Handy Transparency: Unobtrusive Interfaces for Distributed Object-Based Tangible Interactions

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Problem Statement

Every object tells a story. We take for granted the ways in which collections of everyday objects in our lives become narrative bearing structures, representing information about who we are, where we have been, and what we like. This research investigates techniques for using computationally enhanced objects to tell interactive stories.

There have been several attempts to merge research in interactive narrative with research in tangible interactions. One popular approach has been to distribute narrative "lexia" – modular fragments of a larger story or stories – across a series of tangible devices. Holmquist et al. describe an object-based tangible storytelling system in which readers use a barcode scanner to retrieve video clips in a narrative puzzle (Holmquist, Helander, & Dixon, 2000). Mazalek et al. created a tangible narrative system called *genieBottles,* in which readers open glass bottles to "release" trapped storytellers (genies) which reveal fragments of narrative information (Mazalek, Wood, & Ishii, 2001). Madej designed a tangible narrative system in which children created animated digital stories using RFID tagged blocks on a physical game board (Madej, 2007).   In each of these examples, the link between the narrative lexia and the tangible objects is functional first, aesthetic second, and semantic a distant third. In other words, the objects in each of these systems function primarily as physical buttons, activating narrative information that is often only loosely connected to the objects themselves.

The problem with these prototypes is that their mapping of tangible object to systemic outcome generally tends to emphasize the function of the object, rather than the *meaning* of the object. I contend that one of the unique affordances of an object-based tangible narrative is the ability to emphasize each object as a site for *embodied narrative meaning*. In each of the examples above, the objects are *gateways* to meaning, rather than *loci* of meaning. This is in part due to the limitations of the technology employed in their creation and in part due to a failure to frame the interactions with the objects in a way that emphasized their physicality.   In this study I propose a new approach to tangible object-based narratives that more closely couples the meaning of the object with the meaning of the story. Stories told through objects have the potential to engage senses not ordinarily invoked in traditional storytelling experiences. Touch, taste, and smell are currently underutilized for the telling of stories and their potential as additional channels for narrative information remain unexplored.

Domain

My interest is in creating new knowledge about a specific form of tangible storytelling, and about the cognitive processes surrounding interaction with narrative objects in general. This project is a form of

what Fallman calls *design-oriented research* (Fallman, 2003). Fallman argues that HCI as a field is design-oriented, suggesting that the act of "making" is central to knowledge creation (Fallman, 2003). For this research, my emphasis is less on the engineering aspects of the tangible device, and more on the interactional benefits of different degrees of tangibility. At a conceptual level this is driven by Bolter and Grusin's theories of mediation from the humanities and Heidegger's conception of *equipment*, as described by Dourish for the HCI community and Winograd and Flores for the AI community (Bolter & Grusin, 1999; Dourish, 2001; Winograd & Flores, 1986).   This situates my work at the intersection of new media theory and embodied interaction.

What Drives Design

I am, as always, primarily interested in the conceptual side of tangible research. The intent of this conceptually driven approach is to explore ideas with far reaching implications for TUI design, rather than engineering a solution to a single defined problem. I theorize interactive tangible objects exist in a perpetual state of oscillation between Heidegger's notions of *ready-to-hand* and *present-at-hand* (as interpreted by (Dourish, 2001) and (Winograd & Flores, 1986)). Dourish interprets the notion of present-at-hand to refer to situations in which tools "break down", suddenly becoming the focus of our attention. He contrasts this against the notion of ready-to-hand, wherein tools disappear from our perceptions and serve as invisible extensions of ourselves.

 I argue that it is possible to interpret Heidegger's concept of present-at-hand as being a precondition for an awareness of a tool as a meaning bearing object. I contend that the notion of present-at-hand shouldn't be reserved solely for when a tool breaks down, but for any situation in which an awareness of the tool as a *meaningful thing* occurs. Thus, I can use a hammer to drive nails without thinking about it and it will remain invisibly ready-to-hand. However what if I become aware of the wear of the hammer's grip, which in turn puts me in mind of my father, to whom the hammer once belonged? What if this calls my attention to a place where he carved his initials in the handle? The hammer has not broken down as a functional tool, but is no longer an invisible extension of my hand. It has shifted into a state of being present-at-hand, due to a web of associative entanglements in which it exists, rather than to a breakdown of functionality. These entanglements are unique to this particular tool: a different hammer would not evoke the same reaction. In this case the hammer is not just a stand-in for any hammer, but instead a specific hammer with a specific story to tell. In this case, I would suggest that one of the roles of breakdown is as a possible gateway into a present-at-hand awareness that extends beyond the moment of breakdown. The roughness of the hammer grip wearing against the palm is sufficient to interrupt the flow of the work, but once that interruption occurs, the mind is free to explore a range of awareness and association surrounding the tool.

In TUI research, one of the canonical properties of a tangible is a meaningful coupling of physical and digital representations (Ullmer & Ishii, 2001). In this case, the notions of ready-to-hand and present-at-hand become even more confused, as the operation of the tangible object as an interface device often involves attention being paid to the object. I argue that tangibles exist in a super-positioned state between these two awarenesses. When the tangible is present-at-hand, it exists in the mind of the

reader as a meaningful physical representation; however, as an interface device it remains ready-to-hand as a functional physical stand-in for its associated digital representations.

To put this in a different context, I think that it is possible to productively map Heidegger's notions onto Bolter and Grusin's concepts of *transparent immediacy* and *hypermediation* (Bolter & Grusin, 1999). In their writing, interactions with mediated experiences exist in a state of immediacy, unless something happens to jolt the viewer into an awareness of the mediated nature of the experience, which they term hypermediation. I think that it is possible, through tangible interactions, to collapse these two states into a single space, in which attention to the medium of interaction – the object – feeds back into attention to the message – the narrative.

Research Question:

Can a glove based interface help create a stronger semantic relationship between a tangible object and an associated audio story than a stationary scanning "pad"?

Definitions and explanations:

Most of the concepts employed by this definition are fairly self-explanatory. The most tricky notion is that of "strong coupling", which bears some additional explanation. The goal of this research is to converge the interactor's cognitive experience of the narrative with her bodily experience of the narrative, via narratively salient interactive objects. I describe this convergence as "strong coupling", which is congruent with the definitions of TUIs that we are working with in this class.
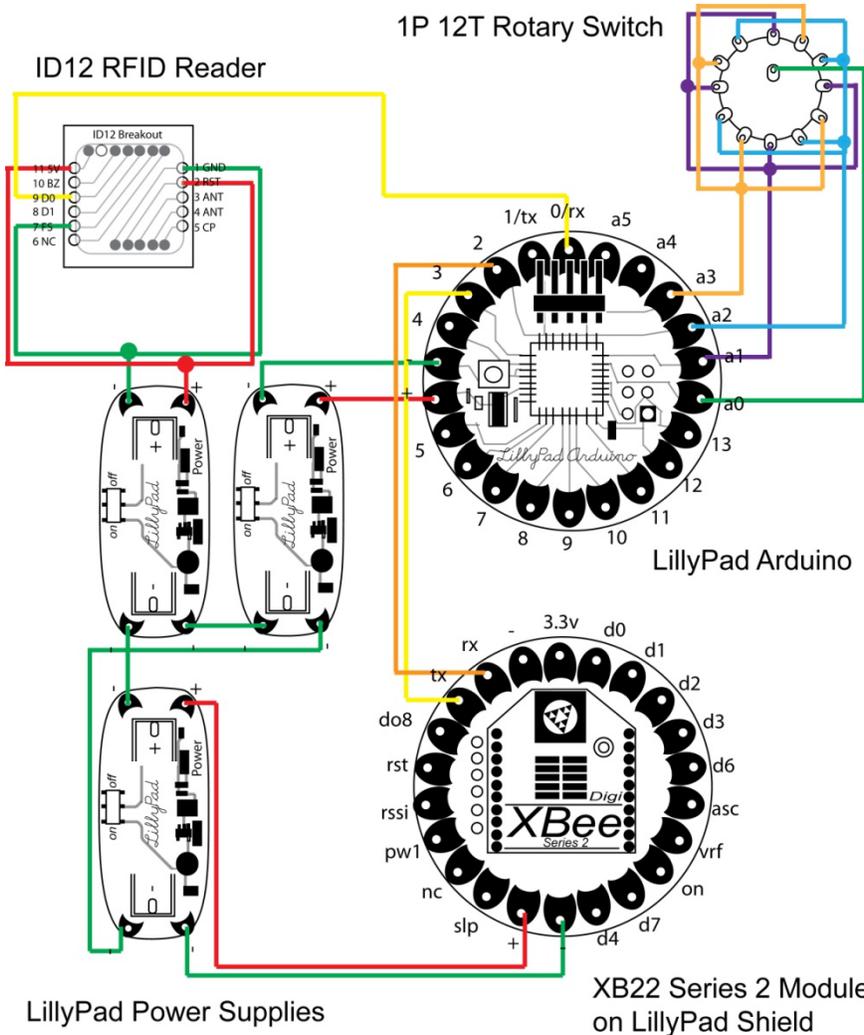
Figure 1 – Proposed Circuit Diagram for RFID Glove

Nature of Prototype

The study I propose will investigate an interaction technique that will very

literally emphasize the *present-at-hand* nature of the tangible interactions, by removing much of the cumbersome apparatus found in earlier prototypes (the barcode scanner from (Holmquist et al., 2000) being the most egregious example).   My prototype system will embed a very small RFID reader in the palm of a glove, which will communicate with a server via an XBee wireless radio. An interactor thus equipped will be able to scan RFID tagged objects [Figure 1] [i] by turning them over in her hands. When scanned, objects will reveal story information in the form of audio files that will be played back in the environment. It is my hope that this interaction will permit more of the interactor's attention to be focused on the objects themselves, rather than on the act of selection implicit within previous prototypes.

For the sake of comparison, I also intend to implement a version of this prototype in which interactors wave tagged objects over an RFID scanner to reveal the associated story components. In each version of this experiment, the narrative artifact will remain the same: a collection of story fragments, each one associated with a different object, which will be read aloud over a pair of speakers when activated.

Central to this prototype is the choice of objects themselves, and their salience to the associated narrative [Figure 2]. To aid in keeping the objects and stories conceptually coupled, the objects have been assembled and used as the basis for a series of brainstorming and writing exercises, intended to develop a story that is firmly grounded in each object as a narrative artifact. This activity took place over the summer, and generated a rich collection of object-story associations which will inform the authoring process for this stage of the research.

Figure 2 – Some of the Narrative Objects

Due to the relatively discrete nature of the RFID tags, it will be possible to tag each object in such a way as to leave it aesthetically intact. The limited range of the RFID activation will mean that participants will need to handle and examine each object in order to activate the story event. I see this as having both positive and negative implications.   On the one hand, requiring the interactor to explore the object more thoroughly will hopefully reinforce her experience of each object. On the other hand, if the interaction does not occur quickly enough, the interactor may assume that the object is broken, and discard it.

Validation Approach

Given the conceptual nature of this research, validation will involve a somewhat qualitative approach to the interaction. I intend to run two studies in parallel, with two different sets of participants. The goal will be to measure the extent to which they successfully map narrative lexia to specific objects.

As I develop the prototype there are a few areas where I will need to take care in order to obtain valid results. One area of concern is in the initial mapping of narrative associations to specific objects. If the relationship between the object and the story is unclear, or tenuous, then the coupling of object to response will also be unclear. One way to avoid this is to elicit narrative associations for each object from a number of different people, during the design phase, in order to guide the design towards stories that most effectively incorporate the objects into them. Another strategy would be to incorporate detailed description of the object into the story text (although this feels a bit like cheating).

The second area of concern has to do with the affordances of the glove. If the glove is too large or too small, or too bulky, or too rigid, it will interfere with the natural grasping and manipulation of the objects, thus interfering with the desired interaction. From a design standpoint, the best solution is to build the hardware in such a way as to be mountable on a number of different gloves, in order to determine which one interferes the least with the hands-on interactions. Trial and error, combined with informal user studies amongst participants with differently sized hands will probably be sufficient to deal with this concern.

A closely related concern is the range of the RFID reader, and the placement of the RFID tags. I will need to figure out a place to hide the tag on each object, in a way that does not interfere with the reader's ability to recognize it. I expect that there will be a tension between hiding the tag, and making it readable. Again, trial and error are going to be essential to this design process.

 As with any study exploring cognitive and experiential phenomena, the biggest challenge lies in trying to accurately measure or observe something that takes place inside the mind of another person. For this research, I will be relying on a combination of informal interviews, and assisted recall, using a combination of the objects, and the associated audio clips to elicit information from the participants about their embodied awareness of the objects as part of the story. Rather than seeking to statistically prove that the glove-based interaction better foregrounds the objects in the mind of the interactor I will be performing an analysis of the interactor responses in order to better characterize the types of interactions afforded by each condition.

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[i] NOTE: I created this diagram over the summer. There are some serious flaws in the design, which I need to address in this course. One obvious change that I wish to make is to replace the analog rotary switch with a digital rotary encoder. I also need to solve some serious grounding issues that are currently frying my components, possibly through the inclusion of diodes in a protection circuit.