

Supporting Free Play in Ubiquitous Computer Games

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ABSTRACT

Children's imaginations allow them to experience creative and exciting play activities. These types of experiences fall under the category of free play, a type of play activity that is essential to children's development. Traditionally, computer supported cooperative play (CSCP) has been limited by the constraints of technology. The structured, static nature of computer interaction does not support children's free play behaviour. Researchers in the area of ubiquitous computing propose that interfaces should facilitate natural communication and support the way we interact in our natural environment. Although advances have been made in the domain of work, there is still very little technology that encourages free play behaviour. Our current project examines what the essential elements of free play are and how we can take a human-centered approach to support these elements. The current instantiation of the project is described along with our plans to extend the current work.

INTRODUCTION

When I was a child, we made up all sorts of exciting games; sometimes using only our imaginations and whatever was lying around in the backyard. An upside-down tricycle became a spinning wheel; a fire hydrant became a drive through window; and an old sheet became a superhero's costume. This type of play activity falls under the definition of free play, a specific type of play that is essential for children's development. As children's play habits mature, their play becomes more structured and more rules are developed. However, the need for free play does not change.

As children begin to use computers for play activity, their behaviour is limited and constrained by the structured nature and poor interfaces of today's desktop systems. Although work has been conducted to explore new interaction paradigms for children's computer play [5], there are few situations where a computer system encourages or supports free play. Although on-line games may fit the definition of free play, the interpersonal interaction available in playing multiplayer desktop or online games is not as rich as that which we experience in a face-to-face situation and does not provide the same experience as a co-located, dynamic game. Thus, on-line games may have all of the right components, but whether

the experience and benefits of free play are lost in the distributed communication, is yet to be qualified.

As a computer scientist, I would like to work to promote interaction not isolation, and design computer systems that renew social interactions. At this time, technology does not effectively support our complex, co-located, interpersonal interactions, especially in the domain of play. Our research goal is to create a play environment in which the computer acts as a mediator; where the focus is to facilitate interactions between people, not between people and technology. We feel that advances made in the area of ubiquitous computing can help nurture this goal. In short, we are developing a system that moves beyond the current impoverished interactions that people have with electronics (and with each other as supported by electronics) to support, utilize and inspire enjoyable and exciting interactions with each other and technology.

Ubiquitous Play

Weiser's vision of ubiquitous computing included the notion that technology should be designed to fit into our natural human environment [15]. Providing natural interfaces that facilitate rich interpersonal communication between humans has been proposed as an important research direction in ubiquitous computing [1]. In particular, interfaces should closely model the way humans interact with the physical world. We have seen this theory put into practice in the domain of work. New interaction metaphors for computing devices, including novel displays and input devices, are emerging to support the way we interact with physical media [1]. Much less work has been conducted in the domain of play.

The advances made in the research area of ubiquitous computing have strong implications for the idea of ubiquitous play. The use of context awareness, readily available computing resources, and ever-present connectivity can yield exciting advances in ubiquitous gaming and play. However, the approach we are taking is not technology driven. Rather, we have been investigating how people interact with physical media and how to best support these interactions in the digital domain. Still, it is our impression that ubiquitous play will be the key factor in providing computer-supported free play activity.

There are few groups that have been investigating the area of ubiquitous games. Pirates! [2], developed by researchers

at the PLAY and NOKIA research studios, integrates some of the social aspects of traditional game play into computer games. This is accomplished by bringing the computer game elements into the physical world. MIT Media Lab has been exploring the use of plush toys to control animated characters [11]. Zowie's Redbeard Pirates Quest™ and Ellie's Enchanted Garden™ allow children to move physical models representing characters to interact with a toy [18]. Finally, toys like the Cybiko [17] and Tamagotchi [19] are moving into the arena of ubiquitous games by allowing children to carry them at all times.

FREE PLAY

Play is very important for children's development. Children develop physically, mentally, and socially through free play activity [14]. Researchers agree that free play is characterized by five factors:

1. Voluntary- people can enter and leave at will
2. Spontaneous- play can be changed by the players
3. Involves pretend elements- play is different from everyday experience
4. Engaging- separated from the surrounding activity
5. Fun and Pleasurable- enjoyed by all of the players [3].

Free play is different from toys, games, and play. The characteristics that separate free play from games and the generic description of play have to do with the spontaneity and pretend elements of free play. For example both soccer and Live Action Role Playing Games (LARP) are play activities. However, soccer as a game does not involve pretend elements and is generally not spontaneous, thus not classified as free play like LARP games. The described characteristics of free play, especially pretend and spontaneity, provide many benefits for children. To illustrate the benefits of free play, we will address physical, cognitive and social development separately.

Physical Development

Children use free play to develop gross and fine motor skills [6]. Beyond motor skills, free play has a direct influence on the growth of brain cells and synapses. There is a need for them to run, skip, jump and engage in all sorts of other activities to develop their cortical mantle [7]. There is also increasing evidence from brain development research that when children play less there are serious consequences for cortical development [3].

Cognitive Development

Children's free play behavior contributes to their cognitive development as well. Development that is affected by free play includes language skills, symbolic thought, the abilities to focus and control behavior, and problem solving [3]. Vygotsky [14] believes that through free play, children are able to master their own behavior since play serves as a tool of the mind. He states that children's highest level of self-control occurs when playing and that

play creates a zone of development for the child. In this zone, children can play without risk of consequences, increasing their belief that they are competent and capable learners [3].

Social and Emotional Development

Play is essential to children's emotional development. Children use free play, before speech is used, to express joy and to deal with their fears and traumatic experiences [3]. Pretend play is especially important for developing feelings of power over the environment, emotional awareness and increased sensitivity to others [Singer and Singer, 1977 as cited in 3]. Through pretend play, young children develop emotional strength and stability while older children develop humour, spontaneity, and positive feelings about themselves [Piers and Landau, 1980 as cited in 3].

COMPUTER SUPPORTED COOPERATIVE PLAY

Play activity on the computer has not been supportive of the characteristics of free play. Although computer games may be engaging and fun, there are many guidelines and imposed rules that inhibit spontaneity. Computer programs traditionally require structured interaction, especially when playing in a face-to-face environment. Emergent interaction techniques have presented solutions to some of the inhibiting factors, but there is still a lot of research to be done before we can claim to have created seamless support for co-located multi-player computer games.

Collaborative and Co-located Play

Significant work has been invested into on-line, distributed, multi-player games. These types of games are very popular and provide many of the characteristics of free play. However, the experience of playing a game on-line is very different from playing in a face-to-face environment. In distributed games, players are unable to use physical cues like gestures, body language, and gaze to communicate. Also, awareness information about the state of the game and other players must be communicated explicitly. In the physical world, these interactions are a natural part of our lives. Exploratory research was conducted to examine the differences when children played the same game in both shared and distributed environments [12]. A shared environment was found to facilitate collaboration and to increase a shared understanding of the workspace through communication. This suggests that although distributed, multi-player games may support the requirements of free play; it must be qualified whether the experience and benefits of free play are lost in distributed communication.

Although free play activity does not have to be conducted jointly with others, I will be focusing on the support for concurrent, multi-user interaction. Providing simultaneous support for multiple children playing together has been shown to increase motivation, engagement, and concurrent interaction [13]. Children enjoy playing together and can be very engaged in a collaborative task. Research has shown that children experiencing enjoyment from technology is an essential aspect to encouraging their further exploration of technology [8]. Traditionally,

computer games have eliminated some of the social aspects of traditional game play [14]. The majority of computer games are played individually, while non-electric games are played collectively [14]. Not only are games played with more than one player more challenging and fun [14], but the social aspect of multiplayer games makes them a rewarding experience to us, as social beings [4 as cited in 14]. Providing support for multiple people playing together can yield an exciting, social, gaming experience. Providing support that closely mirrors the manner in which people interact together in the physical world is even better.

Tangible aspects

In order to leverage people's interactions with the physical world, researchers have investigated the affordances of, and the bridge between, physical and digital media. Inkpen et al. examined children playing the same pattern matching game using both physical and digital media [13]. Although support was provided for concurrent multi-player interaction in both conditions, the level of concurrent activity did not match. When using physical playing pieces, players interacted concurrently 69% of the time as opposed to only 27% of the time when using digital playing pieces. The emergence of tangible interfaces (TUIs) [9] has effectively addressed this issue. TUIs use physical objects to interact with computers and are a valuable method of supporting face-to-face collaboration. TUIs take advantage of the idea that physical objects naturally afford certain interactions [9]. Manipulating physical objects requires positioning the body within space, providing a rich channel of non-verbal communication and awareness between multiple people collaborating together [13].

Physical Aspects

Ishii et al. [10] define computer supported collaborative play (CSCP) as "computer technology that enhance[s] physical exertion, social interaction, and entertainment in sport and play." My vision of CSCP corresponds to the vision related by Ishii et al. [10]:

"We expect that CSCP research will guide us to design a new form of HCI that we call the "athletic-tangible interface." This refers to a new class of interaction that uses tangible objects and full-body motion in physical spaces with digital augmentation. We believe that a person's physical prowess and sense of kinesthesia can be leveraged to strengthen the quality of a collaborative play experience in the physical/digital domain." (10, pg. 395)

If TUIs utilize our natural interactions in physical space, the athletic tangible interface augments this by providing support for full-body movements and physical activities. Physical activity provides many benefits, especially for children. Gallahue [6] writes that:

"Movement is at the very center of young children's lives. It is an important facet of all aspects of their development, whether in the

motor, cognitive, or affective domains of human behavior." (pg. 24)

Not only do sports yield athletic and physical benefits, but also contribute to social communication and coordination skills. And motion can be engaging and entertaining when combined with a computer game [10]. Although movement is not central to the definition of free play, I believe that utilizing movement in free play behaviour can provide a richer, more interactive and engaging experience.

Skill Acquisition

The final component to an effective co-located CSCP environment is the leveraging of players skills. Games that are engaging may have small 'luck factor', but the skills of the players are the determining factor affecting the outcome. Even in games that have large random components, like games played with cards, the player's skill is an essential component of the game. All sports require skill development but many computer games fall short in this aspect. For example, The Sims™ is a very popular single player computer game (www.thesims.com). In this game, players make their virtual characters do activities and interact with other characters in the game. While playing, your Sim may become a top chef, an astronaut, an amazing athlete, or a top-notch piano player. Meanwhile, the individual who is playing the game did not learn one of these activities, but has only become better at virtual time management. There is a place for these types of games, however, it would be valuable and enjoyable for the players to develop skill along with their characters.

It would also be valuable for the skills that the players already have to be used as input into the game. If by teaching a virtual character, the player also learned and experienced new things and was able to use these skills as input into the game, the gaming experience would be that much more grounded in the real world. Of course, if the game utilizes too much of our real world activities, it would be too real, being more like life and less like a game. One of the elements of free play is the element of pretend; the notion that the play activity is different somehow from our everyday lives. However, some abstract mapping of our real world situation into the game environment could provide motivation and enjoyment. For example, contextual information could be used as input to the game. Heart rate and other biological signals have been proposed as input to a game. Location and relative proximity have been also been proposed as input parameters [2]. In our work, sensors to determine the state or level of a player's physical activity could directly affect the health and well being of their virtual characters.

THE E³ PROJECT

Our current project to examine some of the issues related to co-located CSCP is called the Extreme Electronic Entertainment (E³) Project. The E³ Project is a new undertaking, designed to explore new interaction paradigms that will support multi-user collaboration and competition in CSCP. We are investigating techniques to

integrate the strengths of traditional physical and virtual play in a hybrid physical/electronic game environment. In particular, we are examining how technologies such as new displays and interface techniques can enhance natural, enjoyable recreational interaction between users.

There are many salient features of physical board games that cause them to be enjoyable to play. For example, most games are very interactive. The interface to the game is generally non-oriented, allowing for multiple people to view the board from multiple angles. Board games are mobile, and provide support for dynamic groups and house rules. Most importantly, the board is simply present to facilitate interactions between people, not interactions with the game. On the other hand, computer and video games provide for complex simulations, evolving environments, impartial judging, the suspension of disbelief, and the ability to save the state of the game. By combining the advantages of each of these modalities, a new hybrid class of games can be formed.

Our Current Game

We have created a hybrid platform to investigate questions related to ubiquitous gaming. Our game environment consists of a tabletop display system with a custom sensor interface. Initially, we have configured the game for six players although the goal is to have dynamically changing groups. The game board is a projected map, tessellated into a grid of 20 by 30 hexagons. Each hexagon represents a space that the characters are allowed to occupy and is one of four terrain types: water, plains, forest, and mountains. Initially, the map is not projected, with the exception of hexagons where players are located. As the players move around the board, the map is dynamically revealed. Players are initially separated into two teams and are unaware of their team members. The goal of the first phase of the game is to discover your teammates. The story the players are given follows:

Years ago an asteroid crashed into the Earth. The asteroid had traveled from a far away galaxy and carried with it an element that isn't native to our planet. Ancient civilizations realized that this was no ordinary rock and built many layers of protection around it from fear of what powers and energy it might contain.

Two alien civilizations are now in dire need of this element. It is as essential for their survival as oxygen is to ours. They have been scanning the universe and found the signal emanating from Earth. It is now a race between the two species to reach the desired element. Our harsh environment will not support their life systems so they have transformed their life energy into human form. Every sunrise, their life energy is harnessed and used to replenish their inferior human form.

The aliens did not anticipate the interference that our atmosphere would cause and the information

relating to their transformation has been scattered all around the area. Now both races appear foreign to their alien eyes and they cannot tell who is who. They must make their way secretly around the site to gather the essential transformation data. But in doing this, they cannot reveal themselves to the others. If their identity is discovered by the wrong race, they could be in great danger! Whoever can find and decode the essential data first will give their team an advantage to break through the ancient civilizations' traps and puzzles that guard the life-giving source.

As players move around the game board, their job is to collect clues that remain hidden in clue holders like rocks and logs. The clues are information relating to members of the teams. For example, a clue might read "the captain on the other team does not have blue eyes". As players pass near other players on the board, they can make observations about the other player's appearance. For example, an observation might be the height of the other player or the colour of their hair. Observations are always direct, while clues might contain indirect statement as in the example. Players must gather as many clues as possible while avoiding being observed, to try and solve the logic puzzle to figure out their teammates. Clues and observations are presented on a handheld computer to maintain private information while playing on a public display surface. The exchange of clues and observations along with any private communication is not mediated by the game and must occur between players in the real world. Finally, to avoid a turn-taking game strategy, we implemented an energy-based system to move around the game board. Each type of terrain has an associated energy factor that depletes the player's energy as they move through. For example, it is harder to climb mountains than walk through the forest. The characters' energy is replenished cyclically throughout the game and they must time their exploration accordingly.

In order to move about the projection, we have implemented a custom sensor interface. The playing surface contains an array of 600 infrared phototransistors, each corresponding to a hexagon in the game. Each character playing piece contains an infrared light emitting diode. The pieces emit a pulse that is sent through the phototransistors to the serial port and interpreted by the game. Pieces also have buttons that are pressed to correspond to actions in the game. Pressing a button changes the pulse transmitted to the game. To the players, interaction with the game itself is seamless. The pieces provide natural interaction that players are accustomed to from playing with physical figurines. However, our augmented pieces provide a great deal of functionality to interface with the game. This was very important to our research, as we wanted the players to focus on each other, not on the interface. This sensor system provides us with a seamless input to the hybrid game system.

The display system consists of both the tabletop projection for public information as well as the handheld computers for private information. The handheld computers also act as input to the game by allowing players to perform actions and make choices on the handhelds. We deliberately limited the interaction through the handhelds to maintain focus on the other players, not on the private displays. The handhelds communicate to the game control through an 802.11 wireless network. All public input occurs through the pieces which connect to the game control via the serial port. The game control handles all game input, logic, and updates the display based on events in the game.

Although this game does not currently support many of the ideas previously discussed, it was created as an initial foray into the area of ubiquitous games. There are plans to extend the computation power of the game pieces. Initially, we plan to implement a second phase of the game. In this phase, players will know their teammates and will be working together to attempt to unravel some of the puzzles and problems in obtaining the needed element. Rewards from phase one will carry over and this second phase will allow us to implement and test the possibility of characters having persistent, but dynamic skill sets. Players will use pre-programmed playing pieces that will provide them with certain advantages in the game. From this, we can investigate dynamic, ubiquitous skill acquisition. Ultimately, our goal is to have playing pieces that store data, interpret contextual information, and travel continually with the players. We plan for these playing pieces to be able to communicate wirelessly with other proximal playing pieces. We also plan to be able to train these pieces so that a player's skill can be leveraged in the collaborative gaming environment. It is in these extensions that the power of ubiquitous computing for gaming environments can be explored.

CONCLUSIONS AND FUTURE WORK

Our plans to extend the E³ are numerous. We plan to create an innovative system that allows people to play a computer game that is unlike any game currently available. The game will be persistent and ubiquitous, collaborative and competitive, collective and individual. Players' personal skills will increase with the skill of their character, both mentally and physically. Players will feel a sense of ownership over their individual characters by keeping these characters to interact with them individually before bringing them to a group situation to play. Players as well as their characters will be trained both mentally and physically to compete and collaborate in multi-player face-to-face game situations. The majority of the research will focus on the meetings between individuals that aren't predetermined but are more serendipitous. At these meetings, individuals will be able to participate in a variety of activities with a variety of dynamic groups. Also, there will be a strong individual component where the player performs certain actions to 'train' their character, both physically and mentally.

In these dynamic, serendipitous situations, the activities will resemble free play. That is, the activities will be voluntary, spontaneous, and engaging, will involve pretend elements, and of course be fun. There are few situations where a computer system encourages or supports free play. On-line games may have all of these components, but it is yet to be qualified whether the experience and benefits of free play are lost in the distributed communication.

Finally, I believe it is important to integrate movement into the game. There is no reason why computer games need to be static in terms of players' physical interactions. With a new interface to the computational component of the game, a more persistent computing environment, and an adieu to wires, a very natural, dynamic, exciting interaction with the computer and between the players can occur. I also believe that a new class of games can be developed. Finally I hope that some very exciting advances in free play will be made when the power of computation for intelligence and simulation can be harnessed and combined with the greater power of a child's imagination.

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