Authoring Tangible Interactive Narratives Using Cognitive Hyperlinks

Joshua Tanenbaum, Karen Tanenbaum, Magy Seif El-Nasr, and Marek Hatala
School of Interactive Arts + Technology
Simon Fraser University
350 – 13450 102 Avenue
Surrey, BC V3T 0A3 Canada
{joshuat, ktanenba, magy, mhatala}@sfu.ca

ABSTRACT
Creating content for different forms of interactive narratives requires a different set of skills and techniques than writing non-interactive stories. In this paper we describe a prototype tangible interactive narrative system called the Reading Glove and outline the authoring process used to create story content for it. We begin by discussing different approaches to authoring that are currently in use in interactive digital storytelling. We then discuss in detail the process of writing the story for the Reading Glove and provide an analysis of the fiction created through this process. We put forth the notion of "cognitive hyperlinks": a design technique that we believe has utility for the authors of future interactive narratives. We conclude with a set of general design recommendations for authoring within interactive storytelling systems.

Keywords
Authoring Methodologies, Interactive Narrative, Tangible User Interfaces, Wearable Computing, Object Stories

1. INTRODUCTION
Authoring content for interactive narrative systems is a process that is often shrouded in mystery. For designers of intelligent storytelling systems, the fiction writing process often feels like a creative "black box", within which a number of inscrutable processes occur, before complete prose is extruded. For trained writers this creative process is a systematic one, but such systems are often difficult to articulate and communicate to engineers and scientists for encoding into algorithmic processes. In many cases, the process of make-believe that an author goes through *cannot* be articulated or operationalized. This does not mean, however, that the authoring process defies systematic explication; it simply means that there is work to be done to attempt to bring both the engineer's and the author's perspectives into dialogue with each other in order to better understand how to write content for interactive narrative experiences.

In this paper we describe the authoring process for a prototype tangible interactive narrative system called the Reading Glove. We begin by discussing different approaches to authoring that are currently in use in interactive digital storytelling. We then discuss the process of writing the fiction for the Reading Glove in some detail and provide a close analysis of the fiction created through this process. We describe a design methodology structured around the idea of "cognitive hyperlinks" that can be applied to a variety of interactive narrative forms.

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2. INTERACTIVE NARRATIVE
There are two significant and parallel directions within the interactive narrative research community. The first direction contends with questions of computationally structuring interactive narratives. This perspective grapples with issues of automatic plot generation [16, 31], the optimization of reader paths through story trees [17, 19], the direction of the behaviors of autonomous narrative agents [2, 5], and the creation of intelligent drama management systems [20, 27]. The second direction asks questions about the conceptual nature of narrative as a phenomenon, and its relationship to interaction. This perspective investigates non-digitally mediated interactive narrative situations, such as improvisational theater [22, 26, 28], and tabletop role-playing games [32] while also asking questions about how narrative emerges in the mind of a reader [1, 9, 30], and developing systems for authoring content for interactive story experiences [14, 23]. These two directions are by no means isolated from each other, with techniques and theories from each necessarily supporting the work of the other. One of the issues uniting both of these areas of research is the question of how to structure and author interactive narratives.

2.1 Authoring Interactive Stories
2.1.1 Hypertext Origins
One of the earliest models of interactive narrative is the branching "choose your own adventure" structure, which matured into a new form of literature with the advent of hypertext fiction. In its most elemental form, hypertext consists of a system of narrative fragments, often referred to as "lexia", interconnected by "hyperlinks", which were navigated to form linear routes through much larger narrative spaces. Theorists and aficionados of hypertext positioned it as the next significant literary movement: one uniquely suited to the computational medium [3]. However, critics of the branching structure observed that in order to deliver a satisfying sequence of meaningful branching options, the authoring process would of necessity grow exponentially more difficult and complex with each new level of the branching tree [7]. Other critics called out hypertext for not truly utilizing the dynamic and emergent properties of digital platforms, calling it a "stillborn" medium [33]. Hypertext grapples with the issue of the

"authoring bottleneck": a situation where the exponential demand for more story content quickly exceeds the capabilities of a single human author. Mateas and Stern refer to this as a "combinatorial explosion" [14].

2.1.2 Creating Content

Within the interactive digital storytelling (IDS) community a number of other avenues have been explored, intended to reduce or eliminate the need for such Herculean feats of authorship, while retaining the quality of hand-crafted human narratives. Much of this work has grown out of early explorations within the artificial intelligence and computational linguistics communities. Roger Schank's group at Yale was instrumental in early investigations of computationally generated story content [21]. Various approaches to this task have attempted to model the creative processes of human authors [4, 31], to simulate worlds in which stories can occur [12, 16], and to reduce narrative sequences to formal algorithmic equations [10]. Many of these early experimentations opened the door to today's AI-driven narrative technologies. The emotional simulation-driven *FearNot!* system, for example, bypasses questions of authorship by attempting to realistically simulate the responses of children being bullied, relying on the human predilection to impose known narrative structures on situations [1, 18]. However, in many cases, even the most robust AI system requires a substantial amount of human authoring to succeed.

One approach to content creation for interactive narrative comes from Mateas and Stern, the creators of *Façade*, which is arguably the most successful interactive narrative to date. In order to help make their task manageable they developed a methodology for "procedural authorship" [14]. They frame the content creation for *Façade* in terms of a series of procedural social games, where the score reflects character affinity and attitude. To make the content computationally tractable, they authored at an extremely high level of granularity, specifying sentences, gestures, and facial expressions that could be hierarchically intermixed by the AI engine. The result was a body of extremely flexible and modular story content. Authoring at this level of granularity allowed them to generate coherent conversations between the player and the AI characters, but the effort involved in creating this content was extraordinary: they estimated that the process took them "two man-years" to create a 20 minute long experience [13].

2.1.3 Computationally Assisted Authoring

One of the reasons that interactive narratives are so difficult to develop content for is that there is a pervasive and often unspoken assumption that a good interactive story should be able to support and anticipate any possible direction the reader might want to take it in. This need to predict possible reader directions requires authoring effort far beyond that involved in the creation of a more traditional linear story. A recent new direction in authoring for interactive narratives is to augment a human author's capabilities with extensive computational database support. Database driven approaches to content creation allow authors to more exhaustively explore a potential narrative space, and to more easily anticipate meaningful directions in which the story might be taken at any given point. Swanson and Gordon describe one approach that searches through an extensive database of personal blog entries, looking for story content at the sentence level [25]. Using a "call-and-response" structure, the system uses sentences written by users as a heuristic for an NLP search to find appropriate follow-up sentences within the database. This system relies on the emergent qualities of narrative to give a sense of coherence to a set of otherwise semantically unrelated phrases. Sullivan et al. describe a system called QuestBrowser, which draws on a database of "common sense" associations between objects in order to suggest possible connections to authors of CRPG quest content [24].

In the case of both of these systems, the database is used to either suggest unexpected directions for the story to go in, or to support the creative – and predictive – process of the author. We propose a systematic process for authoring narrative databases, and introduce the notion of *cognitive hyperlinks* as a valuable tool for visualizing and authoring non-linear narratives.

3. Cognitive Hyperlinks

Cognitive hyperlinks are reoccurring themes, characters, locations, and other literary elements that help a reader to make sense of the structure of a story. Traditional linear narratives use recurring themes, characters, and locations to build a coherent and whole narrative picture. Because a linear narrative assumes that it will be read from beginning to end in an orderly fashion, these recurring elements are loosely played out over the course of the text, and are not necessary to comprehend the story's structure of cause and effect. In hypertext fiction, hyperlinks take the form of explicit navigational options for the reader to follow, building strong bridges between different lexia, and creating a specific, knowable, "path" through the text. In hypertext fiction, the author knows with some confidence where the reader just was, and where she is going next within the story.

In a non-linear narrative without these formal constraints, we argue that it is the role of the author to provide the reader with a much denser associative web in order to better help her situate herself within the story. To do this we propose that each lexia be understood as existing suspended within a dense intersection of *cognitive hyperlinks*: both *explicit* and *implicit* references to the ephemeral content of the story, and to the specific media objects that serve as anchors for that content.

Explicit hyperlinks resemble the hyperlinks in a piece of digital hypertext fiction, in that they provide a clear path through the story, by directly mentioning other media objects or lexia within the system.

Implicit hyperlinks are similar to the recurring themes in traditional linear literature, providing indirect pointers to other narrative content. For a non-linear narrative these must be much more densely packed, in order to accommodate a reader approaching the story from any point.

In the following section we describe our own authoring process for an interactive narrative system called the Reading Glove. Our process draws on notions from hypertext, emergent narrative, and database driven authoring.

4. THE READING GLOVE

The Reading Glove is a wearable RFID device which allows readers to "extract memories" from tagged physical artifacts, engaging them in an audio-based interactive narrative. As the interactor picks up and handles RFID tagged objects [**Error! Reference source not found.**], the glove's RFID reader communicates the tag information wirelessly to a laptop running MaxMSP. This triggers the playback of recorded story fragments

associated with the object being handled. For further details on the technical and interaction design elements of the glove, please see the forthcoming paper [29]. Our intention with the design of this system was to create an interactive story where the physical experience of the objects was integral to the construction of meaning in the mind of the reader.

Figure 1. Interacting with tagged objects using the Reading Glove

4.1 The Authoring Process

Our interest with this system was to explore the different imaginative and cognitive possibilities for interacting with a body of static narrative content written with an interactive reading approach in mind. This required a very different approach to the content authoring process than that which we would have taken in writing a traditional linear narrative. We contend that the iterative process modeled here provides the authors of interactive narratives with a set of useful design techniques for creating content intended to be accessed in a fragmentary and interactive form. We drew inspiration from games like Myst [8] where the player is placed in the role of investigator, decoding the traces of narrative left behind in the object-record of an environment to reveal the story contained within. We used the metaphor of "psychometry" or "object reading" to explain the reader's ability to reveal the memories of objects by handling them. In this section we attempt to demystify the creative process that underlay the creation of the narrative content.

4.1.1 Object Selection

To write a story that could be told with objects we needed to develop our own design methodology. We had several high-level design goals for the narrative. One of our central critiques of previous object-based narrative systems ([6, 11, 15]) is a broad tendency toward using generic objects with few intrinsic narrative associations of their own. To address this, we resolved to write a narrative that existed in both a textual form and within a specific collection of meaningful objects. We further determined that in order for this system to be successful, the objects would need to add to the narrative texture of the final story at a level that was uniquely object-specific. In other words, we set out to write a story that required the objects themselves in order for it to be complete; a story that could not be communicated purely through language. This type of writing involved an iterative process in which the text of the fiction was in constant dialogue with a set of related object components.

We chose to begin with the objects, in order to help ground the writing within what would ultimately be the medium of its communication. Over a period of several weeks we visited antique shops and thrift stores in search of inspirational objects. We had some rough criteria for object selection:

a) Objects should invite touch. This might mean pleasing material textures or complex objects that could not be apprehended without physical handling.

b) Objects should be mechanically interactive. We favored objects that moved, opened, and closed when possible.

c) Objects should fit together as a collection. We looked for objects with similar color schemes, and for objects that could conceivably come from the same place and time.

d) Objects should support a wide range of uses, associations, and imaginings. This was a largely subjective criterion, but we sought items that could conceivably tell an abundance of stories.

e) Objects should appear to have a history to them. We looked for older items with evidence of a lifetime of use.

Figure 2. The 12 narrative objects

After several weeks of collecting and assembling, we settled on a set of 12 objects [**Error! Reference source not found.**]. These included (top to bottom and left to right) an antique camera, an antique telegraph key, a pair of silver goblets, a top hat, a leather mask, a coffee grinder, antique goggles, a wrought metal rose, a glass vase on a metal stand, a ceramic bottle, an antique scale, and a bookend with a globe on it.

4.1.2 Creating a Narrative Database

The selection of objects served to productively constrain the narrative possibilities for the story to a manageable domain. Unlike a purely digital or textual narrative, where the available number of conceivable narrative states is functionally infinite, the tangible narrative space placed us in a situation where we could author within a large – but finite – set of narrative possibilities.

With this conceptual space bounded by the objects themselves, it became possible to exhaustively explore the narrative possibilies contained within, using a collaborative brainstorming process.

We each individually generated a list of all of the ways in which we imagined each object could be used in a story. We then combined our lists to form a long list of each object's possible narrative uses and associations. These combined lists formed a database of narrative possibilities, authored by humans, but serving a similar function to the commonsense databases used for QuestBrowser [24]. Our lists included specific functions of the objects, as well as more conceptual associations and symbolic implications of them. The mask, for instance, might be worn by a juggler, or a carnival character, or it might simply represent a hidden identity or disguise. Below is a selection of the associations we developed for the telegraph key object:

- Used to transmit messages
  - Secret codes
  - Birth/death announcements
  - End/beginning of war/military orders
  - Celebrity news (breaking of records, etc.)
  - Emergency signals from ships
  - Personal correspondence/conversation
  - Messages from beyond the grave/across time
- Selling of information
- Double crossing/double agents
- Frequencies – broadcasts and transmission lines
  - The ability to listen in and intercept
- Cryptography, ciphers and code breaking
- Resistance fighters – spreading info behind enemy lines

These lists provided us with a pool of raw material from which to construct narratives using this collection of objects. We refer to the entries on these lists as "story fragments".

4.1.3 Thematic Analysis

Our next step, after generating a narrative database for these objects in the form of the above lists, was to categorize the story fragments into loose thematic categories. This allowed us to parse the fragments by genre, rather than by object, which in turn gave us a better understanding of possible inter-object relationships. Our analysis of our narrative database revealed seven broad themes. We parsed the story fragments from our narrative database against these themes, as shown in Table 1.

Table 1. Narrative Themes

Theme	# of story fragments
Crime, noir, mystery, murder	**42**
Romance, love, society, affairs	**34**
War story/espionage	**47**
Ghost story/supernatural	**28**
Children's make believe	**24**
Adventure, travel, piracy	**46**
Science, alchemy, engineering	**55**

These themes are not formal genres, but they do help to delimit the types of stories which we could use these specific objects to tell. Given the object choices, and the criteria used for their selection, it was unsurprising to find that many of the themes were evocative of a historical and fantastic fictional world. Each phase of the authoring process was intended to gradually narrow the narrative domain to produce a coherent story. Selecting objects that fit together and evoked a similar feel was the first step; categorizing possible story fragments into themes provided a further winnowing of the narrative possibilities into a set of possible individual stories.

4.1.4 Paper Prototyping Plots

Our intention with these themes was to map out the narrative territory in which a number of stories could be told using the objects as points of commonality. Thus, this collection objects could represent an intersection of multiple narratives. One of our long-term interests in this research is to explore the cognitive processes of meaning making in readers who are given a tangle of overlapping narrative fragments, however for this initial version of the prototype we elected to author a single story using these objects. This allowed us to refine the authoring process, and to develop writing techniques that supported an exploratory and interactive approach to the content. This process could be repeated with the other thematic categories to produce multiple stories arising out of the same objects.

To create the first story we picked the "war story/espionage" theme, which we viewed as an interesting challenge. We needed to construct a sequence of events that could be told entirely through object associations. To do this, we printed out slips of paper with each narrative fragment in the chosen theme which we could fluidly arrange and reorganize. Spreading these slips out on a table, we were able to explore a number of different associated connections between different objects, which allowed us to construct a timeline of story moments connected to objects [**Figure 3**].

4.1.5 Writing the story

The paper prototyping process provided us with a skeleton for the sequence of events that we wanted to write about, but this framework was not yet a complete story. Knowing the events and objects that would comprise the narrative, we sat down and wrote out the background and setting for a central character and narrative situation around which this story would revolve. This part of the process was the most like writing traditional linear fiction, although the presence of the rigid material constraints provided by the objects and the story fragments made it feel a bit like an exercise in a fiction writing class. At the end of this process we had a skeletal sequence of events, and a world and set of characters which could be used to execute those events. All that remained was to develop the specific narrative content that best utilized these resources. To do this we needed to carefully compose a set of narrative lexia that communicated these narrative details, while also taking the semi-random nature of the player's access to story fragments into account.

For each object's occurrence in the plot, we wrote a short piece of narration centered on that object. These narrative "lexia", when strung together, form a single short story, told through objects. Of the twelve objects we started with, we ended up using ten of them. Four of these objects had only a single occurrence in the storyline, while six of them occurred twice, for a total of sixteen different narrative lexia. These were all written in a first person past tense narration, and were recorded as sixteen separate audio files. These varied in duration with the shortest running 17 seconds and the longest lasting 38 seconds. The entire narration was 7 minutes long. In order to help the reader isolate each

narrative lexia from the others, a distinctive chime was placed at the beginning of each sound file. This short story represented a single narrative puzzle to be solved but interacting with the selected objects.

Figure 3. Paper prototyping the espionage story

4.2 Analyzing the story

We wanted the story to make sense regardless of the order in which participants engaged the objects. We resolved to write a story about a spy who is betrayed by his own agency for political reasons and has to flee for his life. By structuring the plot as a puzzle which is being pieced together by the central character/narrator, we were able to reflect the fragmentary nature of the interaction within the form of the story.

4.2.1 A Web of Cognitive Hyperlinks

Figure 4 illustrates a high-level overview of the structural systems that we developed through the writing of the story to help support a non-linear reading process. This overview is not intended to be read in detail, but instead to illustrate the system of *implicit* and *explicit cognitive hyperlinks* built into the text. The straight black arrows represent direct mentions of other physical objects that the reader can interact with (explicit hyperlinks) while the curved colored lines represent the recurring thematic connections that run through the story (implicit hyperlinks). As an authoring tool, we found that consciously visualizing this web of connections [see Figure 4 below] allowed us to anticipate possible reader confusion, and to predict certain reading patterns and routes through the story. Thus, when a reader selects the camera, she learns about a roll of film which was hidden inside a coffee grinder. When she selects the coffee grinder she learns about a rose which was used as a signal. In this way, the story provides clues about how to piece itself together, via explicit cognitive hyperlinks. Each lexia also includes a direct reference to its associated object [Figure 4].

Some objects also have multiple lexia associated with them, which are triggered at random when the participant interacts with them. These "intra-object" associations are designed to help support the reader's understanding of the chronology of the story, by positioning themselves along the story's timeline. Because each object also has "inter-object" associations in the form of explicit hyperlinks to other objects, this type of temporal cuing provides the reader with hints about the larger chain of associated events. Thus, when a reader selects the top hat, he might hear about the character choosing the hat as part of a disguise at the beginning of the story, or he might hear about the character pulling the hat over his face to hide from his enemies at the end of the story. Each object was also connected to specific narrative themes running through the story, via implicit cognitive hyperlinks. The top hat always represents disguise of some form, both in its own lexia and in the lexia of other objects which make reference to the hat. The telegraph key represents the main character's only connection to his old life, while the goggles are associated with the story's main antagonist. By providing thematic associations to each object, we hoped to help give readers access to the underlying narrative structure while still allowing them room to make their own narrative meanings.

4.2.2 Initial user studies

We performed an informal user study, which took the form of an expert review of the system by inviting colleagues to explore the initial story implemented in the Reading Glove. Each participant was recorded interacting with the system, and then briefly interviewed with questions intended to ascertain the extent to which they were able to make sense of the story. Seven participants from the graduate student population used the Reading Glove to "read" the story, taking between 11 and 13 minutes each (with one exception) to complete their experience. Due to the size and informality of the study we hesitate to draw generalizable conclusions, however a few encouraging interaction trends were observable that we believe constitute anecdotal evidence that the narrative was working as designed.

Table 2 lists each participant alongside the number of objects selected and interacted with, the number of lexia experienced, the total time spent reading, and our subjective assessment of the participant's overall comprehension of the story. This last column is by no means a formal quantitative measure. Instead, it is derived from the participant's self assessment of reading comprehension – as indicated by statements like "I didn't feel like I had a good grasp of what was going on," and "I think I understand the whole story now", and from our own assessment of the participant's ability to recount specific story details, such as characters, locations, and order of events.

Due to the semi-random nature of the system none of the participants experienced every one of the lexia. Unsurprisingly, there appeared to be a direct correlation between the number of lexia heard by a participant, and that participant's ability to recount the story afterwards. More surprising, however, was the ability of some participants to substitute accurate guesses for lexia that they had missed in their exploration. In one case, Participant 2 missed a significant step in the story during his reading, but

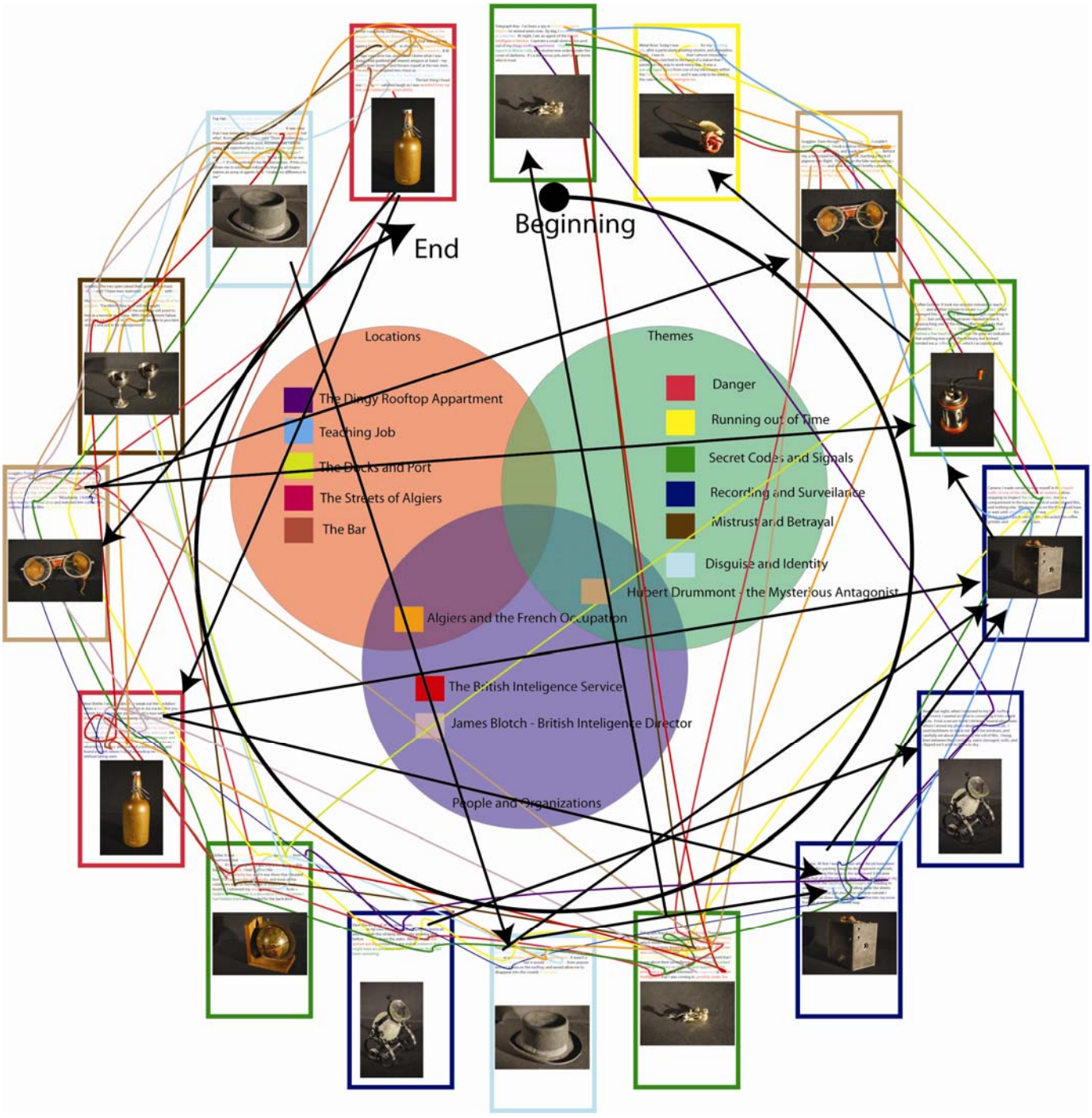

Figure 4. The espionage story, diagrammed

when asked to reconstruct the events, was able to accurately bridge the narrative gap in his description. In another case, Participant 7 stopped to think carefully about his story understanding before systematically triggering objects until he had uncovered what he considered to be the critical missing lexia. The semi-random aspect of the lexia selection was intended to encourage exploration; however, it introduced a degree of variability into the system that prevented some participants from being able to make sense of the story. In the case of Participants 4 and 6, we observed a particular approach to the reading of the system. Each of them systematically selected each object once, and then declared that they were finished. Participant 6 was encouraged to continue exploring, but due to poor luck uncovered only 1 new audio file. Consequentially, their story comprehension was very poor. In contrast, the other participants approached the system like a game or a puzzle that needed to be

solved. Their interactions were characterized by more object activations, and by a more analytical approach to the experience, often interrupting the playback of lexia they had encountered one or more times, in order to search for new content.

Table 2. Reading Comprehension Patterns

User	# of Actions	# of Lexia Heard	Time Spent Reading	Story Comprehension
1	31	15	12:26	Excellent
2	18	13	10:46	Excellent
3	15	10	12:12	Moderate
4	10	10	7:03	Poor
5	20	14	12:58	Excellent
6	19	11	11:59	Poor
7	26	14	12:53	Excellent

In a few cases, the inter-object references appeared to be predictive of the navigational choices made by the users, but the occurrence of this pattern was too rare to be accounted for by anything other than chance. Most of the participants commented that they enjoyed the way in which the story fit together like a puzzle, and many of them commented on the ways in which the objects served as external referents for the story content. One participant remarked that "it was interesting how I could tie specific memories to specific objects." Another participant said "I really like the fact that in addition to the audio you have these, sort-of touchstones, so like you can go back and listen to that part of the story, you have like…a visual. Just like in real life if you're remembering something, like if you're looking around your room and you see…'I remember getting that statue at GenCon' or something. So having that visual touchstone as a memory holder I think is a cool thing." The ability of this small group of readers to in large part make sense of the story suggests that our basic authorial assumptions were sound but that more work needs to be done in teasing out the best way to maximize both exploration and coherence. As with other forms of media, one component of understanding the story involves having a certain level of literacy in and comfort with the medium of communication. Participants who were more willing to play around with the interactive elements achieved greater narrative comprehension. This suggests that one path to enhancing story understanding is to investigate ways of teaching people how to "read" these kinds of stories and understand this novel medium.

5. CONCLUSIONS AND FUTURE WORK

In this paper we have described the authoring process for a new tangible interactive narrative system called the Reading Glove. This system is still in the early stages of its development, and currently only has a single story implemented within it. Although early in its development, the Reading Glove has provided us with a valuable tool with which to test and develop techniques for authoring non-linear and interactive stories. We used the authoring process of the Reading Glove as a case study of how to create content for interactive narratives. We described a number of specific compositional techniques that we employed in order to devise a story that was uniquely suited to the interactive context in which it was situated, including narrative association generation, thematic analysis, and paper prototyping. We have presented an iterative authoring process intended to generate a database of narrative possibilities from which specific stories may be composed. We have also discussed the notion of "cognitive hyperlinks", which help to move a reader through the story regardless of which point she approaches it from.

5.1 Design Recommendations

If we look at this process more generally, we can derive five high-level recommendations from the approach which we believe have utility for authoring any interactive narrative piece.

Constrain the narrative domain early. This helps to avoid the authoring bottleneck by limiting the directions in which the story can go. We did this by using physical artifacts to structure and delimit our narrative space.

Explore the domain as fully as possible before committing to specific narrative content. This might take the form of a conceptual associative database, ontology, or some other system of knowledge representation. We chose to do this using a brainstorming process, but it might also be accomplished using computational databases, an increasingly popular technique.

Use analytical techniques to identify patterns in your narrative data. We used a coding process that is similar to that used in Grounded Theory. This allowed us to observe important patterns in the data we had generated, making authoring easier.

Use paper prototyping to make the narrative tractable. By printing our story fragments on color-coded scraps of paper, we were able to create external structures and relationships that were otherwise difficult to visualize and track.

Embrace non-linearity via cognitive hyperlinks. Although our story is ostensibly a linear narrative, it is designed to be read in a non-linear and fragmentary fashion. This is due to a dense web of self-referential links that operate at a number of levels, including narrative themes, character associations, locations, and specific components of the interface and medium itself.

While these recommendations grow directly out of the process of authoring for the Reading Glove, we believe that they have utility for a wide range of interactive narrative systems, and particularly non-linear storytelling systems.

5.2 Future Work

The next step for the Reading Glove project is to conduct a broader set of user studies investigating the role of tangibility in narrative coherence, as well as exploring the user experience of the wearable technology. In particular, we want to investigate how using non-tangible representations of the objects, such as tagged photographs, changes the experience of the story. Results from these studies will be used to produce a second iteration of the prototype, which we hope to expand to include multiple overlapping stories as well as video projection to augment the audio narration. Longer term plans also include a larger installation version of the project that incorporates environmental and spatial characteristics explicitly into the story. We also intend to investigate whether or not a reader can untangle multiple overlapping object narratives, which will allow us to further explore our narrative database. We think that tangible, wearable, and embedded technology holds a great deal of promise for creating engaging interactive narratives as well as interesting research directions. This initial exploration of the authoring

process for tangible stories is just the first step in a series of investigations on narrative and interaction.

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