Ubiquitous Pleasure: A Study of Location-Aware Gaming

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1 Abstract

In this paper, we argue that computers are moving towards more ubiquitous integration with more traditional human activities, such as games. As a result, we argue that there will be an emergence of "location-aware" computer games, which merge the virtual reality of computer games with the physical location of the players. We ask the question of whether such games can be considered more pleasurable to players, and what aspects if any make this possible. We then run several user studies to answer this question, comparing a "location-aware" game to a similar computer game and physical-based game. The results gathered from these studies suggest that "location-aware" games can be more pleasurable than traditional games, and that the key aspects which make these games pleasurable are that of player-player interaction and the actual user interface utilized by the game.

2 Introduction

Games have existed in human civilizations for centuries. With the emergence of computers as outlets for entertainment, traditional games of human-human interaction have begun to be replaced by games involving fantastic virtual worlds, which provide visual and auditory immersion through 3D graphics and surround sound. As these computer games become more and more complex, and the reach of computers becomes longer and longer, it only seems fitting that a new genre of games will emerge that will embrace both the social aspects of human-human interaction with the endless

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possibilities of human-computer interactions. These games will involve the players interacting with objects or other players physically, while paralleling such interactions in a computerized virtual world. In order for a program to successfully analyze the actions of a player in the physical world, however, the context of that player must be determined, as discussed by [1, Arminen, 2006]. As noted, location is one of the most important aspects of context. As such, we will focus on what we will term "location-aware" games, that is, computer games which account for the players' physical location and incorporate that data into the game itself. This is in part because no standardized frameworks exist by which to determine other aspects of a player's context, and in part because technologies which sense users' locations are already being used in everyday situations. As such games have yet to emerge into the mainstream, there are questions which must be posed and answered before "location-aware" computer games become a marketable commodity; What sort of game genres are possible using "location-awareness"? What sort of playing environments should a "location-aware" game occur in? What exact technologies should be used for such games? Perhaps most importantly is the question: Can such "location-aware" games be considered more pleasurable than their more traditional counterparts? And, if so, what aspects make them more pleasurable for players?

Previous work conducted with regards to "location-aware" games is mentioned in Section 3. To answer our question, we will proceed to outline a method by which the playability of such a "location-aware" game can be tested against that of a traditional human-human game and a semi-traditional human-computer game, using "Flow" Theory in Section 4. We will then discuss the results gathered from such a method in Section 5, and we end with thoughts on possible work that such results might lead to in Section 6.

3 Related Work

There are many documented instances of "location-aware" games which have been created solely to answer some of the questions posed above. [2, Bell et al, 2006] created a basic computer game for mobile devices which relied on the existence of 802.11 hotspots, both public and private, for game play. This game, Feeding Yoshi, is designed to be similar to the Japanese game of Mogi in that it is very flexible as to when players can and should play the game, and is meant to be "interwoven with the patterns of everyday life." Players must collect food items scattered throughout their general

area in order to feed a virtual pet. A study using the game was conducted over three large cities and asserted in its conclusions, among other things, that the players benefited from the flexibility of the game. Such a study suggests that long-term location-based games may need to shy away from less flexible traditional computer game genres such as first-person shooter or third-person action games for mainstream acceptance.

Other games which fall into the same category as Feeding Yoshi appear in [7, Magerkurth et al, 2005]. These include Treasure! as well as Can You See Me Now?. Both games also rely on 802.11 hotspots, with players holding PDAs and attempting to collect virtual coins in the game of Treasure! and players with PDAs attempting to catch virtual avatars controlled by players at computer terminals in CYSMN. These use location as a crucial aspect of the game, but these games are not as flexible in game play as Feeding Yoshi. Yet part of all of these games is social interaction, which occurs through actual game elements (swapping food items in Feeding Yoshi, stealing coins in Treasure!, direct interaction in CYSMN). The environment of all these games is similar as well, as they all span multiple 802.11 hotspots.

Other implementations of "location-aware" games have attempted to introduce location-awareness to games of a shorter-duration, which occur in a more closed environment. [8, Mansley et al, 2004] created an entire environment capable of sensing the location of "bats", small devices containing two buttons, status LEDs, and a buzzer for basic I/O. This environment spanned a laboratory, and was used to implement a game similar to 'CounterStrike' or 'Capture the Flag'. Each player was given a "bat", which acted as a shotgun or mine-layer as well as an indicator of health points. The game had varying levels of success depending on the exact implementation, but allowed the researchers to note that the players' "bats" (which lacked significant computational power), when heavily relied on to deliver real-time responses to game events, could destroy the network latency. In addition, the researchers investigated using Bluetooth as a possible implementation mechanism, but noted that its limited range and network handover issues could create difficulties for larger implementations.

To tackle the issue of network latency in such close-contact, faster paced games when using an ad-hoc network, [10, Riera et al, 2003] created a new framework for games designed for mobile, ad-hoc architectures. Although at the time of publication an implementation was still in development, the framework deviated from the notion of a centralized game server by creating multiple "Zone Servers", each of which are mobile units that service requests from a group of players and propagate game-wide messages and events to other "Zone Servers". Any player in a game may be a "Zone Server" and not

know it, and the servers are set up to ease the transition of association of a player from one server to another. Although not as suitable for games which rely on instantaneous game-world updates (such as a first person shooter) due to the limitations of ad-hoc networks, the researchers were working on an implementation to test the latency of the system.

Finally, [5, Janecek et al, 2005] investigated the use of Java 2 Micro Edition versus the .NET Compact Framework in multiplayer gaming applications on PDAs communicating via WLAN. They benchmarked both platforms with regards to integer arithmetic and communication performance, before implementing a real-time game of 3D Pong using both platforms. The results showed increased graphical performance from the .NET framework, but suggested that communication performance was limited by the computational power of the individual PDAs.

These studies show various reasons for and against certain implementations, and give clues on the role of location-awareness and its role in computer games. They study technologies, both prototypes and commonplace, and their potential roles in such games. However, none of the related works cited seemed to address a crucial question: Are "location-aware" games more pleasurable to users than their counterparts? It is this question which we set out to partially answer.

4 Our Approach

The question of whether or not "location-aware" games are more pleasurable than more traditional forms of gaming defines the potential of such games. According to Reuters, the net worth of the video games industry is approximately 30 billion dollars, and that does not include the net worth of industries associated with traditional human-human games (which would include many sports gear manufacturers, among other things). If "location-aware" games can be shown to captivate players successfully and more often than other games, it is likely that businesses will invest capital into the field of location-awareness, and thus possibly expand and/or standardize it.

Our question makes use of the specific term of "pleasure" in reference to user experiences while playing games. Before we can begin to evaluate the question, we must define this term and provide a framework by which we can evaluate the "pleasure" associated with a certain game. We will define the term "pleasure" to be synonymous with the "flow" state as described by [9, Cskszentmihlyi, 1990]. The implications of this association will be further explored in later sections.

To attempt to answer this question, we also assert that direct comparisons between the various forms of games must be made. Much like how sports-based video games must incorporate the real-life physics and atmosphere of their traditional forms, "location-aware" games must incorporate the aspects of both computer games and physical games which players find enjoyable. To continue the sports-based video game analogy, we must also decide on an arbitrary level of realism versus fantasy. In designing a sports-based video game, a designer might decrease the level of virtual gravity, or introduce special 'power-ups' for the player character in order to appeal to a certain audience, at the expense of realism. While this detracts from the incorporation of real-life game play aspects, it allows the game to appeal to a wider audience, and plays on the strengths of computer games (that is, the element of fantasy). Similarly, "location-aware" games must skirt this fine line between the realism which is inherent in the physical world, and the potential for fantasy through a virtual medium.

To help establish the role of realism versus fantasy, we also need to decide on the technology with which we will implement the "location-aware" game. The exact "awareness" of location varies from technology to technology, and using any custom-made location sensing system limits the potential of the research in regards to mass-acceptance as the work will no longer apply to many existing technologies. Existing implementations of location-aware systems include 802.11, Bluetooth, RFID, GPS, and GSM/other cell-based identifications. Of these, GPS, GSM, and 802.11 are centralized to some extent or another, and can provide for location-awareness in relation to the physical world more easily than Bluetooth and RFID, which are ad-hoc in nature. The choice of technology obviously affects the types of games possible (RFID is not very suitable for fast-paced gaming due to its relatively short range and slow signal).

To facilitate the direct comparisons called for between our "location-aware" game and other traditional games, the game chosen to be implemented must be possible to play both on a computer and in the physical world. As mentioned previously, many sports games fall into this category. While tabletop games such as Chess or Go fall into this category as well, we exclude them due to their lack of a true location-based game component. By limiting the games that we can implement to such a subset, we allow for usability studies to be conducted on both the "location-aware" implementation as well as the computer and physical implementations. We assert that it is this data which will probe the feasibility of location-awareness in gaming.

Finally, we must define a number of players for the game, and must set

this number so that it does not deviate between various implementations of the game. This is to say, were we to attempt to answer the question of location-awareness's playability with the game of baseball, our data would be useless if the location-aware and physical games required full teams and the computerized version was single-player. To effectively compare usability study between the implementations, they must be as similar as possible.

4.1 Evaluation/Methods:

The implementation we tested followed the guidelines above. The game was a simple one which adapted easily to either a physical or a virtual world. It falls within the genre of murder mysteries, adapted from the board game "Orient Express" based on the Agatha Christie novel. In the board game, players play the role of detectives on-board a train traveling from Paris to Istanbul. A few minutes after players board the train, one of the passengers is killed, and the players must navigate the train compartments to interrogate suspects and wait-staff as well as gather clues to determine the murderer(s). All players are considered innocent and are detectives, but there are eight non-player suspects, seven non-player wait-staff, and six on-train location which can be searched for clues. The players roll a colored die to move around the train compartments, and each roll of the die has the potential to move the train closer to Istanbul. The game ends when the train reaches the end of its track, and at that point all players must guess as to the murderer(s)'s identity. The player who guesses correctly having used the least amount of clues is named the winner.

In converting this board game to a form which can be implemented as needed for this project, some rules needed to be added or modified. The original board game calls for very little interaction between the players, and so the idea of an "accomplice" to the murderer was introduced. As the game progresses, one of the players is informed that they are on the side of the murderer and must stop the players from guessing the killers true identity at the end of the game. To help them in this goal, they gain abilities during the various stages of the game, measured by the trains distance away from Istanbul. In the first half of the train ride, the accomplice may hide clues to throw off the other players, and is informed of the murderers true identity at the halfway mark of the train ride. In the second half of the game, the accomplice may try to remove other players from the game for a short duration by using scattered items, in order to hinder their acquisition of clues.

To inform players of the overall progress of the game, all players are called

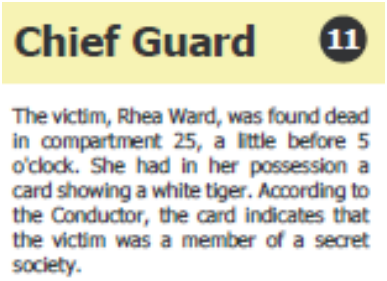

Figure 1: Examples of Physical Clues

into a common room during "border checks" in which the train transitions from one country to another. During such border checks "telegram clues" are read to all players. This was also added to facilitate contact between the players. In addition, players are given restrictions on their clue acquiring so that they must constantly traverse the train to gain additional clues. Players who gather clues in the same train compartment as another player must share the clue that they have gathered. The movement of the train towards Istanbul was modified so that the trains movement is dependent on the number of clues that have been gathered by players. The objective of the game remains the same for the detective players as in the board game; however the accomplice player wins if none of the detectives accuse the correct suspect at the end of the train ride.

This game was easily implemented in both the physical world as well as within a computer. In the physical game, players represented their avatars, and the playing field consisted of an empty college building hall, with physical clues as in Figure 1 and items (such as sheets of paper with notes scrawled on them) scattered throughout. Train compartments were represented by specific rooms within the building. Such a game also required a moderator, to ensure that all players were acting in a fair and consistent manner. Before the game started, the accomplice was selected randomly by the moderator. Upon being removed from game-play by the accomplice, a player had to leave the premises of the "train" to a "safe area" for a set amount of time. Clues and items were represented as actual pieces of paper, and actions occurred verbally, between players (who reported them to the moderator). All players were required to keep track of their own clue counts, and the clue sheets they used were given to the moderator at the end of each game session.

The computer game consisted of all players sitting at various terminals (which were in the same room for ease of administration). A moderator was necessary, as although the computer game server acts as a fair moderator the players were sitting in the same room. The train existed only in a virtual world, and was represented by a PNG image of the player's current train compartment, as well as an overhead map of the entire train (with the occupied compartment shaded) in the upper corner of the screen as in Figure 2. A text message box hung towards the lower bounds of the screen served as a chat-window by which a player could type short messages to any player in the same train compartment. Updates to the player of in-game events and perceptions ("You hear a scream echo down the hall...") were given by a pop-up dialog window, and virtually all game-affecting user input was done through the mouse. All game clients interacted with a single game server through standard UDP over Ethernet as in Figure 3. In any train compartment, the player was presented with buttons to select "Search Compartment", "Look Here (or Forward, Back)", "Yell (Exclamation, Scream, etc...)", "Pick Up/Drop (Item)" and "Interrogate (Someone)". The accomplice, instead of the "Yell" option, was presented with an option either to "Hide" evidence or to Kill another player depending on the country the train was in. In this implementation, the player was not allowed to hide more than two compartments' evidence, and "wounding" other players could only be done if the accomplice and the victim were alone in a compartment, due to the programming of the game client and server. Basic controls also existed to move the player between compartments. In all cases, game state updates were done on the server, and were either broadcast to all game clients in the case of chat messages or game status updates, or were given to clients through a traditional client-server exchange when a player moved from one room to another, or when a player made an action. Clues and items were reported through the dialog pop-up window. All other basic rules of the game held true in this instance.

The final rendition of the game which we wanted to target with this study, that is, the "location-aware" version, placed the players in an empty building as in the physical version of the game. However, each player also possessed a mobile device (cell-phone) which was periodically connected through computers in the various rooms to the same central game server as in the computer version. This connection as well as how player location was tracked is discussed below. Messages were sent by the mobile devices to the game server, which maintained the game state. In this version, the player could not move themselves around the train by selecting compartments on a virtual representation, but had to physically move from section to section.

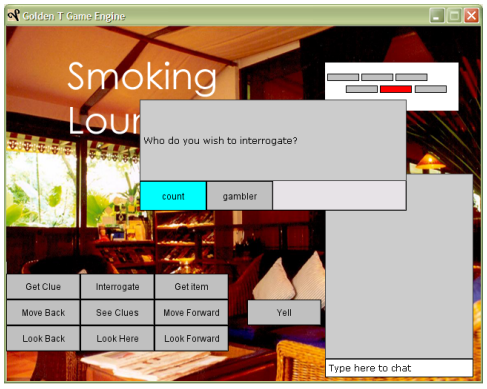

Figure 2: A Screenshot of the Computer Client

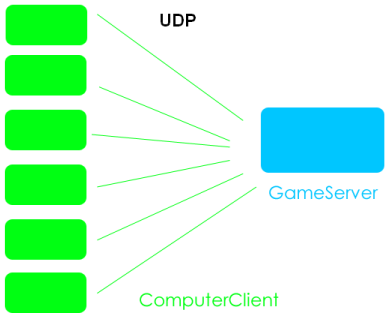

Figure 3: Graphical Representation of Computer Form's Architecture

However, actions were done completely using a slimmed-down GUI interface, and game messages were visible on the mobile device through a text popup on the game client as in Figure 4. No physical moderator was technically required, as the game server acts as a fair moderator, but players were monitored during this implementation as well.

The location aspect of the final implementation required a location-aware technology to be used that allowed player movement to be tracked as they moved between train compartments. Initially this was planned using RFID readers with every mobile unit and RFID tags on every door frame, but due to the expensive nature of RFID readers (and the relatively short range of hobbyist models) use of this technology was re-evaluated. Instead, Bluetooth dongles connected to devices in each room were adopted, to take advantage of the built in Bluetooth implementations in many cell-phones. Computer terminals were equipped with Bluetooth dongles and ran a phone-computer service which accepted data from a mobile device, relayed the information via UDP to the central game server, then sent the reply back to the mobile client via a Serial Port connection over Bluetooth as in Figure 5. An instance of this service was present in each room representing a game location.

To ease the task of creating the computer implementation, Java 2 Standard Edition was used for its cross-platform portability as well as its accessible multi-threading interface. A Java 2 game engine, the Golden T Game Engine [4], was used to provide a GUI framework. The central game server for both digital implementations was also written in Java 2 Standard Edition, and used only standard Java libraries.

Java 2 Micro Edition [6] was used to program the location-aware imple-

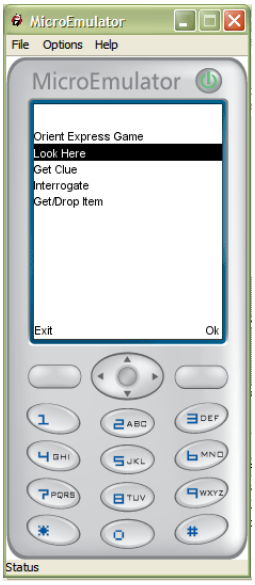

Figure 4: A Screenshot of the Phone Client

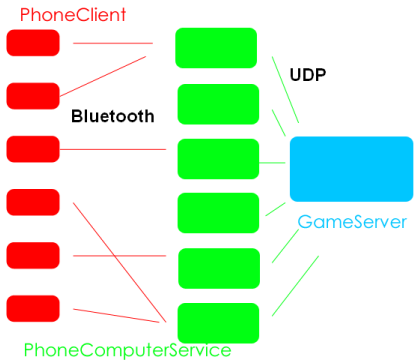

Figure 5: Graphical Representation of Phone Form's Architecture

mentation, due to its ability to run on many untampered mobile devices. To allow for Bluetooth communications, the JSR-82 Optional Bluetooth API for Java was used both by the phone client and the phone-computer service. Specifically, the Intel Bluecove API for Java Standard Edition [3] was used in the phone-computer service, while the actual API for the mobile devices varied from device to device.

Two user studies were run. In the first, six players were asked to "player-test" each form, and the surveys discussed below were given at the end of each game, as well as at the end of all three. In this test, however, the players played a stripped-down form of the game. The game rules were given as in the original board game, with no "accomplice" player and no "overhearing" of clues, although "border-checks" were still given. In addition, the location-aware form was played on laptops simulating a mobile device's hardware, rather than an embedded system.

In the second study, five players participated in a "formal user study" where they played each form of the game with all of the rules in place. Players were monitored more closely for their reactions and as in the "player-test" user surveys were given at the end of each game form, as well as at the end of all three. In this study, players attempted to play the location-aware

form on actual cell phones.

To collect data from the players, various strategies were employed. In the purely physical form, the moderator noted down player comfort/discomfort and player involvement, while in the other implementations the central game server logged all player movements and actions.

Surveys were administered to the players after each of the three game forms, which contained open-ended questions meant to elicit player input on game play and areas in which the game implementations could be improved. A separate set of surveys were administered to players after the conclusion of all three game forms, consisting of comparative questions. These surveys were meant to highlight areas in which certain implementations were highly successful/unsuccessful and offered players a chance to offer their combination of most desired features from all three implementations.

The surveys attempted to discern whether players reached a state of "flow", and if not, how close they were to reaching such a state. As applied in [12, Salen et al, 2004], "flow" can be broken down into a set of prerequisites and effects. The four prerequisites of "flow" are challenging activity , clear goals, clear feedback, and the paradox of having control in an uncertain situation. All of these prerequisites are provided by the rules of the base game. Players are challenged logically to deduce the identity of the killer and are given a clear goal to identify the correct suspect at the games conclusion. All clue-gathering results in immediate feedback to players which help them progress towards the goal (in the case of the accomplice, the challenge, goal, and feedback all come from their interactions with the other players). Every player is given the ability to control their own actions at any given time, yet the winner of the game is in constant uncertainty until the games conclusion.

The effects of "flow", as given by [12, Salen et al, 2004] are stated as the merging of action and awareness, concentration, the loss of self-consciousness, and the transformation of time. The surveys asked both general and specific questions to probe whether players experienced these effects, and thus entered a "flow" state. Since the length of each game session was not fixed (it was dependent on the trains movement, which was dependent on the rate of collective clue-gathering) each survey asked players to estimate how long the session took. The surveys also asked for player reactions concerning the games atmosphere as well as the players ability to perform in-game actions. These questions were meant to help judge whether the player lost track of time, as well as whether they immersed themselves within the game.

Once the data was collected, each session was reviewed to determine the collective level of "flow" that its participants reached, and once each

session was reviewed they were compared to one another. It was hoped that through this process of comparison, a hierarchy of implementations could be established showing relative pleasure levels of players. Other questions on the surveys referred to specific implementation features, in order to gauge possible reasons why one implementation provided a greater "flow" state than another.

5 Results and Discussion

The two studies that were run were held under significantly different conditions, and the results gathered from each differ as well. The initial player-test utilized a subset of the game rules without most of the game components that were added to facilitate player-player interaction. In addition, the initial player-test was run in an academic building hallway, while the formal user study was run in a private residence hall. The formal user study utilized the full set of game rules. Finally, the player-test players consisted completely of Computer Science majors, while the range of majors participating in the formal study varied.

5.1 Player-Test

The player-test was run in the hallway of the Northwest Science and Engineering building. There were six participants, who were first asked to play the physical form, then the computer form, and finally the location-aware form. As both digital forms had not had extensive user-testing prior to the game sessions, players were given small sheets of paper to mark down bugs during these forms. Based on comments written down on these sheets, it is obvious that bugs were present in both of these forms. Locations were set up in a single hallway, with the two ends of the hallway each representing a location, and four rooms in between representing locations as well. Surveys administered after the first version, the physical form, showed a mix of player reactions. Two thirds of the players suggested in their responses that if given a choice they would not replay this form. Players who stated they would play this form again attributed this to the player-player interaction, which they rated higher than players who did not wish to play the physical form again. However, in this entire player-test, the game was run without many of the game additions which were meant to facilitate player-player interaction, and this is evident in the responses of players on all the game forms, where this aspect of gameplay was generally ranked lower than all others. Notes taken by players during the physical form were collected by

the moderator, and these all show a wide range of approaches taken to keep collected clues organized. Some players simply kept a running list of clues, similar to the "clue inventory" system implemented in the computer client, while others kept visual representations of all known suspects and crossed off names as they collected clues.

The computer form was run next. During this test, several bugs were noted by various players including picking up or dropping items that don't exist as well as being stuck in a compartment and being unable to leave. One player remarked on a survey, when asked to describe the game session, "Array Index Out of Bounds!" As in the other forms, player-player interaction was ranked as the worst aspect of gameplay, and several player responses took issue with the computer client's interface. Several players stated the 2-D graphics reduced the realism of the game form, and one player stated that "movement seemed random" or arbitrary. Players did not seem too keen on replaying this game form either, with responses such as "Not until final [version]" and "Yes if debugged easier to play".

Finally, the phone form was run. In this game session, players walked around with laptops instead of an actual mobile device. A J2ME emulator termed "MicroEmulator" was used, as well as the Intel Bluecove JSR-82 Optional API for Bluetooth on Java SE, to run the phone code. Although the emulated cell phone application was responsive and console output was visible (as to tell when the application was negotiating a Bluetooth handshake or whether it had locked up) the game was unable to be completed due to issues with Bluetooth. Clients took up to 30 seconds to create a connection with a location, and often after creating a connection to a location and then moving to a different location a player would break the application. Game features which required sending players a "broadcast" message did not work in this implementation, and player responses on the surveys reflected the state of the application. Interestingly, player responses on the surveys for this form did not attack the text-only interface, but applauded it. Players stated they would play the form again, "if it didn't crash".

Upon reviewing responses from players after all three forms, player pleasure was only apparent in the moderator's notes. Based solely on the individual game surveys, player displeasure can be noted in all three version; players wished for a more organized interface when playing the physical version, a more graphical interface when playing the computer version, and a usable interface when playing the phone version. However, players did seem to enjoy themselves immensely during all three sessions as logged by the moderator, and during both the physical and phone forms there was a lot of player-player banter that was never mentioned on any of the surveys.

When asked to rank all three versions, players split down the middle into two groups.

The first player group felt that the computer version was the best of the three. They cited the larger resolution of the client and the "clue inventory" system as advantages it held over the other versions. These players, based off their responses to the comparative end-game study, seemed to obtain pleasure mostly from the logic-puzzle aspect provided by the game. They were content to sit in a chair and formulate guesses as to the true identity of the murderer(s). The players in this group stated that movement was actually one of the traits which forced them to rank the other versions lower. They enjoyed the "quick-play" possible in the computer version, due to the lack of physical movement, but all conceded that the player-player interaction in this form was its weakness.

The second player group felt that the location-aware version was the best of the three. They seemed to obtain their pleasure from the immersion they felt by playing the game in the physical world. These players highly valued the player-player interactions of the game, and enjoyed the cleaner interface provided by the mobile application. They ranked the computer form as their least favorite, due in part to the lack of immersion and lack of interaction.

Players did not seem to have a clear idea on how to combine all three game forms into one cohesive game, as evidenced by one response: "One hand on a computer mouse, one on a PDA [and] my rouge[sic] legs wandering through the CS/EE department". Upon reviewing the surveys, it seemed as though many of the players did not enter "flow" states based on their responses. This was attributed to the large number of bugs in both digital game forms, as well as the use of only a subset of the original game rules. It was hoped that during the formal user study, better results would be obtained as players would be experiencing the full games, and would have many opportunities for greater player-player interaction. This, it was believed, would shift player focus towards the interaction between themselves and the game world / other players from the logic puzzle provided by the game's clues.

5.2 Formal User Study

The formal user study was run in a private residence hall. Rooms were set up on various floors of the building to act as locations. The participants were first asked to play the computer version, then the phone version, and finally the physical version. Player pleasure was much more evident in the

moderator's notes and the overall responses on the surveys. After the first game form, the computer client, all players wrote they would play the game again. Numerous responses showed players immersing themselves in the game. One player, upon being asked to write whether they'd play the game again, wrote "Yes! I didn't win and I want to." Time estimates from players also showed that the players generally felt as though more time had passed during the session than actually had, and combined with the moderator's notes it seemed as though this transformation of time was a consequence of player enjoyment. Some player responses targeted the computer client's interface a few players enjoyed how it kept track of clues while others wished for a different system. Player responses also suggested that the use of more graphics and less text would have been desirable. Regarding the gameplay aspects of this form, players consistently ranked player-player interaction as the most lacking area.

The next game form, the phone client, was run using actual J2ME enabled cell phones. Locations were set up throughout the residence hall, and players installed the appropriate JAR and JAD files to their phones using either OBEX push over Bluetooth, or by downloading the files through email. Unfortunately, the phone client code suffered from game-breaking bugs not present when it was run through a J2ME mobile emulator. Players reported that many times upon selecting actions in the game's menu, the phone would either seem to ignore the user's command, or hang. The cell phones had difficulty forming Serial Port Profile connections to the phone-computer services in any of the locations. Players had varying success depending on cell phone manufacturer, and the mobile units' lack of responsiveness caused the game session to terminate before the game could be concluded. Surveys were administered to the players, but only some filled them out. Immediately afterward, the physical form was run, and the players who had not completed surveys after the phone client combined their responses on the physical form's survey to mention features and aspects of the phone client. In both the physical and phone forms, players ranked player-player interaction as the best aspect of gameplay, with anti-cheating moderation as the weakest aspect. Players mentioned enjoying the physical movement aspect of both forms in the surveys. Time estimates from players showed that in these forms as well players believed more time had elapsed than had. A few players mentioned issues with the simple text interface of the phone client and stated they would have preferred a "graphical phone client".

Both the surveys for the phone form and the physical form bear evidence of players entering "flow" states, although it is clear that the players had difficulties maintaining such a state during the phone implementation. Players

commented to the moderator after both forms were run, stating their enjoyment of the physical form and their disappointment that the phone form was unplayable. After all three forms were run, players were administered a comparative survey which asked them to compare and contrast all three game forms. Upon being asked to rank all three forms, players split between the computer client and the phone client as their top rank just as in the player-test. However, unlike in the player-test, the justification used to rank the forms was significantly different. On the surveys of players who preferred the computer client, the justification given was that it was the game form which had ran the smoothest. These players enjoyed the visual interface which was not present in either of the other game forms. The other players ranked the phone form as the most enjoyed. These players considered the concept of the location-aware implementation to be ideal, and stated that the physical movement and face-to-face interactivity it presented the players with combined with the lack of paper clues made it the most desirable form. In their criticisms of the form, however, these players were quick to point out the numerous bugs and flaws in the phone client. On all of the end-game surveys of the formal user study, every player marked the phone client as the game with the greatest room for improvement, and most players when asked to provide a single game version that encompassed all three forms agreed that such a game would look and play similarly to the phone client. Although more players stated the phone client was their top ranked form over the computer client, the surveys taken after each game form clearly show players entering a deeper "flow" state during the computer form. The "flow" states reached by players during the physical form is comparative to those reached during the computer form, but of the three the computer form seemed to provide the greatest amount of pleasure to the users. It should be noted, however, that this was the first game form administered, and this could have biased player pleasure.

5.3 Overall Results

Although there were issues with both studies, several conclusions can be drawn from the results. The inclusion of strong player-player interactions in a location-aware game is paramount. Player pleasure was much more pronounced when the player's participation in the game involved interacting with other players. The user interface presented to the player is also important, and this was commented on by many of the players.

The type of players targeted by the game may affect the pleasure players derive from it as well. In the player-test, all players were Computer Science

Majors, and thus were focused on and enticed by different aspects of the games than in the formal study, where player majors ranged from Mechanical Engineering to Political Science.

However, there were many areas in which the study could have been improved. Due to the bugs experienced by players in both studies, gaining additional conclusions from the results of these studies is not possible. Player responses varied widely depending on how "tolerant" players were to glitches and errors in the digital versions, and this was also partially dependent on the player's gaming and/or technical background. However, it can be noted that players' pleasure was not limited to only a single form, but was apparent in all three.

Other conclusions as a result of this work can be made on improvements to future studies, as several things could be changed to provide clearer results. The computer and phone clients need to be put through more extensive user testing prior to any studies being run. The use of JSR-82 should be rethought, as many cell phone manufacturers seem to be non-compliant with the specifications described in the API. By possibly switching from Bluetooth to 802.11 wireless, many of the handover issues and connection problems present in the phone client could be avoided. A greater number of user groups should be run through the formal user study, to provide a greater depth of survey responses to analyze. Finally, the format and questions asked on the game surveys should be reworked in light of the responses given in these studies to better assuage player enjoyment and concentration.

6 Future Work

Work left to be done based on the results of these studies may follow several directions. As the studies showed that, among other things, "location-aware" games have one or more hurdles to clear before they become more successful, they revealed areas in which these games lack playability. Future research might focus on designing more usable mobile graphical interfaces, even incorporating 3-D graphics into such an interface. It might also focus on choosing a more suitable "location-aware" technology, as the use of Bluetooth in this study led to many of the phone client's issues.

Further research might also include a greater exploration of alternate genres of games and their potential integration with location-awareness. The game used in these studies falls into more of a category of Point-And-Click Mystery or Adventure (if describing the computer version) rather than a Social or Action game. By studying the feasibility of coupling various exist-

ing computer games with location-awareness, more possibilities of successful "location-aware" games can exist. The generally prevailing player view that the phone client allowed for a game with more player-player interaction (which was desirable), even though it didn't work as well as the computer client, suggests that any new game created or picked for further research should contain such interaction as a key aspect.

7 Conclusion

In this study we hoped to show that "location-aware" games can blend the best attributes of computer games and traditional games. We asserted that we may show this by comparing the three types of games via usability studies of users levels of "flow", or pleasure. Although the results yielded by two user studies did not allow for a conclusive statement on the pleasure of "location-aware" games, they did highlight areas, specifically the amount of player-player interaction within a game and the game's interface, which affect user pleasure regardless of the game's implementation. This research was important as it addressed a question left unanswered by most of the current work in the field whether or not a "location-aware" game is more or less pleasurable than a traditional game. Although, even after analyzing the results of the studies, this question cannot be answered, the studies have shown methods by which future researchers can attempt to judge player pleasure in such a context, as well as some key areas which affect player pleasure.

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