Master thesis in Mobile Informatics

Collaborative Games – Makes People Talk

Johan Larsson
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Göteborg, Sweden 2002

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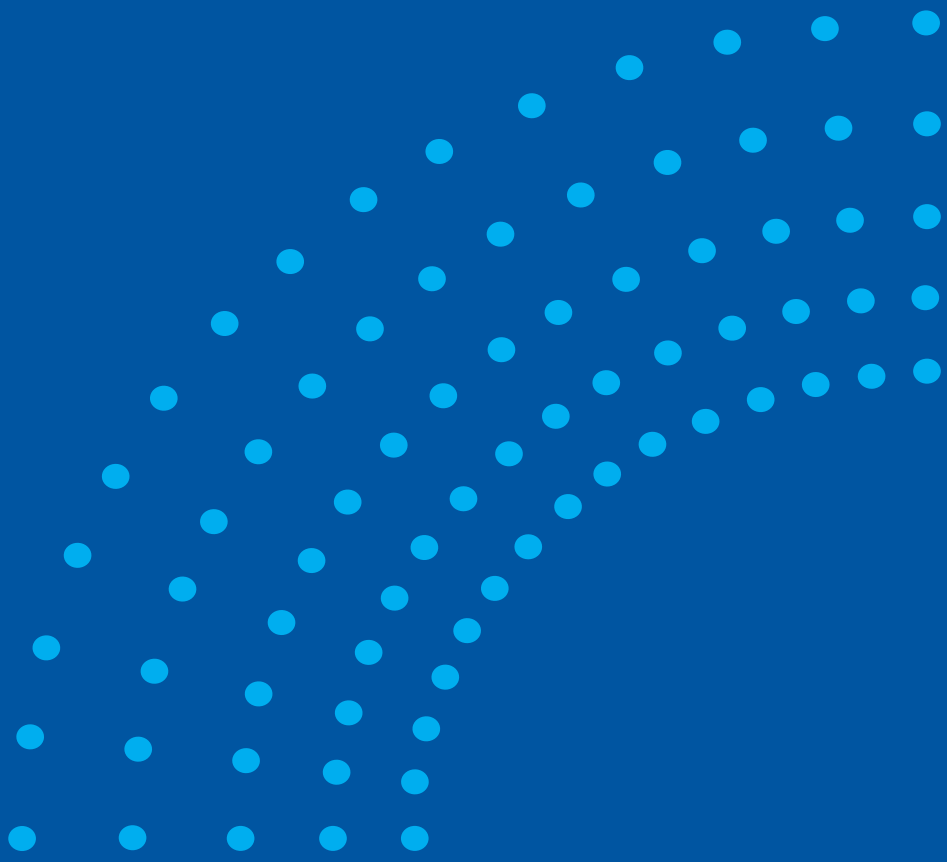

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Teenagers' use of mobile face-to-face collaborative computer games
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The report is available at:
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Abstract

Our main purpose was to explore how teenagers used mobile face-to-face collaborative computer games. In this report we therefore describe the development and use of what we call mobile face-to-face collaborative computer games. These games are played among co-located people on a handheld devices connected in an ad hoc network. The research was conducted in three phases: the workshop phase, the development phase and finally the evaluation phase. In the first phase we studied three traditional games, both on a theoretical level and empirically. The aim was to identify the design patterns that made people collaborate and interact face-to-face. The workshops resulted in three collaborative design patterns; the multiple keys pattern, the shared screens pattern and the guide-and-follow pattern. During the development phase we selected three famous computer games: Pac-man, Tetris and Asteroids. These games were then redesigned to incorporate one of the collaborative design patterns each. During the evaluation phase we studied teenagers at a local high school cafeteria play these games during a period of two weeks. Our evaluation showed that the developed computer games generate collaboration and interaction among the co-located gamers. Teenagers also seem to enjoy playing this type of computer games and used a trial-and-error approach when learning how to play. The games will soon be available for free download on the web.

Keywords: CSCP (Computer Supported Collaborative Play), wireless, design, mobile, face-to-face, co-located, handheld computers, games.

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Finally we would like to thank our families and friends for existing!

Contents

1 Introduction

Games have been an important activity among people for thousands of years but the activity has never been as interesting to explore as it is today. Playing and gaming has now been transformed into a digital form just as many other activities in peoples day to day life. When games got transformed into a digital form some people started to argue that these form of play were antisocial (Setzer & Duckett, 1996). Maybe this argument proves true but we take a different standpoint. Instead of focusing on the consequences of playing computer games that are antisocial in nature our aim is to design computer games that make people collaborate and interact in a face-to-face setting. Traditional game play is played in a social setting among co-located people and Daft and Lengel (1986) asserted that face-to-face is the richest form of information processing because it provides immediate feedback and with feedback understanding can be checked and interpretations corrected. Several research initiatives have aimed to regain some of the social aspects of traditional game play. One example is the Pirates! project (Bjork et al, 2001). Pirates! is a multiplayer game implemented on handheld computers connected in a wireless local area network. This game was designed to be played among co-located people and the researchers approach was to move computational game elements into the physical world. This was done with the help of proximity-sensor technology.

We believe that by moving computational elements into the physical world, as done in the Pirates! project, may introduce a new level of complexity. One also restricts gaming to a specific place and when looking at traditional game play this feature seems unnecessary to achieve social interaction and collaboration in a face-to-face setting. If one is to design truly mobile multiplayer computer games one should not put restrictions on the game by demanding people to be on a specific place at a specific time. Our view of a truly mobile multiplayer computer game is a game that can be played with co-located people anywhere, anytime and do not require any local infrastructure.

Our interest in social and collaborative mobile computer games started during a course given at the IT-university in Göteborg 2001. The course was called Mobile applications and networks. During this course we developed networked computer games targeted for handheld devices. The project was called CaféTrek and can be visited at www.cafetrek.com. The project goal was to develop games that encouraged social interaction and collaboration rather than isolation and the targeted playing environment was a public café. The games that were developed during this period have been tested and demonstrated in public several times (for example at Comdex Nordic 2002). The games were developed on a platform used for creating ad hoc networked applications. Engineers define an ad hoc network as a collection of wireless mobile nodes dynamically forming a temporary network without the use of existing network infrastructure (Broch et al, 1998). What this means, from our point of view, is that the computer games developed for ad hoc networks requires people to be co-located to be able to play. Furthermore co-located people can interact and collaborate in a face-to-face manner. Our experience from the CaféTrek project shows that networked computer games that are played when co-located does not make people interact for the soul purpose of interacting. People seem to need a common goal, within the game, to collaborate and interact face-to-face. The networked computer games that were developed during the CaféTrek project did not in any way

require non-mediated communication to be played and the players did not receive any clear advantages by doing so. In this respect the CaféTrek project failed. These facts made us realize that just because people are able to interact and collaborate face-to-face does not necessarily mean that they do it. Furthermore one cannot rely on properties of a specific technology to generate face-to-face collaboration and interaction among people.

Our experience therefore suggest that if one is to succeed in designing a mobile computer game, that makes people collaborate and interact face-to-face, the computer game has to incorporate some aspect that require people to do so. One also has to make this interaction part of the game play. When examining traditional game play one soon realizes that this form of play also requires people to be co-located. The difference is that in this case people seem to interact and collaborate face-to-face constantly. To be able to find what triggers this behavior one need to study how these games are designed and how people play these games. Our approach in this project is therefore to study traditional games both on a theoretical level and empirically. Our aim with these studies is to identify design patterns used in traditional games that make people interact and collaborate face-to-face. These design patterns will then be integrated into existing computer games. We choose to call these games mobile face-to-face collaborative computer games. The mobile face-to-face collaborative games that are developed during this project will have a rather different target group from that of the CaféTrek project. These games will be designed primarily to be suitable for teenagers. The mobile face-to-face collaborative computer games will then be played by teenagers in a local high school cafeteria in Gothenburg during a period of two weeks. We will then present the result of this use as our main result in this report.

Four main points motivates our work. First of all people are social beings and social interaction generally attracts people, online as well as offline Aronson (1994). Furthermore computer games provide for complex simulations, evolving environments, impartial judging, the suspension of disbelief, and the ability to save the state of the game (Mandryk et al, 2002). According to Hollan & Stornetta (1992) face-to-face conversation and communication provides a richness of interaction seemingly unmatched by any other means of communication. Research also suggest that teenagers use their mobile phones for purposes other than calling distant persons; they do things together, and the mobile phone takes part in this collaborative action Weilenmann & Larsson (2000). Finally when people share an event it becomes more than the sum of its parts. There is something present that we cannot explain and it is almost impossible to transfer this “something” into words.

1.1 Research Question

How do teenagers use mobile face-to-face collaborative computer games?

1.2 Research Purpose

The high penetration of mobile technology among teenagers in Scandinavia suggests that new services can be deployed relatively fast. There may also be a commercial potential in these services. Taylor and Harper (2001) argue that when technologies are adopted they become part of an already established social context and this context often shapes the use of technologies. It is this shaping and use we aim to study. There are several scientific reports available on the subject of teenagers' use of mobile technology. Weilenmann & Larsson (2000) have for example reported that teenagers use their devices collaboratively. We take these findings a step further by integrating collaborative aspects into mobile computer games. Our main purpose is therefore to explore how teenagers react when introduced to mobile face-to-face collaborative computer games.

1.3 Target Group

Our research is targeted for people interested in the collaborative aspects of mobile computer games whereas the mobile face-to-face collaborative computer games developed during this project are primarily targeted for teenagers. The report can also be interesting for people that are interested in the use of mobile technology among teenagers in a more general way. We believe that teenagers are experienced users of mobile technology, primarily in form of mobile telephones but also mp3-players, portable CD-players and Minidiscs etc.

1.4 Definitions

Computer Supported Collaborative Play (CSCP) is defined by Ishii, Wisneski, Orbanes, Chun and Paradiso (1999) as "computer technology that enhances physical exertion, social interaction and entertainment in sport and play".

Design pattern, as we use it, does not have the same meaning as in software design purposed by Gamma et al (1994). In this report we use the term design patterns as a way to describe a way to design games that encourage collaboration and interaction among co-located people. It is therefore not related to the actual software architecture of the games.

We define **collaborative design patterns** as patterns that are relatively general and can be reused in several games to make people collaborate and interact.

We define **traditional game** play as an activity where the main purpose is to socialize, interact and have fun. The activity does not require a computer and should also involve more than one player. The players should be co-located so that face-to-face communication is possible.

An **ad hoc network** is a collection of wireless mobile nodes dynamically forming a temporary network without the use of existing network infrastructure or centralized administration (Broch et al, 1998).

Stimulated social interaction (or forced social interaction) occurs when the rules of a game encourage the players to interact socially (Zagal et al, 2000).

Spontaneous social interaction occurs when the players spontaneously decide to interact. The game rules do not enforce this type of activity, it just happens while the players participate (Zagal et al, 2000).

2 Background and Related Work

In this chapter we present earlier research that is related to our work. We start of by describing a field called CSCP and then continue by describing the different types of mobility described by Luff and Heath (1998). The chapter ends with a description of a mobile game development project called Pirates!.

2.1 Computer Supported Collaborative Play (CSCP

Ishii, Wisneski, Orbanes, Chun and Paradiso (1999) define computer supported collaborative play (CSCP) as "computer technology that enhances physical exertion, social interaction and entertainment in sport and play". They take a rather technical approach in their research when developing their PingPongPlus system. They use ball tracking algorithms and develop an underlying technology for an "interactive architectural surface" which can track the activities happening on the surface.

Mandryk, Maranan & Inkpen (2002) have explored the space between board games and video games. Their purpose was to develop technology that promotes social interaction rather than isolation. They describe the differences between board games and video games by saying that most board 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, providing support for dynamic players and locations. The flexibility of board games allows for house rules. They also argue that the board, for the most part, is simply present to facilitate interactions between people, not interactions with the game. 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 they are arguing that a new hybrid class of games can be formed. They think that their hybrid board/video game has the potential to enhance natural and enjoyable recreational interaction between friends. Their prototype called False Prophets makes use of sensor technology to connect the virtual and the physical world. To support real world interpersonal interactions private communication was not supported or mediated by the game. This forced the player to communicate in a non-mediated fashion.

2.2 Mobility

Luff and Heath (1998) have identified three types of mobility: micro mobility, remote mobility and local mobility. Micro mobility is defined as the way in which an artifact can be mobilized and manipulated for various purposes around a relatively circumscribed, or "at hand", domain. Remote mobility is concerned with mobility between different physically dispersed places and local mobility describes the mobility within a building or a room.

2.3 Teenagers use of Mobile Technology

Weilenmann & Larsson (2000) shows in their article "Collaborative use of Mobile telephones" that the mobile telephone often is used collaboratively. Teenagers share information on the phone, as well as the phone itself. Teenagers use their mobile phones for purposes other than calling distant persons; they do things together, and the mobile phone takes part in this collaborative action. Their fieldwork where conducted at places where teenagers regularly spend time, such as cafés, public

transport and school cafeterias etc. Many other research initiatives report the same results. Taylor and Harper (2001) have observed the same type of sharing. They report that in some cases they had trouble determining who the phone, that was being shared, belonged to.

2.4 Information Richness Theory

The information richness theory was first introduced by Daft & Lengel (1986). They use four different properties to discuss media. They are feedback capability, communication channels utilized, source and language. They asserted that face-to-face is the richest form of information processing because it provides immediate feedback. With feedback understanding can be checked and interpretations corrected. Face-to-face interaction also allows the simultaneous observation of multiple cues (e.g. body language; facial expression and tone of voice). These cues can convey information beyond the spoken message. They are known to be complex processes, and ones which physical proximity facilitates.

2.5 Stimulated and Natural Interaction

The article "a model to support the design of multiplayer games" presents an approach to support the initial steps in the design process of multiplayer games. This article also presents the terms stimulated and natural (spontaneous) interaction in games. Stimulated interaction is described as interaction that is encouraged by the game design and therefore essential for the game play. Spontaneous interaction is all the other social interaction that occurs between players, not necessary for playing the game (Zagal et al, 2000).

2.6 Pirates!

Researchers have been trying to combine computer games and social aspects of traditional game play before. An example is Pirates! (Bjork et al, 2001), a project by Nokia Research Center in Tampere, Finland and the PLAY research studio at the Interactive Institute in Sweden. They try to maintain social aspects of traditional game play by moving computational game elements into the physical world.

In the game Pirates! all players are equipped with a handheld device symbolizing a "ship". Sensors are placed, in the physical proximity of the game area so that events can be triggered whenever a player approaches. Interaction with other players was done through the handheld computer, although the players needed to be physically close to one another. Position sensing was also used to define so called "islands" where players could find treasures and monsters. All interaction with these types of objects found on "islands" was also done through the interface of the handheld computer.

3 Methodology

In figure 3:1 we present our overall research method. In the model three different phases can be distinguished. The phases are visualized by the black boxes. The first phase is the workshop phase; the second is the development phase and the last phase is the evaluation phase. The other boxes visualize input and output from the different phases.

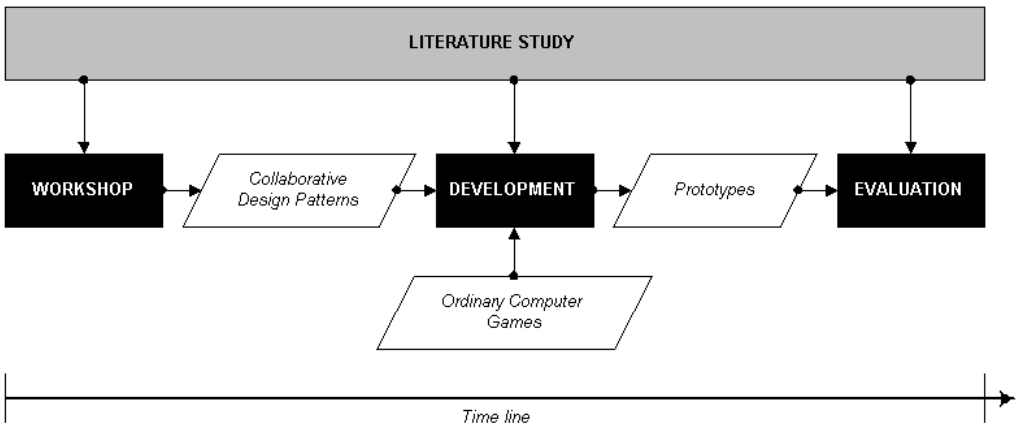

Figure 3:1 Overall work method

First we identified the collaborative features of traditional game play. To do this we studied traditional games. This study was made on a theoretical level by studying the rules of the games and how the game play was constructed. We also performed workshops with groups of people playing these games, mainly because we wanted to empirically study if the design patterns really made people collaborate and interact face-to-face. Our goal with these studies was to identify design patterns that make people collaborate and interact with each other during game play and these studies resulted in three collaborative design patterns. Our next step was to locate computer games that were suitable for our purpose and then redesign them to incorporate the collaborative design patterns we had identified. The development phase resulted in four different prototype games. These mobile face-to-face collaborative computer games were studied in use at a local high school cafeteria and we report on this use as our main result.

The qualitative methods purpose is according to Lundahl and Skärvad (1999) to increase understanding and gain insights of individuals, situations and their course of actions. They also argue that the qualitative methods can contribute to create meaning and context for actors that in a certain situation try to handle and solve specific problems. As our research focuses on trying to understand how teenagers use mobile face-to-face collaborative computer games we have chosen to use a qualitative method called group observations in our work. This method will be described in detail in the following chapter.

3.1 Group Observations

During the workshops and the evaluation phase we studied groups of people and to be able to study groups and group processes we needed access to methods to register what happened in the interaction between people. Observation is such a method.

Einarsson and Chiriac (2002) have developed a theoretical model for conducting group observations. They describe a way to systemize and describe different forms of group observations. Their model is based on two dimensions. The first dimension categories the observation as either hypothesis testing or theory generating. The second dimension refers to what degree of structure the observation has. They use two terms to describe the structure; high degree of structure respectively low degree of structure.

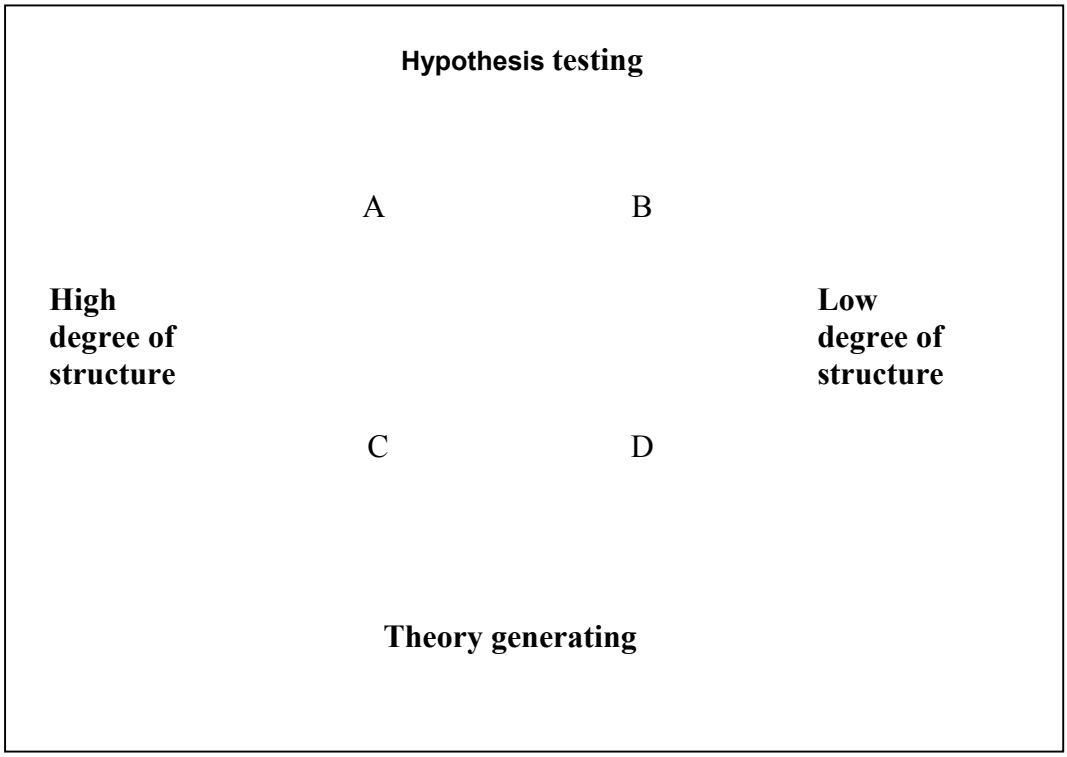

Figure 3:2 The theoretical model for group observations by Einarsson and Chiriac (2002)

If the research is focused on testing already present knowledge the study is hypothesis testing while research that focus on producing new knowledge is theory generating. Observations of groups can be done with higher or lower degree of structure. With structure they mean how well defined the way of doing the observations are beforehand.

During our observations we will only have two predefined categorizes, stimulated and spontaneous interaction. Our observations will therefore have a low degree of structure. Our purpose with this research is to increase the knowledge of teenagers' actual use of mobile gaming and we are not testing the validity of any already present theory. The observations will therefore be theory generating. Based on these facts we arrive at the conclusion that our observations best fits in quadrant D of the framework developed by Einarsson and Chiriac (2002).

3.2 Literature Study

The literature study spanned for a period of two months and from start we focused on publications dealing with board game studies, handheld game experiments, and game

collaboration studies (CSCP) etc. Some research was done on the public library of Göteborg and school libraries but most of the useful information was found through electronic sources. Databases like ACM Digital Library **(**http://www.acm.org**)** with bibliographic information, abstracts, reviews and full texts were searched using keywords like CSCP, collaborative, board games, social and ad hoc.

During the development phase we explored theories on game development and especially game development on handheld devices. We used the books *Game Programming Gems 2*, *Pocket PC Game Programming* and *Game Programming All in One*. Some electronic resources were also found useful like http://www.flipcode.com/ and http://www.gamedev.net/.

3.3 Development

All prototypes are developed with Microsoft Visual C++ and Microsoft Embedded Visual C++. The network layer was implemented on a platform designed to facilitate rapid development of high speed networked applications. The platform is called OpenTrek and is available for download at www.opentrek.com. All graphics programming was done using a platform called GapiDraw that is available at www.gapidraw.com. Both platforms are developed by the Viktoria Institute in Gothenburg. The prototypes run on both Windows XP and handheld computers running the PocketPC operating system. The prototypes have been tested on the Toshiba e740 and Compaq iPAQ H3630. The Toshiba e740 is equipped with an internal WLAN card as standard whereas the Compaq iPAQ had to be equipped with an external WLAN card. However, we recommend running the prototypes on Compaq iPAQ to achieve best performance and highest stability.

3.4 Alternative Method

We think that using a video camera to capture interesting actions during our observations could probably be very useful. However we argue that filming the participants might influence their behavior to a degree where we lose interesting scenarios. We therefore chose not to use a video camera during the evaluation phase.

4 Implementation and Realization

In this chapter we present describe the work done during the different phases. The chapter is divided in three subchapters describing one phase each.

4.1 Workshop Phase

We selected three traditional games for our study and we studied the rules of these games extensively. We also conducted three workshops to empirically see how and if the patterns triggered face-to-face collaboration and interaction. As said earlier our purpose with this phase was to identify the collaborative design patterns used in traditional game play.

4.1.1 Selection of the Games

The selections of the traditional games were based on two criterions. The games should require the players to communicate face-to-face. The games should also be well known and easy to learn. Based on these criterions three games were selected. One card based game called *the Sign*, a game called *Pictionary* and a game called *Hide the key*. We categorize these games as a highly cooperative and the main goal of these games seem to be to socialize, interact and have fun. These games are also well known and easy to learn.

The sign is a card based game and a deck of standard playing cards is all you need to start playing. The game is team-based and the players need to communicate and cooperate within the team. *Pictionary* is also a team-based game and highly cooperative in nature. In both of these games the teams are competing against each other. *Hide the key* is a game that can be played almost anywhere. The game does not require any equipment except for a key or a similar object that is easy to hide. The game is heavily cooperative in its nature and extremely easy to learn.

4.1.2 Participants and Location

These types of social games are usually played in an informal environment together with friends. This suggests that trust is already present between the players from start. Due to this the workshops were held in a home environment and all the participants were acquainted. We believe that the workshops came very close to an ordinary game session and we, as researchers, participated in the sessions as players.

4.1.3 Description of the Games

The Sign requires four players and they are divided in teams of two. Before the game starts each team should have decided upon a sign to be used (e.g. blinking with the right eye or similar). The sign chosen cannot involve physical contact. The game is played with a standard card deck of 52 cards. The deck is divided into two parts, playing cards and score cards. The jack, queen, king and ace cards, in all suits, are used as playing cards. The rest of the cards are used as score cards. The score cards are shuffled and divided up in three equally thick piles. The three piles are put on the table on a straight line with about 15 to 20 centimeters apart. The playing cards are handed out to the players and the player sitting next to the dealer starts the game by sending one of his cards to the next player (counter clockwise). This player continues by sending one of his cards to the next and so on. The object of the game is to collect four cards of the same type. This is called a winning hand. The player who sits right

next to the dealer only needs three cards of the same type to have a winning hand. When a player has a winning hand his mission is to signal this to his team mate. After the signal has been sent all players are allowed to hit one of the three piles on the table. The team that succeeds in hitting two of the three piles is the winners of the round and gets to pick up a score card. The score are the same as the value of the score card. After the hitting the player that gave the sign is required to show his hand as proof. The role of the dealer rotates clockwise during the game. The game is over when any of the teams has collected as many points as agreed upon beforehand. If nothing is decided the first team that breaks the 50 points barrier is the winner. More information about this game can be found on http://hem.spray.se/widholms/kottelag.htm. This information is unfortunately only available in Swedish.

Pictionary is a game that is bought of the shelf and is a little more complex than the other two games. There is also more equipment involved in the game play. For a thorough understanding of this game see appendix A. In short the object of the game is to identify through sketched clues as many words as necessary to advance to the finish square and correctly identify the final word. Furthermore the game is team-based and the teams compete against each other. The game is highly cooperative and generates substantial amount of face-to-face communication.

Hide the key is a descendant of the classical Hide and Seek and the concept is very easy. One player leaves the room while the other players agree on where to hide the key. When the first player comes back into the room he is given a clue of where to look. The clue is given in form of the words bird (high), fish (low) or in between. The player searching for the key can ask the other players if it is hot (near) or cold (far away). In this way they can guide him towards the key.

4.1.4 Workshops Result

We have chosen to only include a small description of the relevant findings during the workshops. This is due too the fact that our only purpose with these studies were to identify design patterns that made people collaborate and interact in a face-to-face setting.

The Sign requires the players to work in teams. They also need to cooperate within the team to collect points. In this game “the one man show” is totally impossible because the team mates need each other to become successful. One player cannot take action on his own without first communicating it to his team mate. Our main finding from this workshop was that *both players need to take action at the same time and the sign is used to coordinate the players’ actions.*

In Pictionary the piece of paper that the picturist draws on seems to have a central role in the game play. It is being shared heavily within the team and during the *all play category* (see appendix A for an explanation) the drawing is also shared between the teams. After the solution has been revealed the paper is once again passed around to be reviewed and commented. The flexibility of the paper seems to be critical for the game play and generates substantial amount of communication. It seemed as if the paper is being used as a mean for communication. The participants also moved around to be able look at the other teams’ drawings (e.g. leaned over the table). Our main

finding from this workshop was that *the drawing paper has to be shared both between and within the teams. The players often moved around the table to be able to see what the other teams were drawing.*

In the game Hide the key people guide a player towards a hidden key. They have information that the player searching for the key is lacking. Their mission is to communicate this information to him by using just two words. The rules state that only the words cold and hot are to be used but we observed people using more fine tuned clues by extending the words hot and cold. They used for example words like ice cold, stone cold, very cold, lukewarm, very hot and extremely hot. Our main finding from this workshop was that *one player act as a guide for the other.*

4.1.5 Collaborative Design Patterns

Based on our findings we have derived three collaborative design patterns. We argue that these patterns are very general in nature and can be reused in several games with the purpose of generating collaboration and face-to-face communication.

4.1.5.1 The Multiple Keys Pattern

This pattern is based on cooperation between the players. The players need each other to advance in the game. For example a door in the game can require two keys to be opened and one single player can only access one key. This makes cooperation necessary even in a game that is based on competition between the players. This pattern is heavily used in the game *the Sign* to force people to collaborate and communicate. The player needs to communicate with his team mate in order to collect points. It is impossible to collect points without the help of a team mate. This makes cooperation necessary to be able to play the game successfully.

This pattern is highly related to the information richness theory introduced by Daft & Lengel (1986). The game the sign that this pattern is derived from forces in fact the players to use body language to coordinate their actions by the use of the secret sign.

4.1.5.2 The Shared Screens Pattern

When using this pattern the playing field of the game is distributed on several of the players' screens and the players need to share their screen with their co-players. The pattern is found in the game *Pictionary* where the drawing paper is shared both within and between the teams. Without the ability to see the drawing the players cannot make any valid guesses. The drawing is also shared after each draw session for the purpose of being reviewed.

Handheld computers and mobile phones have at least one thing in common. They both have small displays. This has often been regarded as a major disadvantage when compared to non-mobile devices like stationary computers. Especially when discussing computer games. In our view game developers seem to focus too much on porting existing games to mobile devices instead of looking at the mobile device as a new type of gaming device that require different kinds of games. Games played on a stationary computer with a big screen; extremely good network and process capabilities are not necessary well suited in a mobile context.

We have chosen a different perspective in this pattern. We do not consider the small screen as a disadvantage. Instead we focus on the situations in which it becomes an advantage. When considering the situations in which a small screen has an opportunity to become an advantage physical and social presence becomes a key factor.

The possibility of combining screens to construct a bigger playing field is one example. Small devices can be moved around in an extremely flexible manner. People may move around with their device to get a view of the other players' devices. It might even be necessary to have access to the other players' screens to get the bigger picture of the game environment.

Luff and Heath (1998) have identified three types of mobility: micro mobility, remote mobility and local mobility. Micro mobility is defined as the way in which an artifact can be mobilized and manipulated for various purposes around a relatively circumscribed domain. Handheld devices are very flexible and can easily be moved and passed between individuals. The shared screens pattern makes use of the micro mobility that is associated with handheld devices. It forces the players to share their devices with each other. Furthermore the research conducted by Weilenmann & Larsson (2000) shows that teenagers use their mobile phones collaboratively. They compose SMS messages together and participate in the same phone call by passing the phone between each other. We therefore argue that this type of sharing of mobile technology is already present among teenagers today we just take these findings one step further by integrating them in a computer game.

4.1.5.3 The Guide-and-Follow Pattern

The guide-and-follow pattern is based on imperfect information and distributed information. The simplest way to understand this pattern is to think of a rally car in action. The car has a driver and a co-driver. The co-driver has information about the track and is responsible for giving the driver instructions to base his actions on. This player has the map but no possibility to steer; this makes cooperation necessary to successfully play the game. This pattern is highly present in the game *Hide the key* where the players that hide the key are responsible for guiding the searcher towards the key with the help of the two words; hot and cold. As seen in the workshops the players extend these words to be able to communicate more fine tuned clues. One might say that the players that hide the key has the map and are responsible for guiding the player searching for the key towards it.

Daft & Lengel (1986) discussed media in terms of four different properties. When using the guide-and-follow pattern among co-located people all four properties are relevant. Feedback can immediately be transferred between the gamers. This feedback can come in form of questions or in form of body language. The players can use different forms of language to be able to communicate more then just simple words. They can choose to raise their voice or they can choose to whisper, all depending on the situation.

4.2 Development Phase

The selection of computer games was made based on three different criterions. The three criterions were familiarity, ease of play and proven playable on existing mobile devices. The motivations for these criterions were that we wanted games that were easy to learn and to play on a mobile device. We did not want to risk that to much time would be spent on learning how to play the games during the evaluation phase. Furthermore we wanted the individual game sessions to be short and rapid. The selected games were Pacman, Tetris and Asteroids. These games are all classical and highly addictive computer games. They are also well known and easy to learn.

Four different prototypes were developed, one for each collaborative design pattern. Two of the games were developed by students attending to the course Mobile Applications and Networking 2002 at the IT-university in Göteborg. The games were used with permission from the developers. Even though four games were developed only three of them were used in the evaluation. The game we chose not to use in the evaluation is called PocketPong and is a version of the very famous Pong game. The game is described in appendix B. The other three games are described in detail on the following pages.

ScoreTrek (2 – 5 players)

By: Johan Larsson, Johan Skårman

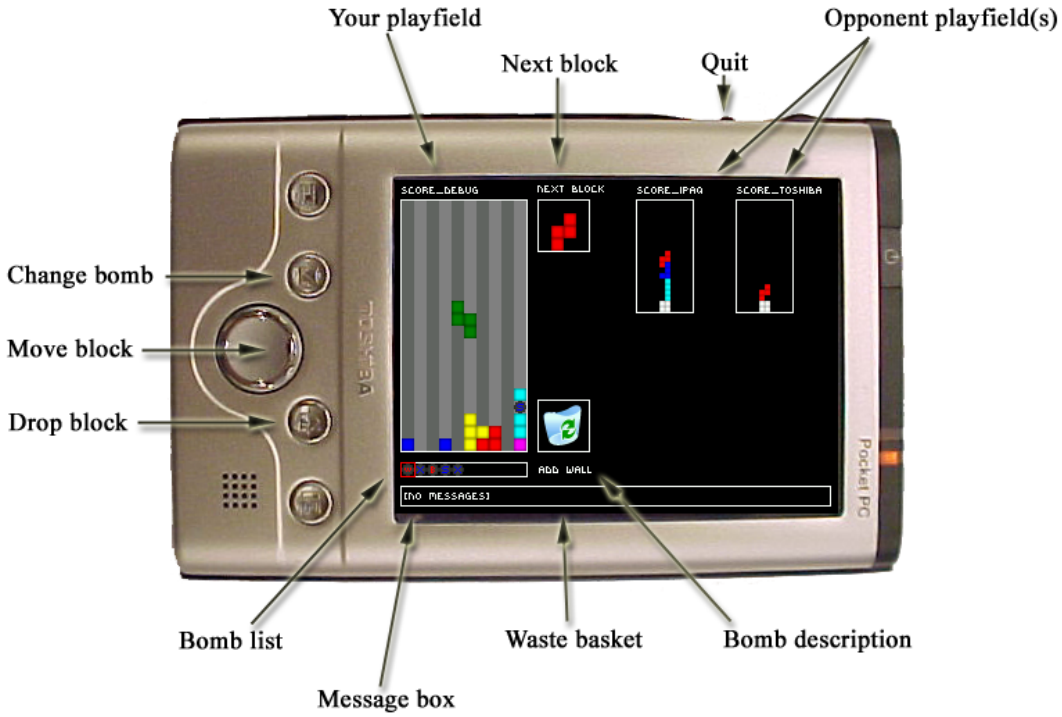

Figure 4:1 ScoreTrek

ScoreTrek is a Tetris *(See High Score! The Illustrated History of Electronic Games page 196-197)* clone for handheld devices based on the multiplayer version Tetrinet which can be downloaded at **http://www.compubum.com/tetrinet/**. The aim of ScoreTrek is to organize the blocks on your own playfield as smart as possible, just as in the Alexey Pajitnov's original Tetris. In addition you can sabotage or help the other players using bombs. These bombs can do all sorts of things like add/delete a row, remove all opponents' bombs or even switch playfield with another player. New bombs will appear on your playfield during the game.

The bomb list is located just under your playfield. Bombs that are located in the bomb list are ready to be used. All players will have five bombs in their bomb list from start. The functions of the initial bombs are selected randomly and the players can and often therefore have different bombs in their bomb list from start. The bombs have two different colors: red and blue. Red bombs are considered bad and blue bombs are considered to be beneficial. The bombs can be used on your own or your co-players playfield. The bomb is used by clicking on the preferred playfield. This is however a bit tricky because you can not use the bombs without cooperating with a co-player. This is the way that ScoreTrek implements the multiple keys pattern described earlier. The player you choose to cooperate with need to have the bomb you want to use in his bomb list otherwise you will not be able to use the bomb. In other words you can only use bombs that belong to the common set of the player you cooperate with and your own set of bombs. Furthermore both you and your co-player need to activate the same bomb and after this is done both of the players need to choose the same playfield to

use the bomb on. The player that first activates the playfield becomes the one placing the bomb. After the bomb has been used it is removed from both of the players the bomb lists. New bombs are acquired by clearing the lines that contain bombs. The acquired bombs will appear in the player's bomb list.

The falling Tetris blocks are moved using the big round button called the joypad. The players can drop the block all the way down using the small button just under the joypad. To activate a bomb you first select the desired bomb in the bomb list using the button just above the joypad or just click on the bomb in the bomb list. To choose a victim you click on the selected victim's playfield.

ScoreTrek uses the multiple keys pattern. This is done in a way that a single user can not use the bombs by him self. He must negotiate with another player to be able to use them. They have to decide what bomb to use and whom to use it on.

Pacman must die! (2-5 players)

By: Alexander Jaako, Annelie Lundén, Stefan Lönn

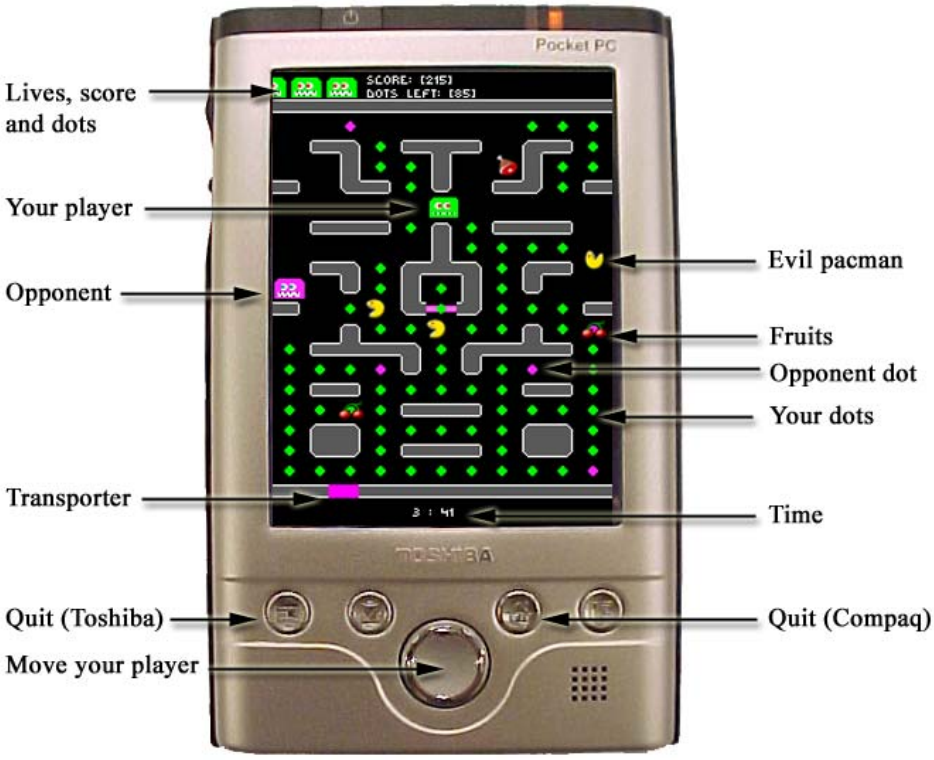

Figure 4:2 Pacman must die!

This game is based on the traditional game Pac-Man *(See High Score! The Illustrated History of Electronic Games page 62-63)*. The original arcade game was a single player game where your mission as Pac-Man was to eat dots and at the same time avoid sinful ghosts.

In "Pacman must die!" the first digital superstar, Pac-Man, has turned evil. Your character now, is one of the ghosts trying to take back all dots from evil Pac-Man who is hunting you at the same time. Since Pacman must die! is a multiplayer game it is a race against all other ghosts (your opponents), whoever eats all their dots first wins. There are also different items, just as in the original game, that you can collect which will complicate things for you or your opponents. Example of such complications is to increase/decrease opponents speed or freeze the opponent totally for a period of time. There is also an item that flips your screen up side down which makes it harder for your opponents to steer their ghosts.

Pacman must die! use the shared screens pattern. This is implemented by distributing some of your dots on other players' playfield so to collect all dots belonging to you, you need to use transporters (doors scattered around on your playfield) to move your ghost to someone else's screen. The pink door down to the left on the picture above is a transporter. When you enter this door you are automatically transferred to another players screen. Once there you steer the ghost from your own handheld device as

usual, but you need to look at your co-players screen in order to see your ghost. The game has multiple levels and the player that first finishes eating all his dots wins. The players are then transferred to a new level.

Earth Defenders (2 – 5 players)

By: Jonas Bylund, Erik Ruisniemi

Figure 4:3 Earth Defenders

Earth Defenders is very similar to the successful arcade game Asteroids *(See High Score! The Illustrated History of Electronic Games page 49-50)*, shipped by Atari in the 70's, where you have a top-down view of your space ship which can be rotated 360 degrees, accelerate/de-accelerate and shoot. The mission, in Earth Defenders, is to save the earth from being attacked by enemy ships. This is true for all players except one. If there are five players in the game one player takes the role as the Opposition Commander that coordinates enemy ships. When less than five players the Opposition Commander is handled by an AI implemented player. When participating in a five player session four people is trying to defend the earth from the fifth player trying to place the enemy groups as smart as possible. The different roles are given the player based on the order that they connect.

Earth Defenders uses the guide-and-follow pattern. Each player has a specific role in the game. Some players are Star Fighters, players that shoot down enemies with their plane. Others coordinate the Star Fighters to the right place depending on what information they get on their radar screen. All coordination is done verbally. Below is a short description of the different roles in Earth Defenders.

- Combat strategy (1player) – The Combat strategy player has a radar screen that sweeps over the whole battlefield. With this overview you can alert your team members of upcoming attacks.
- Star fighters (1-2 players) – Star fighters are long range spaceships that can navigate freely in space and hunt down enemies far out in the outer perimeters.

- Orbital defense (1 player) – The player responsible for Orbital defense takes care of enemies that slipped through the outer defense of the Star fighters. With its rapid firepower Orbital defense navigates in orbit of the earth.
- Opposition command (1 player) – As Opposition command you are constantly looking for gaps in the defense and places enemies in those gaps. A loss for mankind is a victory for this alien scum.

4.3 Evaluation Phase

We evaluated the prototypes during a period of two weeks in local high school cafeteria in Gothenburg. The participants were both males and females in the age between 15 and 18.

4.3.1 Selection of Participants and Location

Teenagers of today have a broad experience in the use of mobile technology in the form of mobile phones. They also have experience of traditional game play and computer games. Finally teenagers normally socialize and hang out in groups. We believe that these facts made teenagers an ideal group for testing our collaborative computer games and a high school cafeteria appeared to us as a natural choice of place.

4.3.2 Data Collection and material

We used six Compaq iPAQ 3630, a digital camera; an mp3-player with recording abilities and game instructions during the evaluation.

The conversations were recorded with the mp3-player and interesting actions were captured with the digital camera. The participants were unaware of the fact that their conversations were recorded. The fact that we do not plan to distribute or publish the audio materials anywhere we chose to leave the ethical discussion out of this report. We also took extensive field notes during the observations and were always two observers in the field at the same time.

As mentioned earlier we organized our field notes using only two categories. These categories were stimulated and spontaneous interactions. Our research is mainly focused on the stimulated interactions that occurred during the use. This is why we have chosen to only report stimulated interactions during game play.

As mentioned earlier we had three different design patterns to evaluate. We chose to isolate the design patterns from each other during the evaluation. Therefore we only evaluated one design pattern at the same time. This was mainly done because we wanted to be able to follow how the pattern affected the participants during a longer timeframe and also alternating between different patterns could possible have confused the participants.

5 Research Result and Analysis

In this chapter we present our findings from our two week observation of teenagers playing mobile face-to-face collaborative computer games at a local high school cafeteria in Gothenburg. The chapter is divided into three subchapters and each chapter reports of the use of one collaborative design pattern.

5.1 The Shared Screens Pattern

In this chapter we report our findings from the evaluation of the game Pacman must die! This game implements the shared screens pattern.

When playing Pacman must die! we observed that the players organized themselves in different physical formations. We identified five different physical formations and these formations seem to be connected to the level of experience the players have in playing the game.

The Line Formation
Gamers with low level of experience of playing this game usually started the game session sitting down in a line formation. This can be seen in picture 5:1 A and 5:1 B. When organized in this formation the gamers are obviously not very flexible, maybe this is why more experienced gamers seem to avoid this formation.

Figure 5:1 Teenagers playing Pacman must die!

The Pair Formation
The pair formation is rather similar to the line formation and is also used among less experienced gamers. The pairs are constantly changing and the formation seemed however more flexible than the line formation. When organized in this formation the gamers sit in pairs of two. This formation can be seen in picture 5:1 C where two of the players sit together. On the picture the left most girl are steering her ghost on the other girls´ screen.

The Circle Formation
When the gamers got more experienced they seemed to realize that they all benefit from collaborating with each other. This is where the more flexible circle-like formation begins to emerge. When organized in this way the gamers can easily switch places with each other. The circle-like formation can be seen in picture 5:1 D. It is usually seen with gamers that stand up even though we have observed circle-like formations among gamers sitting down as well. The inner order of the circle was constantly changing but the circle formation still held rather well.

The Chase Formation
Several times the players started to run around in the cafeteria while screaming loudly to each other. This behavior seems to be triggered by the players who decided to hide their screen to make it harder for their co-players. Picture 5:1 F, where four girls are engaged in a chase, illustrates this formation.

The Over the Shoulder Formation
We observed gamers that seemed to prefer to have a relatively quiet role during the game. These types of gamers did not talk much; they seemed to prefer to navigate around the screens by looking and listening to the other gamers instead of asking. These gamers often stood behind the other players to be able to see their screens. One of these gamers can be seen in picture 5:1 E. We choose call these gamers for *over the shoulder gamers*.

Many gamers used physical contact to get access to other players' screens when necessary. The pictures E and F illustrate this observation. In picture 5:1 E the girl to the right grabs the left most girl's device to get a better view. In picture 5:1 F the gamers are in movement and the left most girl grabs the girl in front of her by the arm to stop her.

Often people that were not directly involved in the game were watching the gamers and their screens. In picture 5:4 E one girl is watching another girl play. Picture 5:4 F illustrates the same thing where the left most girl is studying the two active gamers. They asked question about what the game was about and how to play it. When they wanted to take a more active part in the game the active players often refused to give up their gaming device.

Figure 5:4 Teenagers playing Pacman must die!

Several times one of the players had to leave the game, to go to class, before the game was finished. The game design did not support this dynamic use. The players then solved this problem by borrowing the leaving player's device to be able to continue playing the game. In picture 5:4 D the two gamers has borrowed another player's device to be able to continue playing. They have placed the device so it is visible to both of them. What triggered this behavior is actually a design flaw but this specific flaw did seem to generate some interesting physical sharing of devices.

Some of the gamers had more skill playing the game and we observed that several of the less skilled gamers tried to compensate their lack of skill by hiding their screen for their co-players. This is probably what triggered the chase formation. It also triggered behaviors like the one illustrated in picture 5:4 C where a player throws her self over the player that tries to hide her screen.

As mentioned in the description of the game Pacman must die! the game has a feature which makes it possible to switch the other players' screens by collecting a specific fruit placed somewhere on the screen. This has the effect that the player has to steer his ghost upside down, which is a bit tricky. Several times the gamers rotated their devices upside down when this feature kicked in. In this way they tried to bypass the difficulties generated by the feature. This behavior can be observed in picture 5:4 A and 5:4 B.

One time we observed two gamers switching devices during the game play. This was done in a situation where they were collecting dots on each others screens. However they soon realized that this was no solution to the problem because the steering mechanism was still connected to their own ghost. They rapidly switched back to their own devices to be able to continue gaming.

As described earlier the game Pacman must die! has color keyed doors, called transporters, that lead to the other players' screens. When a player enters a door he ends up on another player's screen. The stimulated interaction that occurred during game play seems to be highly connected to these doors and their corresponding color.

During game play the players need to know who has the device with the color that corresponds to the color of the door he or she plans to enter. The gamers solved this problem by asking each other what colors they were. When they had determined who had a specific color they took action by moving themselves physically to be able to see the screen. They then moved the ghost through the door. A typical situation could look like this:

Player 1: Hmm where should I go?
Player 1: I'll go to green! Who is green?
Player 2: Right next to you.
Player 1: Ok! I am coming baby!

Player 1 starts out by thinking aloud. She then decides where she is to go and asks the other gamers who have the color that corresponds to the color of the door she plans to enter. Player 2 then gives her enough information for her to act upon. She then confirms that she is on her way over there. First she moves her self physically to be able to see the screen and then she moves her ghost through the door.

5.2 The Multiple Keys Pattern

We evaluated this pattern using the multiplayer Tetris clone ScoreTrek. When playing this game the participants divided themselves in teams of two before starting to play. This dividing always went effortlessly. The game did not generate any physical movement worth mentioning but the stimulated conversations we observed were much more sophisticated than during the game Pacman must die!

During game play players often seemed to forget the effect of the bombs and this triggered a lot of communication between the players. We observed participants discuss the different functions of the bombs several times and sometimes none of them knew what a specific bomb was to be used for. The interesting thing we observed in this situation was that when discussing this with their co-players they almost always arrived at the right answer. It seemed as if the group had a collective memory.

The game requires the players to communicate with each other by only allowing them to use bombs that belong to a common set of two players. This is illustrated in figure 5:4. In other words a player has to form a team with another player to be able to use any bombs. Furthermore they can only use bombs that they both have available in their bomb list at a given time and they also have to activate the same bomb. When activated anyone of them can use it.

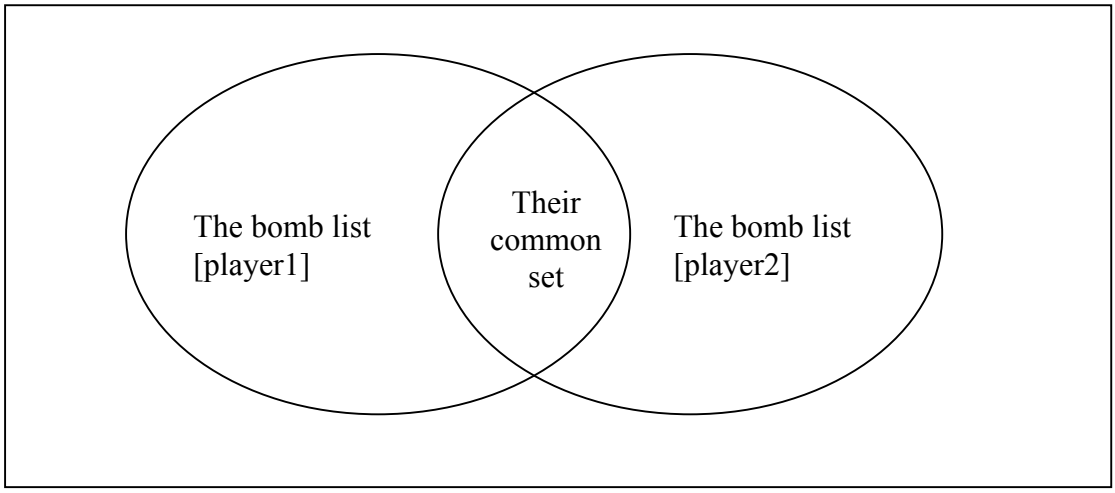

Figure 5:4 the common set

The multiple keys pattern as implemented in the game ScoreTrek generated substantial amount of stimulated communication between the players. First they tried to establish which bombs belonged to their common set. Several times they also tried to establish their future common set by scanning their play field for bombs that were going to be a part of their common set in the near future. In the beginning this process appeared to be very complex and time consuming. As time progressed the players learned how to distinguish the different bombs from each other and this led to more sophisticated ways to establish their common set.

Here is how two different teams could solve the same problem in different ways. In both of the teams one player has a “blue plus sign” and he wants to know if this bomb is part of their common set.

Inexperienced gamers
Player 1: Do you have a “plus sign”?
Player 2: Yes.
Player 1: What color does the “plus sign” have?
Player 2: It is red.
Player 1: Ok mine is blue. I only have blue bombs!
Player 2: All my bombs are red.

More experienced gamers
Player 1: Do you have any blue bombs?
Player 2: No

In both of these scenarios both of the teams achieve the same result but the last scenario is a much more effective way of solving the problem. In the first example the players have not understood the power of using the color of the bomb in their communication. The more experienced players understands that if their team mate is lacking blue bombs there are no point in asking more questions in this specific situation.

When the players decided who to use the bomb on the chosen player often reacted very strongly. Sometimes they also expressed anger and threats about revenge.

Several times some players looked at each others screen to establish their common set. In this way the game ScoreTrek can be classified as a game that implements the shared screens pattern as well as the multiple keys pattern. This behavior was nothing that we had expected to generate when designing the game.

5.3 The Guide-and-Follow Pattern

This collaborative design pattern was evaluated with the game called Earth defenders. The game is the most complex of the three games developed. This led to the fact that the participants were a little confused when playing the game for the first time. The opposition commander seemed to have problems with communicating the direction of the approaching enemy groups. He also seemed to forget to direct the different co-players to different places. This had the effect that all star fighters headed towards the same enemy group, leaving the earth open to attacks from all other angles. As time progressed they grew into their roles better and this made them more effective. They decided for example to divide the screen in four different areas where on player was responsible for a single area. The opposition commander then warned the players when an enemy group was approaching their territory. The opposition commander constantly informed the other players of the current status of the earth.

The roles are given a player based on when he connects to the game. Not knowing this the gamer's switched devices physically with each other, before starting the game, to be able to get to play the role they wanted. The dividing of roles was designed in this way to have an easy way of controlling the number of roles. There can for example be only one Opposition commander and only one orbital defense. This design decision made the gamers exchange devices with each other.

The Opposition command used the spectrum of his voice to be able to communicate more than just the words transferred in the message. He could for example scream to one of his co-players when an enemy group came very close. When the enemy group where at a greater distance he used a more normal tone of voice. We believe that this made the gamers feel more engaged in the game.

During the observations of the game Earth Defenders, implementing the guide-and-follow pattern, the Opposition command often showed his radar screen to his co-players. This made it easier for him to divide the different enemy groups to the players engaged in defending the earth, as Star fighters.

6 Discussion

Our purpose with this research was to design computer games that made gamers collaborate and interact with each other in a face-to-face setting. Furthermore we wanted to learn how teenagers used these games and how the social shaping of this use was to affect the games. Our evaluation has showed that the developed computer games generate this collaboration and interaction among the gamers. Teenagers also seem to enjoy playing this type of computer games.

Furthermore we have moved the findings reported by Weilenmann & Larsson (2000) and Taylor and Harper (2001) on collaborative use of mobile technology among teenagers one step further. This was done by integrating the collaborative aspects they have reported on into mobile computer games. The games tested did not only allow collaborative use but also encouraged or forced it. As said earlier we call these games mobile face-to-face collaborative computer games. Our evaluation has shown that teenagers enjoy this type of social computer games. The local sharing and using seemed to occur very natural among the teenagers we studied. Several of the participants asked us when these games were to be released for mobile phones. This indicates that there is a commercial potential for this type of games.

Taylor and Harper (2001) argue that the social context often shapes the use of technologies. Our research has tried to make this shaping visible. We observed that teenagers tried to bypass features that were implemented in the games by for example turning the device up side down or switching devices with each other. Our view of teenagers is that they are very creative users. We therefore believe that one cannot foresee how the use of a new service or technology will be used before one has actually studied its use. It seems as if teenagers are an ideal group for testing new and innovative design ideas on. Our experience shows that teenagers show no fear when introduced to new technology and they seem to prefer using a trial-and-error approach over being told how to handle the device. The game instructions we had designed and brought to the evaluation were given very little attention by the teenagers. We also observed that people not involved in the game learned how to play by watching other gamers play. This could of course have tremendous impact on the design of new technology. One might argue that developers need to consider this when designing technology targeted for teenagers. Developers cannot expect users to read a thick manual or listen to someone instructing them; instead they will need to design for this trial-and-error approach.

The shared screens approach is the pattern one should use if one is to generate physical movement. To generate more sophisticated communication one should use the multiple keys pattern or the guide-and-follow pattern. The evaluation has shown that the patterns can possible be used together in the same game with positive results. Our experience show that the multiple keys pattern can in some cases resemble the shared screens pattern to a very high degree. We observed gamers playing ScoreTrek who tried to establish their common set by looking at each others screens. The same was true with gamers playing Earth Defenders. The combat strategy player showed his screens to his co-players several times. The relation between the patterns seems to be stronger than we had anticipated. This suggests that we ought to try to combine the

patterns in the same game and then study its use. Maybe we then will be able to say more about the relations between the patterns than we can do today.

The three types of mobility described by Luff and Heath (1998) are all supported by the games we have studied. During the evaluation of the shared screens pattern gamers were forced to use the flexibility of the mobile device to its maximum to be able to play. Luff and Heath (1998) call this type of mobility micro mobility. Furthermore we observed people running around in the cafeteria screaming to each other. Luff and Heath (1998) categorize this type of mobility as local mobility. Finally by using a platform supporting the ad hoc networking technology the games do not require any local infrastructure and therefore the games also support what Luff and Heath (1998) call remote mobility. Based on these facts we argue that the games developed during this project are actually truly mobile computer games.

6.1 The Shared Screens Pattern

During our observations of this collaborative design pattern we identified five different physical formations. These formations we chose to call the line formation, the pair formation, the circle formation, the chase formation and the over the shoulder formation. We believe that there are a strong connection between the level of experience the players have in playing the game and these five physical formations. As the level of experience grows among the players the more flexible physical formations they seem to choose. They try to make, what Luff and Heath (1998) call micro mobility, flow as easy as possible. The teenagers we studied seem to have no problem with being physically close to each other during game play. Furthermore they often grabbed each others devices to be able to see them.

6.2 The Multiple Keys Pattern

Most of the communication and collaboration that we observed during the evaluation of this pattern was connected to the establishment of two players' common set. This feature was very successful in generating communication and collaboration between the players. The fact that the players in some cases shared their screens to be able to establish their common set more easily made us realize that this collaborative design pattern could possibly be combined with the shared screens pattern.

The players seemed to constantly forget what the bombs in their list were to be used for. This possibly means that the interface of the game needs some polishing to be more intuitive. However this design flaw let us observe what we call the collective memory. When discussing the bombs with their co-players they almost always arrived at the right function of the bombs.

6.3 The Guide-and-Follow Pattern

We used the game called Earth defenders during the evaluation. This game seemed a little more complex for the gamers to understand then the other two games. The game required more time to be able to play it successfully. This pattern also triggered screen sharing. The fact that the different roles were given the players based on the order in which they connected forced the gamers to exchange devices with each other to be able to get the role they wanted. The pattern did not generate any physical movement but the conversations that occurred during the game play were very dynamic. The

opposition commander used the dynamics of his voice to be able to communicate more than just words. This is what Daft & Lengel (1986) call complex processes and it is described in detail in their media richness theory. When screaming to his co-players they reacted more strongly and they took immediate action.

7 Conclusion and Future Work

Our research has shown that mobile multiplayer computer games can be constructed so that apart from the enjoyment of interacting with others the players can take on enemies and tasks with greater ease since they can achieve more together than individually, as in Earth Defenders. A computer game can also be constructed so that it requires people to communicate face-to-face and force them to let the other players view their screens during game play, as in ScoreTrek and Pacman must die! Furthermore we have shown that services suitable for ad hoc networks can be designed to make use of the necessary physical proximity that often is being viewed as a major drawback when discussing ad hoc networks.

The most interesting pattern to study was the shared screens pattern. The behaviors we observed were far beyond what we had anticipated. We therefore suggest that further research should be conducted here. Different computer games, based on the shared screens pattern, could easily be developed and studied. Our data on the use of the multiple keys pattern and the guide-and-follow pattern show very interesting results but we still believe that for a full coverage of their use more data has to be collected, maybe in the form of interviews with the participants. The timeframe should also be extended to several weeks and if possible, the participants should be equipped with their own device during this timeframe.

The collaborative bomb framework used in the game ScoreTrek showed very useful for generating sophisticated communication between the players. This suggests that it can be used in several other types of games. We therefore plan to design a more general version of this collaborative bomb framework that can be used when developing other mobile face-to-face collaborative computer games. This framework will be released for public download at http://jojosoft.gapidraw.com.

Combining the three patterns in one mobile face-to-face collaborative computer game is another area we leave unexplored in this project. When the general collaborative bomb framework is developed we might design a game that implements and uses all three collaborative design patterns we have described in this report.

During our evaluation we let the teenagers borrow a mobile device. This was due to the fact that not many teenagers today own a handheld computer and therefore we could not study its natural use. This made it impossible for us to study the remote mobility aspect of the games. Questions like: Where would teenagers play mobile collaborative face-to-face computer games? Would they share the device with their co-players in the same way if they owned the device or would they be more careful with the sharing? These questions remain unanswered. We therefore believe that further research has to be conducted to answer these very important questions.

Finally we argue that people ought to be explorers and therefore we ought to explore new ways of using technology available today. In doing this we need to realize that when technologies are adopted they become part of an already established social context and this context often shapes the use of technologies. Our research has been very explorative and we believe that we have contributed to widening the concept of what a computer game really is. We hope that more research will be conducted within this area in the future.

If more time had been available we would have complemented our observations with interviews to capture the participants' subjective opinions and thoughts about the mobile face-to-face collaborative computer games.

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8.3 Electronic resources

ACM, http://www.acm.org

Flipcode, http://www.flipcode.com

Gamedev, http://www.gamedev.net

GapiDraw, http://www.gapidraw.com

OpenTrek, http://www.opentrek.com