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Once Upon an Object... Computationally-Augmented Toys for Storytelling

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ABSTRACT

We are developing design principles applying tangible interfaces to storytelling. This paper describes an underlying philosophy and three resultant designs for computer-mediated toys, exploring how the merging of physical objects with computer technology can enhance children's storytelling. Each prototype aims to develop a specific set of both oral and written storytelling skills, as well as collaboration, sharing, and the notion of revision. By creating narratives, children learn about culture and identity, and develop a sense of self. In addition, narrative can be used as a gateway to draw girls into technology. The use of multi-sensory interfaces allows for richer interaction.

Keywords

storytelling, children, computer-mediated toys, identity, education, gender, tangible interfaces.

Motivation

Storytelling plays an essential role in children's exploration of self, by affecting three aspects of development: 1) cognitive, 2) emotional, and 3) social. 1) Cognitively, we perceive the world in a narrative manner [3]. People organize their world and make sense of their lives by creating coherent narratives which change according to context. 2) The construction of narratives is emotionally empowering. Converting an idea into a story, and then sharing it, builds self-esteem. 3) Storytelling is an intuitive form of social interaction specifically geared towards sharing and relationship-building. Teller and listener can be temporally together, engaged in collaboration with feedback loop. Or a storyteller may construct a story alone, and later share it with others. In addition to these three developmental aspects, storytelling is a form of play particularly appealing to girls [10] It can, therefore, serve to draw them into technology. Lastly, stories give meaning to objects; objects give stories tangibility. We place meaning into the everyday objects which surround us, using them as place-holders for our personal narratives. These objects, therefore, become external anchors to who we are and how others see us.

Background

We organize our theoretical framework in four domains: 1) role of identity, history, memories, and culture, 2) storytelling and narrative, 3) gender issues in toys and game design, and 4) integration of physical and digital worlds.

1. Identity through Objects and Stories

We surround ourselves with objects to aid in the establishment, expression, and maintenance of self-identity. Gonzalez [8] defines this grouping of objects as an *autotopography*, "a spatial representation of identity." Objects are a physical embodiment of aspects of the self, providing external proof and support of identity. Such objects anchor the individual's constantly changing sense of self, by serving as place-holders to their personal narratives. In this sense, they serve as archivists of the individual.

The stories the objects hold are fundamental constituents of our memory. A story is composed of memories, experiences, knowledge and/or reflections [24]. It gives life to past experiences by making the events in memory significant to others and to ourselves. To become masters of our own experiences, we must be able to narrate them. At the individual level, we weave a narration of our own lives to construe our role in the world. At the cultural level, narrative gives cohesion to shared beliefs and transmits values.

2. Education & Storytelling

Polkinghorne [20] describes narrative as "a scheme by means of which human beings give meaning to their experience of temporality and personal actions." Stories are considered by teachers and educational researchers as one

of the most effective teaching methods [18]. Children enter school accomplished storytellers and fantasy players, yet their talents for imagery and illusion are under-utilized [9]. Narratives are a valuable transformation tool for education. Story production develops content knowledge, structural knowledge of types of narratives [11], and context awareness by reflecting variations in the narrator-listener relationship. Traditionally, storytelling belonged to the oral tradition. By using computational-augmented objects to tell stories [28, 7, 14], to the oral and written modes, another dimension can be added: space.

3. Gender issues in toy and game design

A child's initial introduction to digital technology is through computers or video games. Those who enjoy the games become familiar and comfortable with computers and are more likely to pursue related interests. The games, designed mostly by men, tend to appeal primarily to male play styles. "Toys are the visible tools of early socialization, preparing children for adult roles" [16]. In 1989, 93.5% of computer science and engineering faculty was male, with one third of the departments having no female faculty at all [4].

The gender-technology relationship is a negotiation. Gender itself is not an issue, but rather "the process of identification having as background the common social humanity of women and men."[14]. Turkle [26] argues that women have "computer reticence," a "wanting to stay away because the computer becomes a personal and cultural symbol of what a women is not." By encouraging personal appropriation of technology, computers can be seen as a gender-neutral expressive medium. A variety of studies have agreed on certain elements in gender-correlated play styles [see Fig. 1]. There is a noticeable lack of female play strategies in computer games, which may explain girls' negative reactions towards them. Our projects use design alternatives which take advantage of how girls naturally play.

Collaboration vs. competition	Friendship placed above winning. Prefer collaborative games, relationship development.
Creation	Prefer creation, pretend play: empowering activities.
Meta-level of play	Structuring the task or game, *and* acting/playing it out.
Relevant to real world	Purposeful, real-life skill development. Problem-solving, analytical skill development.
Narratives	Characters, story lines preferred to speed, fast action.

Figure 1: Female Play Strategies [10, 16, 13, 5, 19]

4. Merging of the physical and digital worlds in interface design

Although the mouse and keyboard metaphor dominates human-computer interface (HCI) design, there is a trend towards ubiquitous computing and augmented reality [12, 27]. The design challenge is to create a seamless merging of these two worlds, marrying the advantages of the digital world (networking, ease of abstraction) and the advantages of the physical world (legibility of interface, multi-sensory interaction.). We are looking specifically at the effect of such integrated interfaces with regard to children, gender differences, storytelling, and toys and games, by building upon the design concept of "tangible media" [12], and furthering the applications of computer-augmented toys [25].

Barthes [1] writes that the child "creates forms which walk, which roll, he creates life not property: objects now act by themselves, they are no longer an inert and complicated material in the palm of his hand." In the early 70s he was talking about simple inanimate toys. In the 90s, how can we use the computer to leverage the physical characteristics of these objects without constraining the child's natural tendency to "create life"?

Three Design Prototypes

This section describes three implementations of storytelling systems: Family Blocks, Rosebud and Show & Tell.

Family Blocks

The Family Blocks prototype was designed by Umaschi. The main goal of this game-like application is to use storytelling and computationally-augmented toys to help kids learn about their family stories and narrative structure. This prototype is conceived to support activities that enable collection and categorization of family stories as well as creation of fantasy stories based on family stories.

Scenario

There is a family with many stories to tell and a 12 year old girl, Pam, who loves to listen to those stories. She wants to know about the people she sees everyday, and about those who she has never met. She wants pictures, maps, music and everything that helps her understand what it means to have "roots". Pam records her family

stories and collects her favorite pictures. Then she builds a house using her Lego sets and digitally attaches the pictures and stories to her Lego characters. Pam behaves as a play writer by creating a fantasy story that involves all her Lego characters and her family stories. Later, Pam invites her friends to play with her Family Blocks and listen to her favorite stories.

Implementation

This prototype was implemented using the resistor-based technology developed by Borovoy [2]. Each Lego object has a unique value which is read by the Handy Board[8]. This microcontroller talks via the serial port with a multimedia storytelling application specially designed with Macromedia Director to allow story planning. This application allows creation of stories by using a library of situation words like "who," "where," "when,"" how," and "what," key elements for building story events. It also has a library of connective words like "so," "then," and "because," employed by children to weave their sentences into a coherent story. Children plan the story in the computer and attach stories and images to the computationally-augmented toys. Afterwards, they can play by placing characters in the Lego house and observing what family stories are triggered in the different situations that they themselves have set up.

Family Blocks is an example of how the digital world and the physical world of toys can be integrated by providing different activity frameworks for storytelling. The computer is used by the children to pre-plan and construct the fantasy story that will later be played back with the Lego objects. That fantasy story is composed by different family stories that are triggered when characters are placed in certain rooms. For example, when the grandmother is placed in the kitchen facing the oven, a recipe is played back. This example highlights the importance of adding a spatial dimension to storytelling.

Rosebud

This project has two components: the physical toys and the computer which will interact with the child and the toys. We are currently prototyping Rosebud with two types of toys: stuffed animals and Lego building blocks. In both cases, the child manipulates and interacts with the toys and the computer responds, encouraging and recording the stories the child tells.

Scenario

Maria, an eight year old girl, picks up a stuffed animal and the computer asks, with text on the screen and computer speech, "Maria, what's your toy's name?" Maria types in "Harry." The computer asks her about Harry: what's he up to that day, what other toys does he know? Maria begins to share with the computer her stories about Harry. She then picks up Francis, a large stuffed animal cat, and tells stories about him as well. The computer remembers the toys' names and keeps the stories, both audio and textual, in a constantly growing database. Later, when Maria shows her friends Harry, the computer plays back the toy's stories.

Maria and her brother Alex are building with Legos. Alex is building a huge rocket. Maria is building a city. As she builds, she tells stories about the places and the people who live there. Her animated descriptions are linked with the Lego pieces and the stories are told back by moving the Lego structures or figurines. For example, if Prince John goes to the stables, the computer plays Maria's story about the prince going on a quest. Another story-building possibility is to build a tower or building where every Lego is a piece of the story. As a child takes apart or rebuilds the structure, they hear each of the pieces. On the screen appear the written stories, which Maria edits with the computer's encouragement.

Implementation

The Rosebud prototype was designed and is being implemented by Glos. The stuffed animal has within it an IR chip, designed by Poor [21], which transmits an identity signal the computer reads when the child picks it up and holds it in front of the computer. The computer can then link the audio and text stories to that particular ID tag, so that a particular stuffed animal activates its own stories. An old teddy bear, handed down, might hold stories written by older siblings or their grandmother when she was young, giving the child a sense of family, history, continuity.

The Legos, each with a resistor inside it, are placed on a base plate, designed by Martin and Borovoy [17], which scans the rows and columns looking for resistances. By placing Legos on the base plate, they become interactive. The base plate identifies the Legos by their resistances and, as the child builds upwards, continually adds up the resistances in order to identity growing structures. This information is transmitted to the computer and, in a manner similar to the stuffed animals, the computer can link various stories to particular Lego structures. The Lego figures also have unique resistances, so that when a Lego person is moved next to a structure, it also triggers a story

fragment. The base plate serves as a story creation space, where the child can physically design stories of any type and design the form of interaction as well. With Rosebud, rather than building only cars and spaceships, children can build stories.

Children's oral storytelling with their toys is a spontaneous form of storytelling, yet these stories are usually soon forgotten. With Rosebud, these transient stories can be preserved. Rosebud allows this natural form of storytelling to bootstrap children into a more formal type of story writing. The oral storytelling becomes the seed for a rich interaction, where the child learns about writing and editing, and is empowered by the act of creation and sharing the story. The stories are preserved, becoming a rich source of history and memories [7], archiving the child's development.

Show & Tell

This design is a physical instantiation of the old-fashioned round-robin story game in which kids collaboratively build a story by adding sentences. Show & Tell was implemented as a Wizard of Oz experiment by Umaschi.

Scenario

A group of kids and a computer are sitting in a circle around a table. In the center, there is a Lego house with a big Lego clock and a microphone. The Lego clock signals, with a beep, the kid's turn to pass the mike to someone else to continue the story. The computer starts the game: *"Last week, when the Benzons came back from vacations they found..."* Suddenly a Lego object, a dog, barks. The first kid grabs the mike and continues the story: *"...they found a dog that was ....lost and the daughter ... found it and loved him and named him ..."* The alarm beeps. Next kid continues: *"Collie, yeah, she named the dog ..."* The computer jumps in *"and so, grandma entered the room..."*

While the narrator is telling the story, the other players are moving the Lego characters and objects and putting them in different places in the house. While they do so, different noises (steps, closing doors, etc.) or extremely short story triggering ("And so...," "Guess what?," etc.) may appear. The narrator has to incorporate in his/her story the actions that are happening in the Lego house. The children and the computer are creating a collective story that can be played back afterwards. Some kids add their own noises or story triggers to the games, and Later, when their friends come over to play, they find a different storytelling game.

Description

This prototype has not been fully implemented. The Wizard of Oz version runs with the same hardware and software described in the Family Blocks prototype. However, the underlying storytelling conception is very different. Show & Tell is a game with rules and a goal --weave collaboratively a coherent story. The computer, a play-partner, has information about the toys placed in the game board. It can "jump in" at any time and surprise children by adding unexpected sentences to the story.

The computationally-augmented Lego objects help children to easily imagine different stories and situations. Children tell stories by either recording their voices and attaching them to certain Lego objects or by moving the toys in the game board and triggering sounds and stories already attached by the designer. By using a computationally augmented tangible game board located in a table in the center of a circle, everybody can participate and social interactions and cooperation are more likely to happen. Collective storytelling has already a long tradition in children's games. The challenge is to leverage those games by incorporating technology. Some computer storytelling games are looking to bridge geographical gaps by allowing collaborative real time story construction over the Web [20]. Show & Tell specifically looks to enhance, with computationally-augmented toys, collaborative storytelling of children who share the same physical space.

Conclusions

Computationally-augmented toys are a powerful way of introducing children, especially girls, to the world of technology and storytelling. Each of these three projects explores one application design. Family Blocks focuses on culture and family stories. Rosebud concentrates on object history and memory. Show & Tell centers on collaborative storytelling. The combined physical and digital interfaces benefits each application in a different way. Family Blocks allows children to build physical representations of their family stories. In Rosebud, the history of an object can be stored with the object itself. In Show & Tell, the physical pieces allows for a highly cooperative storytelling space.

Future Work

We are in the preliminary stages of user-testing the three prototypes described. We are examining how children interact with computationally-augmented toys by asking questions such as: How do the their interactions differ from those with traditional computer games and toys, and how different storytelling styles are elicited by the different media? What are the interaction differences between boys and girls? We are also developing more robust prototypes, aiming for greater multimedia integration, and adding computer understanding of story structure.

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