottle Opening... I have to go. Don't come back unless you have a way to get me out of here.
Opo	It's been an interesting ball season so far—darn it! [Interrupting himself] It's not a ball season! Opo is my name. You see, when I was a tiny genie, my master hid my bottle behind a commentator's booth in a baseball stadium and now I just can't seem to shake the lingo. And to make things even worse, the commentators were rotten during the time I was growing up in the stadium. I'm an underdog, that's for sure...	We're all sitting out here today, looking to win this one and get out of our bottles. Seala is up, with Junar on deck. Seala is a powerhouse with the water spirits, Wham! Look at her conjure. She's practically glowing with concentration, heh heh. And Junar, what a hitter, they won't keep her down for long, no, sir... she's a tough one. It's not going to be an easy day for this team of genies, though. Me, I don't much care whether

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	my master thought I'd grow up with a sturdy character from being exposed to that great American pastime, but instead I just bore everyone with my lousy commentary. My life is one big losing streak. Sigh.	or not I get out of my bottle. Just go out there and play your position is what I say. But I'm not going to get left behind in the minors while the other genies go on and play in the big leagues!
Seala	[All in a quiet voice] Shhhh. I'm Seala. I can't talk for long because I'm in the middle of trying to conjure the water spirits. I owe everything to them. The thing is, I used to be a little chunk of blue tourmaline, buried deep in the warm brown earth. I spent all my time resting, and daydreamed peacefully... so you can imagine how surprised I was when a hot spring blasted me out of the dirt from below, and vaporized me! After that I fell down into the Great Ocean, where my outsides cooled off and hardened into a tourmaline bottle, with the new, vapory me inside as a genie! I spent a long, long time floating in the sea, thinking about what had happened and talking to the water spirits...	The water spirits gave me the power to protect others while I was floating in the ocean. A little while ago, I was talking to the other two genies and I found out that they are unhappy. I realized that the water spirits could help us understand what we are meant to be. If you want to know the truth, I wouldn't mind getting out of my bottle. It is a lot of work making sure that wishes are not evil, and then granting them. I would rather float... [Reverently] But I will do what the Great Ocean has planned for me, and I will protect my friends and help make everything ok, by finding the water spirits once again.
Junar **Opo**	***Junar*:** Sit tight and don't talk please while I figure out how to escape. ***Opo*:** Well, here it is, folks, she's sitting and figuring it all out. What a genie! Wow! ***Junar*:** I can't believe Seala thinks she's going to summon the 'water spirits.' ***Opo*:** Yes, well, some believe in water spirits, while others, heh heh, they just don't! It's a crazy ball game out there! ***Junar*:** ARGH! It's not a ball game! You're driving me crazy! ***Opo*:** [Dejected] I know it. That always seems to be the case. No one likes to be around me. I hate my life. ***Junar*:** Ok. Well, here. All right already. My instruments of lunar vandalism may still be useful after all, if it will make you stop feeling sorry for yourself.	***Opo*:** What are you doing? ***Junar*:** Carving a baseball onto your bottle. You like baseball, right? Now, silence. ***Opo*:** [Melodramatic] Oh, no. I'll never escape... why did my father's master have to stow the bottle behind the commentator booth! I've been programmed, programmed! ***Junar*:** Ok, so you don't want me to carve a baseball on your bottle. How about a lily pad? Or a dragonfly? What. What do you want? ***Opo*:** I'm doomed. I might as well accept it. I am boring. Carve a rock. A dull, gray rock. ***Junar*:** Look, you're not boring. Cheer up, and be quiet. I'll find a way to get us freed.
Junar **Seala**	***Junar*:** [Brusquely] What are you doing? ***Seala*:** [In a quiet voice] I am meditating. I am calling the water spirits to help us. ***Junar*:** [Sarcastically] Brilliant. Your answer to everything. Water spirits. You're a fool, and you're wasting your time. Well, I guess I can't rely on you to help me get out of this lousy bottle. ***Seala*:** Shhh… Just wait. Be patient, and we'll get help. The water spirits know everything! They would never keep us trapped without a reason. ***Junar*:** They have a reason for me—they think I vandalized the moon! But that's not the point. They aren't even real. ***Seala*:** [Knowingly] You'll see... everything will be ok.	***Junar*:** I'll figure out what to do on my own. You know, I could just keep rocking back and forth until I fall over, roll off this ledge, and smash! I will have escaped. Ha. ***Seala*:** If our bottles break, we may become free, but then again... we don't know what will happen. I don't think we should break our bottles. It wouldn't be right. ***Junar*:** Oh please. I don't believe a word of it. I don't think you want to be ordered around by some strange master any more than I do. ***Seala*:** If we are supposed to be in bottles, granting people wishes, then that is what we have to do. And if that is what I have to do, then that is what I want to do.
Opo **Seala**	***Opo*:** A big question in everyone's mind is, what is going to happen when the water spirits come? Another- when will they be here? And another yet—[Dramatically] will they show up at all? ***Seala*:** Does this answer your question? [Noise of the beginning of rain] It's starting to rain. Just a quiet rain right now, but soon, we'll be surrounded by water... ***Opo*:** Well, folks, whaddya know, the little genie did it! We're all saved! It's raining, and the game Goes ON! But will the rain get us out of our bottles? ***Seala*:** Do we really want to get out of our bottles? I don't know. We have a while yet. This is only the beginning of a fantastic storm.	***Opo*:** The water is flowing in! It's almost up past the ankles of the people around us, it's sogging up their shoes! Soon, it will wash us away! ***Seala*:** No, I'll watch out for you both. Isn't it great? Soon we'll be free as larks... no matter what happens. ***Opo*:** Perhaps we'll be free... or perhaps we're doomed! ***Seala*:** We're not doomed. I'm telling you. They'll know. Look! The water's getting closer... Oh, I'm so excited! I haven't floated in so long! ***Opo*:** Well I have, just the other day a dog picked me up and dropped me in the gutter. I had to go through three masters before one would put me back here! I hope you are right about this whole "freedom" thing...

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Junar **Opo** **Seala**	(rain sounds) ***Seala*:** Here we go... ***Junar*:** Here I go, anyway. I am going to jump off this balcony. It's the only chance. ***Opo*:** The only chance. Well, go ahead. Me, I am not going anywhere. I'd just be more miserable no matter what I did. ***Seala*:** Listen up! Take a look. ***Opo*:** And what do we have, but a flood! Water dropping from the sky! The water spirits, come to save us! Junar turns around to look just before she rolls off the edge! ***Junar*:** I'm just gauging the jump. ***Seala*:** Hmmm hmm (humming), here they come everyone rest, relax it will all be ok now. ***Junar*:** Its just a few sprinkles. There are NO water spirits.	(big water sounds) ***Opo*:** Now, look around us! Folks, the rain is starting to come down pretty hard. Junar doesn't want to admit it, but it looks like the water spirits are on their way! What a hit for Seala. Wow. ***Seala*:** Yes (in her spacey voice) I am not exactly sure what is supposed to happen. I have never summoned the water spirits on purpose before, actually. ***Junar*:** Great. You're summoning water spirits that don't exist and you still don't know what you're doing. I'm jumping. ***Seala*:** Just wait... look... the water is starting to fill the room. ***Opo*:** The children have all taken cover! We're balanced up here, but the water rises rapidly! Maybe it's the water spirits, we'd better hope so because if not this is going to be one rip-roaring bottle-wrenching heck of a storm!

Connecting Segments

	Interrupter Lines	Interruptee Lines	Cut-Off Lines
Junar	1. Well, well, well... 2. You again!	1. I was talking! 2. As I was saying...	1. Good riddance. 2. It's about time!
Opo	1. [Eager] What are you talking about? 2. I'm here!	1. Well if it isn't another genie! 2. You interrupted!	1. And she's outta here! 2. Until next time...
Seala	1. [Spacey] Hey... 2. How is everyone?	1. Hello there... 2. I'm glad you're here.	1. See you later… 2. And poof... you're gone...

End Segments

	End Segments
Junar	1. I thought I told you—don't open my bottle again unless you can get me back to the moon! 2. I don't want to talk now. I'm too busy sulking over the injustice of it all...
Opo	(Written by Jeff Bender) 1. Did you know that Jim Abott pitched one handed for the California Angels? He balanced his glove on the stump of his arm, threw the ball, and by the time the ball got to the plate, he already had his glove on that same hand with which he threw! 2. Are you aware that if an outfielder jumps high on the back wall in an attempt to catch a long-ball that appears to be going over said wall, then he may steal a homerun from the batter? And if he jumps up too tall, catches said ball, and falls over said wall, the umpire will call- homerun.
Seala	1. Among the silence of waves I spent my days calmly breathing Watching the silver line of the sea Rise and fall upon my walls of glass. 2. One stormy day at sea I floated near a manta ray As long as trees are tall was he- he carried me away. A soaring ride returned me to the place where I was found And then the ray flew over me, and dove towards ocean's ground.

Appendix B

It May All End in Aleppo

This appendix includes the full text of the story used in the narrative installation *It May All End in Aleppo* discussed in Chapter 4. The story was adapted from Vladimir Nabokov's short story *That in Aleppo Once…*

Husband	Wife
-- 1 --	-- 1 --
Among other things, I must tell you that at last I am here, in the country whither so many sunset have led. I have a story for you. Which reminds me – I mean putting it like this reminds me – of the days when I wrote my first udder warm bubbling verse, and all things, a rose, a puddle, a lighted window, cried out to me: "I'm a rhyme!" Yes, this is a most useful universe. But just now I am not a poet. I come to you like that gushing lady in Chekhov who was dying to be described.	So I must tell you that I am back in Paris now. Back where it all began. Was it all a dream? Had we really left that poor dog here to die on its own? That beautiful setter that we had bought only a few weeks before… oh I still cry when I think of it! When I walk past the apartment, it all looks so familiar, yet somehow I cannot bring myself to venture in. Not now. Not ever again! But I will tell you how it happened. I will tell you everything right from the very beginning when we left behind that poor beautiful dog.
-- 2 --	-- 2 --
I married, let me see, about a few weeks before the gentle Germans roared into Paris. It was love at first touch rather than at first sight, for I had met her several times before without experiencing any special emotions; but one night as I was seeing her home, something quaint she had said made me stoop with a laugh and kiss her on the hair – and of course we all know of that blinding blast… But now I cannot discern her. She remains as nebulous as my best poem. When I want to imagine her, I have to cling mentally to a tiny brown birthmark on her downy forearm…	I was much younger than he – a poet who had lured me in with his verse. On that night when he walked me home, his words caused a soundless and boundless expansion of what had been during my life but a small pinpoint of light in the center of my being. I suppose that really I had been solely attracted by the obscurity of his poetry; and then I tore a hole through its veil and saw a stranger's unlovable face. But that was not until much later, for we married quickly – only a few weeks before the Germans invaded. And soon after that we bought that adorable young setter.

Continued from previous page...

-- 3 --	-- 3 --
I had been for some time planning to follow the fortunate flight of so many of my friends. She described to me an uncle of hers who lived, she said, in New York. He had taught riding at a Southern college, and had wound up by marrying a wealthy American woman. They had a little daughter born deaf. She said she had lost their address, but a few days later it miraculously turned up, and we wrote a dramatic letter to which we never received any reply. But this did not much matter. I had already obtained a sound affidavit from Professor Lomchenko of Chicago; but that was all we had done to get the necessary papers when the invasion began.	He talked constantly of going to America… of his professor friend in Chicago who could help us. And I told him of my uncle in New York. He had taught riding at a Southern college, and had wound up marrying a wealthy American woman. Their little daughter had been born deaf. I was sure they could help us, and so we wrote a letter to which we received no reply. Of course only now do I know that they had by then moved to San Francisco. Their poor deaf little girl had died, and they could no longer bear to stay in New York. Our letter eventually made it to them, but the invasion began and we left Paris too quickly to receive their reply.
-- 4 --	**-- 4 --**
So we started upon our disastrous honeymoon. Crushed and jolted amid the apocalyptic exodus, waiting for unscheduled trains that were bound for unknown destinations, we fled. Oh, she bore it gamely enough – with a kind of dazed cheerfulness. Once however, quite suddenly, she started to sob in a sympathetic railway carriage. "The dog," she said, "the dog we left. I cannot forget the poor dog." The honesty of her grief shocked me, as we had never had any dog. "I know," she said, "but I tried to imagine we had actually bought that setter." There had never been any talk of buying a setter.	And so the poor dog was left whining behind a locked door, and together we started on our catastrophic journey. We traveled by train from one nameless town to the next, and I watched the scenery blur past us. I cannot forget a certain stretch of highroad and the sight of a family of refugees – two women and a young child --whose old father, or grandfather, had died on the way. With a stick in their hands the women had tried to dig a roadside grave, but the soil was too hard. They had given it up, and the little boy was still scratching and scraping and tugging alone…
-- 5 --	**-- 5 --**
Spain proved too difficult and we decided to move on to Nice. At a place called Faugères -- a ten-minute stop – I squeezed out of the train to buy some food. When a couple of minutes later I came back, the train was gone, and the muddled old man responsible for the atrocious void that faced me brutally told me that, anyway, I had had no right to get out. In a better world, I could have had my wife located and told what to do; as it was, my nightmare struggle with the telephone proved futile, so I took the next local to Montpellier.	The trains eventually took us to Spain, where he decided that after all we would be better off in France. So we boarded yet another train and headed back up the coast towards Nice. At a small town called Faugères -- a rare ten-minute stop on the way -- he said he would get us some food. He got off the train, and that was the last I saw of him for almost a week. Tired and exhausted, I had been left alone on the train. I was sure that he had deserted me, sure that I would never find him again. But still I tried…
-- 6 --	**-- 6 --**
Not finding her in Montpellier, I had to choose between two alternatives: going on because she might have boarded the Marseilles train which I had just missed, or going back because she might have returned to Faugères. I forget now what tangle of reasoning led me to Marseilles and Nice.	At the next station, I got off the train and took another one back to Faugères. Not finding him at the station there, I went on to the Commissariat where the French policemen proved to be of no help to me. Not knowing what to do next, I decided I would do best to move on to Nice, and so I boarded yet another train…
-- 7 --	**-- 7 --**
Beyond such routine action as forwarding false data to a few unlikely places, the police did nothing to help. I looked up various acquaintances among the numerous Russians domiciled or stranded in Nice. A week after my arrival, an indolent plain-clothes man called upon me and took me down a crooked and smelly street to a black-stained house with the word "hotel" almost erased by dirt and time. There, he said, my wife had been found, but of course the girl he produced was an absolute stranger to me…	Somewhere around Marseilles, a young Frenchman joined me in my cabin. Finding me distraught, he listened patiently to my story and then tried to calm me down. He was the perfect gentleman and sympathetic to my plight. He offered me a place to stay in Nice, and having nowhere better to go, I accepted his offer. I stayed at his place for several nights and felt a strong attachment to him almost immediately. But then I ran into some Russian friends who told that my husband had arrived in Nice and was looking for me.
-- 8 --	**-- 8 --**
When at length I got rid of that useless plain-clothes man and had wandered back to my neighborhood, I happened to pass by a compact queue waiting at the entrance of a food store. And there, at the very end, was my wife, straining on tiptoe to catch a glimpse of what exactly was being sold. I think the first thing she said to me was that she hoped it was oranges.	I wanted to find my husband again… to tell him everything that had happened and that I could no longer stay with him. I looked for him everywhere but couldn't even find where he was staying. Our friends in common all said they had seen him, but none of them knew where to find him. We finally ran into each other quite by accident outside a small French grocery store.
-- 9 --	**-- 9 --**
Her tale seemed a trifle hazy, but perfectly banal. She said she had returned to Faugères and gone straight to the Commissariat where she had to borrow some money to reach Nice. However she had gotten on the wrong train and had first traveled to an unknown town. Only two days ago had she finally	Although his tale seemed a trifle hazy, I was still willing to accept it. I had been so sure that he had deserted me, but his words convinced me otherwise. Yet by then it was too late. I told him my story and how the young Frenchman had stolen my heart. I implored him for a divorce – it would be better for

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arrived in Nice. Several days later, she retracted this story and instead claimed to have stayed for several nights in Montpellier with a man she had met on the train. The torture! I spent that night and many others getting it out of her bit by bit, but not getting it all. Until at last she said to me "I didn't – You will think me crazy, but I didn't!" Finally I had to accept the first version of her delay.	both of us I said. But he refused, saying he would rather shoot both himself and me than sail to New York alone. In a similar situation, my father had acted like a gentleman, but all he said was that he did not give a hoot for my cocu de père. It was then that his face became that of a stranger, and I knew I could no longer stay with him. I had to wait to find the right moment to leave…
-- 10 --	**-- 10 --**
Between periods of this inquest, we were trying to get from reluctant authorities certain papers that were required for our visas. When at last I emerged from a dark hot office with a couple of plump visas cupped in my trembling hands, I dashed to Marseilles and managed to get tickets for the very next boat. I returned and tramped up the stairs. I saw a rose in a glass on the table – the sugar-pink of its obvious beauty, the parasitic air bubbles clinging to its stem. Her two spare dresses were gone, her comb was gone, her checkered coat was gone, and so was the mauve hair-band with a mauve bow that had been her hat. There was no note pinned to the pillow, and nothing at all in the room to enlighten me.	I spent several weeks not talking much to him, scared of what he would do. While he spent his days in the Prefecture filling forms and pleading with secretaries to secure our visas, I snuck out alone to see my beloved Frenchman. Together we planned our escape to a chateau in Lozere where we could be free and happy. When at last one day he emerged from the Prefecture clasping our visas, and then dashed off to Marseilles to get tickets for the boat, I hastily decided that the time had come for me to leave. I took with me my two spare dresses, my comb, my mauve hair-band, and my checkered coat, and once and for all I left that dismal apartment that had been the site of so much pain and suffering.
-- 11 --	**-- 11 --**
I tried in vain to find her, but she had vanished without a trace. That was the end. I would have been a fool had I begun the nightmare business of searching and waiting for her all over again. On the fourth morning of a long and dismal sea voyage, I met on the deck a solemn but pleasant old doctor with whom I had played chess in Paris. He asked after my wife, and looked taken aback when I said I had sailed alone. He said he had seen her a couple of days before going on board. She had told him that I would presently join her with bag and tickets.	I wonder now how hard he tried to find me before finally giving up and sailing away on his own. I would have been a fool to go with him, yet I cannot stop thinking of him now. My beloved Frenchman turned out to be just as much of a stranger as he. The chateau in Lozère was little more than empty words, and I spent several weeks in a shabby little cottage in the country. After having spent so much time following others around, it took a while before I found the strength to take my life back into my own hands.
-- 12 --	**-- 12 --**
This is, I gather, the point of the whole story. It was at that moment that I suddenly knew for certain that my wife had never existed at all. Here in New York, I looked for her uncle's name in the directory. It was not there. I went to the address she had given me once, but it proved to be an anonymous gap between two buildings. I now see our mangled romance engulfed in a deep valley of mist between the crags of two matter-of-fact mountains: life had been real before, and life will be real from now on. Yet the pity of it! I am hideously unhappy. She keeps on walking to and fro where the brown nets are spread to dry on the hot stone slabs. Somewhere, somehow, I have made some fatal mistake. It may all end in Aleppo if I am not careful.	I eventually found myself back in Nice and couldn't help inquiring about my husband. He was gone… our friends said he had sailed to America alone. And although I couldn't keep myself from thinking about him and wondering what would have happened if we had sailed together, I knew that this end would be a beginning for me. Like a puzzle, the pieces of my life finally started to fall into place. I returned to Paris, and the nice lady at the post-office gave me a letter from my uncle. He is living in San Francisco now, together with his lovely wife. Perhaps I will go join him, and from this point on my life will once again be real. I will not let our distorted romance torture me anymore, or it may all end in Aleppo if I am not careful.

Appendix C

The Tangible Viewpoints Story

This appendix includes the full text of the first preliminary story tested with the *Tangible Viewpoints* system.

The Diner

INTRODUCTION
It is 6am. A cold wind blows across the bay. Dark waves hit the sides of the ships moored at the Newport docks. Clarissa's hands shake as she wrestles with the lock. As she opens the door, the warm air from inside the Dockside Diner collides with the crisp morning air. She steps inside and flips on the lights. A voice comes from the kitchen in the back. "Is that you Clarissa?" The cook has already been here for at least 2 hours. "Good morning, Barb!" Clarissa says as she tosses her coat behind the long counter that stretches across the entire diner. She starts taking the chairs down from the single row of tables that lines the front wall of the diner by the windows. It's almost time to open. George has been working outside for most of the night. It's been a busy week at the Newport shipyard. But George doesn't mind. The overtime pay will be good, and besides, he actually likes the work. As a Rigger, he spends most of his time moving around heavy machinery, pipes and electrical components. The work is hard, but he couldn't imagine doing anything else. Building ships is his life. His father worked at the shipyard for a long time, and George can still remember being fascinated by all the enormous ships and heavy equipment when he was a kid. He loved to visit the shipyard with his father and always pictured himself working there. But now is no time to let his thoughts wander. Soon it will be break time and he'll grab a bite to eat at the Dockside Diner. The small highway winds in and out of the rocky inlets along the Rhode Island coast. Gavin has been driving for several hours and he can feel pangs of hunger in his stomach. Later today he will arrive in New York city, but he's not in a hurry to get there. He isn't exactly looking forward to the family gathering. His grandparents will surely nag at him for still being single. "Where are the grandchildren?" he can already hear them saying. It's always the same, and he's tired of it. Besides, he really doesn't have time for this. He has a big deal to close in Boston on Monday, and he can't wait to get back. But right now he isn't even close to New York, and he needs to find a place to eat. There must be something open at 6am! He hasn't seen much yet, driving along these small coastal roads. But suddenly in the distance he sees a brightly lit sign. "Dockside Diner" Maybe it's open.

ACT I		
Clarissa	**George**	**Gavin**
The Stranger	Arriving at the Diner	The Dockside Diner
Clarissa is cleaning the counters when the first customer arrives – a young man. She doesn't recognize him. He must be from out of town. "Good morning!" she says. "Have a seat and I'll be right with you."	George enters the diner and takes a seat at the counter. He looks around eagerly for Clarissa. She is waiting on an unfamiliar man seated at a table in the far corner. His clothes look expensive. And he's young and good-looking too. He must have a good life, thinks George.	Gavin throws open the door to the "Dockside Diner" and steps in. A young waitress looks up at him and smiles. Wow! She's great, thinks Gavin as he seats himself at a table near counter.
Serving the Stranger	Casual Conversation	The Pretty Waitress
Clarissa hands a menu to Gavin. "Can I get you something to drink first? A coffee?" she asks. "A coffee would be great!" the man replies with a big smile. Clarissa smiles back, "alright, I'll be right back with that!"	"Looks like it'll be a real cold winter this year, don't you think?" says George. His eyes follow Clarissa closely as she fills his cup with more hot coffee. "I'll have my usual." George can't help thinking how pretty she looks.	The pretty waitress brings his coffee, and Gavin smiles at her again. "I'll have the bacon and eggs special," he says.
The Invitation	The Invitation	The Invitation
Clarissa comes out of the kitchen with a cup of coffee for George. It looks like he's talking with the stranger. She pauses as the stranger gets up and seats himself next to George at the counter.	George sees the strange man smile at Clarissa. "How about joining me at the counter for a coffee?" George asks him. The man looks surprised at first, but quickly smiles. "Sure, why not! I could definitely use another cup!"	Is the man burly man at the counter really talking to him? He seems to be inviting him for a cup of coffee. Can't be too bad, thinks Gavin as he gets up to join him. Besides, maybe he can chat with the waitress too!

ACT II		
Clarissa	**George**	**Gavin**
Conversing with George	Jealousy	Observing Clarissa
Things in the diner seem to have slowed down, and Clarissa strikes up her usual conversation with George. The stranger is sitting next to him, and Clarissa would love to find out more about him.	George sees Clarissa casting quick glances in the stranger's direction, and feels jealous. Women never seem interested in him. He's aware that he's neither good-looking, nor wealthy, and he's definitely not getting any younger.	Seated at the counter, Gavin watches Clarissa and wonders how such a pretty young woman could possibly enjoy working in this sort of place. Maybe he can strike up a conversation with her.
Conversing with the Stranger	His Love for Clarissa	Come to Boston!
The conversation with this stranger—Gavin—has been great! She glances at him out of the corner of her eye, and catches him looking at her with intense blue eyes. He's really good looking and his life sounds so exciting! Maybe she will take him up on his offer to visit Boston.	George watches Clarissa as she tosses her hair and laughs lightly. She seems to be enjoying talking with this man Gavin. He can't help feeling upset about it. After all, he's had strong feelings for Clarissa for years, but has never been able to express them to her.	"I live in Boston," says Gavin. "Wow, I've always wanted to see Boston!" Clarissa replies. Gavin smiles at her, "Well, you should come up and visit sometime. I've got a great little apartment right in the beautiful old downtown."
The Start of a Fight	The Start of a Fight	The Start of a Fight
Clarissa can't believe her eyes when George jumps up suddenly and begins to yell at Gavin. She had been so into her conversation with Gavin that she completely forgot he was there. Still, she can't let them start a fight here in the diner.	He's inviting her to Boston! This is the last straw, and George can't control his rage. He loves Clarissa, and now this stranger thinks he can just take her away. Before he can stop himself, he stands up and yells at Gavin.	Gavin is startled at George's sudden outburst and retorts quickly. "What's your problem, man? Are you in love with her or something? It's none of your business if she wants to get out of this town!"

ACT III		
Clarissa	**George**	**Gavin**
Calming George	George's Rage	Backing Down
Clarissa tries to calm the situation, but George is clearly still enraged. And Gavin's sharp tongue isn't helping either. She's not sure what to do.	George's rage has gotten the better of him. He definitely isn't going to let this guy get away with his insults, and he prepares himself for a fight.	With George's large frame now looming above him, Gavin begins to regret having insulted him. "Look, man, just forget about it," he says.
Regrets	Shame	Paying the Check
Clarissa talks to George in a gentle voice as Gavin leaves the diner. She had never realized he felt so strongly about her, and she feels a little sorry for being so ready to take up Gavin's offer.	George tries to calm himself. He hates this man Gavin and can still feel the anger inside himself. But he feels ashamed for the way he just acted. It's no wonder that Clarissa would never even look twice at him.	Gavin pays the check hastily. He avoids looking at George, who has seated himself back at the counter. He just wants to get out of here.
Back to Work	Forgetting About It	Leaving the Diner
With only George left in the diner, Clarissa begins to clean the tables. She thinks about Gavin and George, and how she nearly found a way to escape her life. But is that what she really wants?	George watches the ocean. It looks like a new ship is coming in to dock. Soon it will be time for him to head back to the shipyard. He feels his anger subsiding. Hopefully this entire morning can soon be forgotten.	Gavin picks up his coat and leaves the diner. Back on the road, he feels relieved. These people live in a different world from his, and he doesn't want to get caught up in it. He would have been better off not even stopping here.

Appendix D

Interaction Surface Designs

The *Tangible Viewpoints* interaction surface is constructed from six acrylic layers that are held together by screws and spacers. They were designed using an application called Corel Draw and were cut on the Media Lab's Lasercutter.

Figure 47: The *Tangible Viewpoints* interaction surface.

Top Layer

The top layer is used to provide a raised border around the sensing area, which gives users a visual and tactile indication of where the pawns can

be sensed. The large circular holes on the sides of the sensing can be used to hold the pawns when they are not being manipulated on the sensing area. The small holes around the edges hold the screws that attach the layers together in place. The top layer is made of 1/8 inch translucent acrylic.

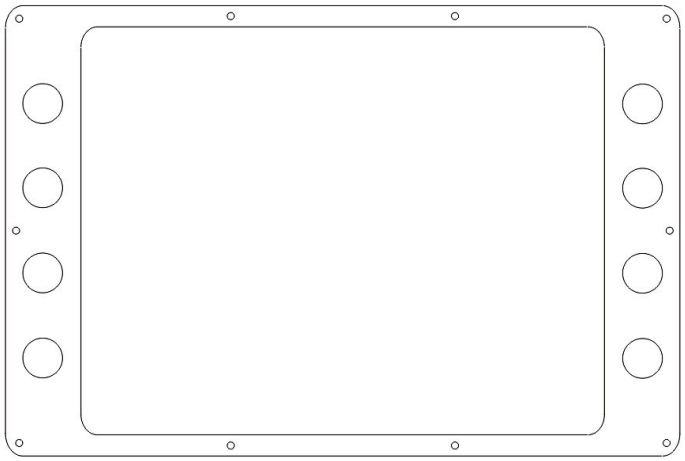

Figure 48: Corel Draw design of the top layer of the interaction surface.

Second Layer

The second layer is the projection surface. It is placed immediately above the grid of wires that form the sensing region. The pawns can thus be moved around above the sensing region (the area that is within the raised border formed by the top layer), and graphics are projected on top of them. The second layer is made of 1/16 inch white acrylic.

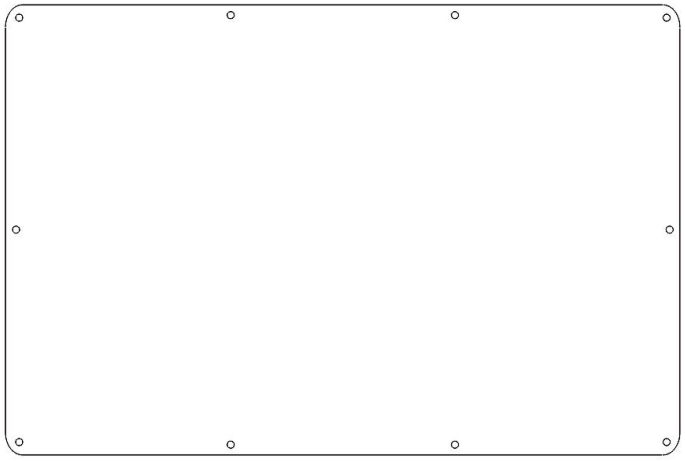

Figure 49: Corel Draw design of the projection layer of the interaction surface.

Third Layer

The third layer holds two sets of Zowie antenna coils in place under the projection layer. Two small rectangular notches along the upper side of the layer allow wires to pass down from the antenna coils of the sensing area to the circuit board. This layer is made of a thin sheet of plastic.

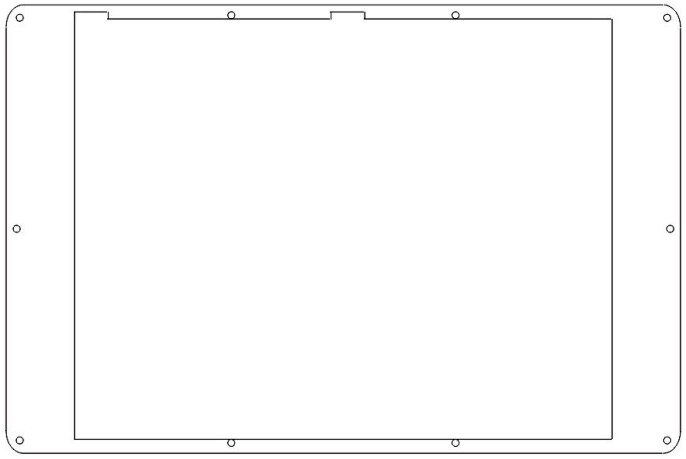

Figure 50: Corel Draw design of the third layer that holds the antenna coils in place.

Fourth Layer

The fourth layer is used to support the Zowie antenna coils in place from underneath. The rectangular holes along the upper side of the layer are used to run the wires from the antenna coils of the sensing area down to the circuit board. This layer is made of 1/4 inch translucent acrylic.

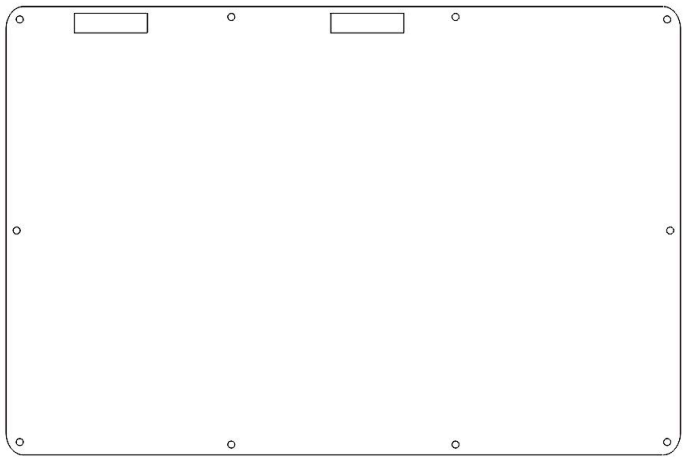

Figure 51: Corel Draw design of the support layer of the interaction surface.

Fifth Layer

The fifth layer is used to support the Zowie circuit boards from underneath, and is separated from the fourth layer using metal spacers. The circuit boards are mounted onto the layer using two sets of three small screws (the smallest holes seen on the image below). The slightly larger holes attach the circuit board support layer to other layers with screws and spacers.

The rectangular indentation on the bottom edge of the layer is used to pass a serial cable to the second circuit board (the first board does not need an indentation since it is placed along the edge of the interaction surface). This layer is made of 1/8 inch translucent acrylic.

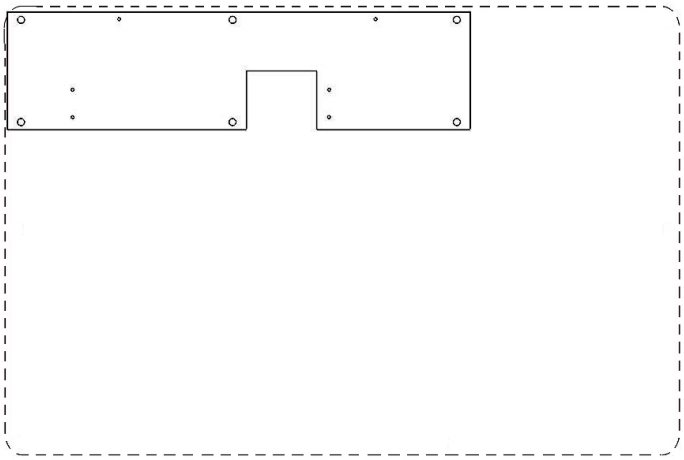

Figure 52: Corel Draw design of the circuit board support layer. The dotted line indicates the edge of the top four layers.

Sixth Layer

The interaction surface stands on four legs that are a separated from the previous layers using metal spacers. The extra two holes on each of the first three legs (seen on the image on the following page) connect to the circuit board support layer. All four legs run from the bottom edge to the top edge of the interaction surface, and are spaced equally from left to right. The legs are made of 1/2 inch clear acrylic.

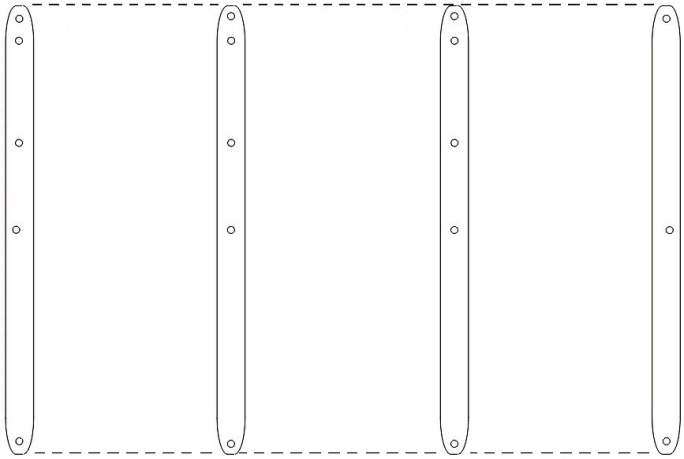

Figure 53: Corel Draw design of the four supporting legs for the interaction surface. The dotted line indicates the edge of the top four layers.

References

[1] Alborzi, H., Druin, A., Montemayor, J., Sherman, L., Taxen, G., Best, J., Hammer, J., Kruskal, A., Lal, A., Plaisant Schwenn, T., Sumida, L., Wagner, R., Hendler, J. "Designing StoryRooms: Interactive Storytelling Spaces for Children," *Designing Interactive Systems (DIS)*, 2000.

[2] Aristotle, *Poetics*. Translated by Malcolm Heath. Penguin Books, London, 1996.

[3] Intille, S., Baird, F., Schütte, A., et. al. "The Kidsroom: A Perceptually-Based Interactive and Immersive Story Environment." IC Technical Report, 1996.

[4] Baker, A., Fenwick, S. "Storytelling" in *Compton's Encyclopedia Online*. The Learning Company, Inc., 1998.

[5] Barry, Barbara. *Story Beads: a Wearable for Distributed and Mobile Storytelling*. M.S. Thesis, MIT Media Lab, 2000.

[6] Barry, B., Davenport, G., McGuire, D. "Storybeads: A Wearable for Story Construction and Trade" in *IEEE International Workshop on Networked Appliances*. November, 2000.

[7] Branigan, Edward. *Narrative Comprehension and Film*. Routledge, an imprint of Taylor & Francis Books Ltd., New York, 1992.

[8] Brooks, Kevin. "Agent Stories" in *AAAI Spring Symposium Series - Interactive Story Systems, Plot and Character*. American Association for Artificial Intelligence, Stanford University, 1995.

[9] Brooks, Kevin. "Do Story Agents Use Rocking Chairs? The Theory and Implementation of One Model for Computational Narrative" in *Proceedings of ACM Multimedia '96*, W. Hall T.D.C. Little (eds), pp.317-328. Boston, 1996.

[10] Brooks, Kevin. *Metalinear Cinematic Narrative: Theory, Process, and Tool*. Ph.D. Thesis, MIT Media Laboratory, 1999.

[11] Campbell, Joseph. *The Power of Myth*. Bantam Doubleday Dell Publishing Group, Inc., New York, 1988.

[12] Campbell, Joseph. *The Hero's Journey: Joseph Campbell on His Life and Works*. HarperCollins Publishers, New York, 1991.

[13] Chatman, Seymour. *Story and Discourse: Narrative Structure in Fiction and Film*. Cornell University Press, Ithaca, NY, 1978.

[14] Davenport, Glorianna. "New Orleans in Transition, 1983-1987: The Interactive Delivery of a Cinematic Case Study," in *The International Congress for Design and Planning Theory, Education Group Conference Proceedings*, May 1987.

[15] Davenport, G., Friedlander, L. "Interactive Transformational Environments: Wheel of Life." (Chapter 1, pp. 1-25) in *Contextual Media: Multimedia and Interpretation*. MIT Press. Cambridge, MA, 1995.

[16] Davenport, G., Murtaugh, M. "ConText: Towards the Evolving Documentary" in *ACM Multimedia '95*, November, 1995.

[17] Davenport, G., Murtaugh, M. "Automatist storyteller systems and the shifting sands of story" in *IBM Systems Journal*, vol 36, no 3, 1997 pp.446-456.

[18] Druin, A., Montemayor, J., Hendler, McAlister, B., Boltman, A., Fiterman, E., Plaisant, A., Kruskal, A., Olsen, H., Revett, I., Plaisant- Schwenn, T., Sumida, L., & Wagner, R. "Desiging PETS: A Personal Electronic Teller of Stories" in *Proceedings of CHI'99*, ACM Press, 1999.

[19] Eisenstein, Elizabeth. *The Printing Revolution in Early Modern Europe*. Cambridge University Press, 1983.

[20] Frederick, Carl. *DarkZOO*. http://www.darkzoo.net, 2nd edition, 1999.

[21] Glos, J. and Cassell, J. "Rosebud: A Place for Interaction between Memory, Story, and Self." *Proceedings of CT '97* (Second International Conference on Cognitive Technology), Los Alamitos, CA, 1997.

[22] Glos, J. and M. Umaschi. "Once Upon an Object ...: Computationally-Augmented Toys for Storytelling" in *Proceedings of ICCIMA '97* (International Conference on Computational Intelligence and Multimedia Applications), February 10-12, Gold Coast, Australia, 1997.

[23] Gorbet, M., *Beyond Input Devices: A New Conceptual Framework for the Design of Physical-Digital Objects*, Master's Thesis, MIT Media Lab, 1998.

[24] Gorbet, M., Orth, M. and Ishii, H. "Triangles: Tangible Interface for Manipulation and Exploration of Digital Information Topography" in *Proceedings of Conference on Human Factors in Computing Systems (CHI '98)*. Los Angeles, April 1998, ACM Press, pp. 49-56.

[25] Ishii, H., Mazalek, A., Lee, J. "Bottles as a Minimal Interface to Access Digital Information" in *Extended Abstracts of CHI '99*, ACM Press, pp.187-188.

[26] Laurel, Brenda. "New Interfaces for Entertainment" in *Journal of Computer Game Design*, vol 2, no 5, 1989.

[27] Mazalek, A., Wood, A., Ishii, H., "genieBottles: An Interactive Narrative in Bottles", in *Conference Abstracts and Applications of SIGGRAPH '01* (Los Angeles, California, USA, August 12-17, 2001), ACM Press, p.189.

[28] Murray, Janet. *Hamlet on the Holodeck: The Future of Narrative in Cyberspace*. The MIT Press, Cambridge, MA, 1997.

[29] Murtaugh, Michael. *The Automatist Storytelling System: Putting the Editor's Knowledge in Software*. Master's Thesis, MIT Media Laboratory, 1996.

[30] Paradiso, J., Hsiao, K. "Swept-Frequence, Magnetically-Coupled Resonant Tags for Realtime, Continuous, Multiparameter Control," in *Extended Abstracts of CHI '99*, ACM Press, pp.212-213.

[31] Pellowski, Anne. *The World of Storytelling*. R. R. Bowker Co., New York, 1977.

[32] Propp, Vladimir. *Morphology of the Folktale*. Translated by Laurence Scott. Ed. Louis A. Wagner, 2nd edition, University of Texas Press, 1969.

[33] Rhode, Eric. *A History of Cinema from its Origins to 1970*. Penguin Books Limited, London, England, 1978.

[34] Richards, Ron. *A Director's Method for Film and Television*. Focal Press, 1992.

[35] Ryokai, K. *StoryMat: A Computer-Mediated Space for Children's Fantasy Play and Collaborative Storytelling*. M.S. Thesis, MIT Media Lab, 1999.

[36] Ryokai, K. and Cassell, J. "StoryMat: A Play Space with Narrative Memory" in *Proceedings of IUI '99*, ACM, 1999.

[37] Stanzel, F.K. *A Theory of Narrative*. Cambridge University Press, Cambridge, 1984.

[38] Strohecker, Carol. *Electronic Collage: The Videodisc and Interactive Narrative*. Master's Thesis, MIT Media Laboratory, 1986.

[39] Strohecker, C. "Tired of Giving In: Experimenting with the Greek Chorus as a Model for Interaction with Stories" in *Nov'Art: Les Etats Generaux de l'Ecriture Multimedia*. ART3000, Paris, 1996.

[40] Strohecker, C., Brooks, K., Friedlander, L. "Tired of Giving In: An Experiment in Narrative Unfolding." Available as Technical Report 99-16. Cambridge MA: MERL - A Mitsubishi Electric Research Laboratory.

[41] "Theatre, History of" in *Encyclopædia Britannica Online*. Encyclopedia Britannica, Inc., 1994-2001.

[42] Tiongson, Phillip. *ActiveStories: Infusing Author's Intention with Content to Tell a Computationally Expressive Story*. Master's Thesis, MIT Media Laboratory, 1996.

[43] Todorov, Tzvetan. "Narrative Men" in *The Poetics of Prose*. Translated by Richard Howard. Cornell University Press, Ithaca, NY, 1977.

[44] Todorov, Tzvetan. *Genres of Discourse*. Translated by Catherine Porter. Cambridge University Press, Cambridge, 1990.

[45] "Western Literature, History of" in *Encyclopædia Britannica Online*. Encyclopedia Britannica, Inc., 1994-2001.