

Pervasive GameFlow

Identifying and Exploring the Mechanisms of Player Enjoyment in Pervasive Games

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PhD Thesis May 2009
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ISBN: 978-91-7264-771-8

ISSN: 1401-4572, RR-09.01

Cover Artwork: Johan Bodén|Creative Camp

Tryck/Printed by: Print & Media, Umeå University
Umeå, Sweden 2009

Acknowledgements

Thank you Charlotte Wiberg for you advise and endless support on all levels, and for introducing me to the great world of HCI research- I hope we still have plenty of fun projects ahead of us!

Thank you main advisor Mikael Wiberg and former main advisor Victor Kaptelinin for your support, advise and for sharing your wisdom,

Thank you John Waterworth, Anna Croon Fors, Karin Danielsson, Daniel Fällman and Henrik Wimelius for your time and valuable feedback during and after the pre seminar,

Thank you Johan Waterworth for the excellent proof reading that really helped me improve the manuscript,

Thank you Johan Bodén for the excellent cover art work,

Thanks to It's Alive!, Resolution Interactive (Matti Larsson), Simon Vincent and Daniel Gjørwell for the fruitful collaborations in our projects,

A very special Thank you to my wife Johanna and my kids Emma and Gustav- for your love, support and patience; you are my reason.

Preface

This thesis is a collection of five papers, complemented by a cover paper. In order to achieve some flow in the text, I have chosen to place the five papers as an integrated part of the cover paper, and not as a separate collection in the end of the thesis.

The following papers are included in the thesis:

Paper 1: Jegers, K. & Wiberg, M. (2006) Pervasive Gaming in the Everyday World. In IEEE Pervasive Computing, January-March 2006 (Vol. 5, No. 1), pp. 78-85.

Paper 2: Jegers, K. (2008) Investigating the Applicability of Usability and Playability Heuristics for Evaluation of Pervasive Games. In proceedings of ICIW'08: Third International Conference on Internet and Web applications and Services, Athens, Greece, 8-13 June, 2008.

Paper 3: Jegers, K. (2007) Pervasive GameFlow: Understanding Player enjoyment in Pervasive Gaming. ACM Computers in Entertainment. Vol. 5, Issue 1. Article 9 (January 2007).

Paper 4: Jegers, K. (2007) Pervasive GameFlow: A Validated Model of Player Enjoyment in Pervasive Gaming. In C. Magerkurth & C. Röcker (eds.): Concepts and Technologies for Pervasive Games; A Reader for Pervasive Gaming Research vol. 1. Shaker Verlag, Aachen, Germany, December 2007, ISBN 978-3-8322-6223-5.

Paper 5: Jegers, K. (forthcoming) Elaborating Eight Elements of Fun: Supporting Design of Pervasive Player Enjoyment. Accepted for publication in ACM Computers in Entertainment, scheduled for Vol. 7 Issue 2, April/June 2009.

Parts of this work have been funded by the European Union and VINNOVA.

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Abstract

Pervasive games are computer games that build, to various extents, on social interaction as a driving force in the game play, on integration between physical and virtual worlds and on constant access to constantly ongoing games from virtually every existing context (anytime, anywhere gaming). This new genre of computer games presents many challenges for both researchers and industry; one of the most important is how to understand enjoyable player experiences in this new kind of computer gaming.

The purpose of this thesis is to *identify and explore the mechanisms in pervasive game designs that are of most importance for creating enjoyable Pervasive gaming experiences*, and further to translate the findings of the exploration into a *playability model* for pervasive games.

My empirical work focuses on the most important aspects for creating enjoyable player experiences when playing pervasive games. Evaluation methods from the usability and playability area have been deployed in order to identify what factors and aspects the players consider of most importance for their experience when they play pervasive games. Three specific pervasive games have been studied; SupaFly, Pervasive Treasure Hunt and Furiae.

Theoretically, the thesis departs from existing knowledge about Playability, and the most prominent and accepted frameworks for understanding player experiences in computer gaming have been considered. Of the existing models and frameworks, the GameFlow model was selected as a theoretical point of departure.

The main contribution of the thesis consists of a model for understanding player enjoyment in pervasive games - the Pervasive GameFlow model. Pervasive GameFlow elaborates the GameFlow model by adding 14 new criteria identified in the empirical evaluations of three pervasive games, criteria of great importance for enjoyable Player experiences in pervasive games.

Further, the thesis answers questions concerning how the players are putting the anytime, anywhere and mobility aspects of pervasive games into practice - how they perceive and handle games that offer constantly ongoing game play. The results also provide insights into the reach or impact of the novel Pervasive aspects of pervasive games and their importance for the players and player experiences. Finally, the thesis provides notes on how evaluation of pervasive games should be performed.

Part 1: Introduction

Millions of people play computer games every day, and it is fair to say that computer games are currently one of the most widespread applications of Information Technology (IT) in the technologically more advanced parts of the world. Beautiful and innovative combinations of art, technology, interactivity and storytelling in the shape of computer games, developed both in commercial industry and more independent contexts, are currently entertaining mass markets of players. Accordingly, computer games have drawn attention from many different research disciplines, spanning from computer science, humanities, social science in general and Informatics in particular. The unique interplay of people and IT that computer games enable make them an interesting and relevant object of study for Informatics and the research field of Human-Computer Interaction (HCI), as the games pose interesting and important challenges for our understanding of the interaction between humans and computers on many levels.

During the last two decades, computer games have served compelling and interactive experiences to an increasing audience. With the goal of providing people with new, innovative and rich experiences, the computer gaming industry has an established history of pushing and driving the development of consumer IT on many levels. The history of IT reveals numerous examples where the domain of computer games has initiated or adopted very early technological innovations, such as technology for compelling computer graphics, alternative interaction styles and social connectivity enabled by the Internet.

It is therefore no surprise that researchers in the early years of the 21st century noticed a growing interest in computer games building on so called *Ubiquitous computing technology*¹ (Björk et al., 2002) as the rising development of Ubiquitous computing devices (such as wLAN connected PDA's, smartPhones, RFID tags etc.) inspired and challenged developers and researchers interested in computer games.

Today, we can see the outcome of this initial interest in the many examples of experimental and innovative computer games that currently go by the collective name of *pervasive games*.² Springing from the ubiquitous

¹ See Part 3 for a short description of Ubiquitous computing.

² Pervasive games challenge the boundaries of traditional computer gaming and our notion of what a computer game is, by integrating various kinds of

computing vision about constant access to computational technology in all possible everyday life contexts (see Weiser, 1993, Lyytinen & Yoo, 2002, Nieuwdorp, 2007, Greenfield, 2006, etc.), pervasive games are today one of the most interesting experimental application areas for Ubiquitous and Pervasive computing technology and represent an interesting vision of current and the near future development of computer games.

Current literature and research on pervasive games (see Magerkurth et al, 2005 or Magerkurth & Röcker, 2007 for examples) most often focus on technological, social, and software architectural aspects. A common theme in related research is the focus on innovation and exploration of the limits or boundaries of pervasive games, and the related research provides very valuable insights into what pervasive games actually can be. By giving examples of pervasive game designs and prototypes, related research tests the concept of pervasive games and points to both challenges and opportunities for pervasive game development as well as illuminating the potential impact pervasive game play may have on people's social norms and conventions in various contexts of everyday life. Few comprehensive attempts, however, have been made to specifically address the issue of *player experiences*³ in pervasive games.

As is the case with most other computer games (with a few rare exceptions in the shape of "serious games" developed for learning and simulation contexts), the major goal or purpose of pervasive games is to create an entertaining experience for the player(s), since the major point and meaning of playing computer games is generally based on the ability of the games to deliver fun. Considering the motivational factors behind people's use of computer games⁴, it becomes clear that a fundamental reason for the appeal of computer games is the ability to deliver experiences of fun; experiences in character clearly different from those evoked by productivity focused objectives or the everyday chores of life. People turn to games for the reward of having extraordinary experiences beyond what other sources in their everyday world can offer.

ubiquitous and pervasive computational technology in game designs. This relatively new genre of computer games often builds on social interaction between players, constant access to constantly ongoing games and integration between physical and virtual worlds in order to create amusing gaming experiences. See Part 2 for a more detailed description

³ A concept used to describe User Experiences (UX) in computer gaming.

⁴ Such as the ability of the game to evoke for instance challenge, fantasy and curiosity; See Part 4 for a brief overview of motivational factors in computer gaming.

If a computer game fails to create an experience of fun for its player(s), the game becomes meaningless from the perspective of the player(s). This implies that knowledge about the quality of the player experience is of fundamental importance to any person or team of people designing pervasive games (or other computer games), as well as for anyone who wants to understand what makes pervasive games fun to play. The research area of Human-Computer Interaction (HCI) has a strong history of developing exactly this kind of knowledge and is therefore particularly well suited to developing new knowledge about Player experiences in Pervasive gaming.

Pervasive games challenge current ways of understanding and dealing with User Experiences in general, and Player experiences in computer gaming in particular. Most traditional models and frameworks for understanding User experiences developed in HCI (such as the usability concept) have been developed within the desktop computing paradigm. The same goes for the specific frameworks for understanding Player experiences in computer gaming that so far have been developed, such as the Playability⁵ concept (see for example Desurvire et al, 2004, Fabricatore et al., 2002, Sweetser & Wyeth, 2005). Traditional computer games build on rather traditional computational technology, and the established ways of understanding Player-computer game interaction and player experiences are based on studies of traditional computer games, which lack many of the fundamental and important features that pervasive games are built on.

The area of pervasive games provides an interesting opportunity to study Human-Computer Interaction and User experiences in a way previously not pursued in academic research. Pervasive games, with their novel ways of delivering gameplay, broaden the possible ways of interaction with computers and computer games and in the end, how we experience computer games. These new experiences needs to be addressed and understood in research, in order to broaden our understanding not only of pervasive games, but of Human-Computer Interaction at large in the next computing paradigm.

From the perspective of pervasive game design, knowledge about player experiences and playability for pervasive games would benefit designers of pervasive games, as it could be deployed to increase the possibility that the games deliver high quality (in terms of fun) Player experiences. From a wider perspective, knowledge about playability of pervasive games would most

⁵ See Part 4 for a description of the playability concept.

certainly increase the general understanding of what pervasive games are and what kind of Player experiences they can evoke.

Following this line of thought, it becomes clear that there is a need for knowledge concerning the playability of pervasive games and an opportunity for academic research and scientific contributions in the area of playability, player experiences and pervasive games.

A traditional and well-established strategy for generating, structuring and presenting general knowledge about user experiences and playability is to make theories, models or frameworks⁶ of different phenomena. The intention with these is to describe general knowledge about a phenomenon in a way that both enhances the general understanding of the phenomenon that the model addresses, and in many cases also makes the model suitable for “filtering” the rich variety of feedback and observations that empirical observation of Human-Computer interaction will produce. To some extent, many models in the HCI area also have the ability to support predictions about user reactions, the human experience or human performance in relation to software performance, in the particular interaction contexts for which the model is created. Shneiderman (1998) notes that in the HCI area, theories (or models, or frameworks) can be both explanatory (assisting in the interpretation of something observed) and predictive (to some extent foreseeing the outcome of different design solutions). An aspect shared by all of them, however, is that they are abstractions of reality and therefore incomplete in some sense. Their quality is assessed in terms of how understandable they are, to what extent they produce similar conclusions for all who use them and whether or not they actually help solving specific practical problems of the area for which they are created.

Different kinds of models have been developed over the years to describe concepts such as usability (e.g. Nielsen, 1993, Nielsen & Levy, 1994) and playability (e.g. Desurvire, 2004, Lazzaro & Keeker, 2004, Thomas & Macredie, 1994, Salen & Zimmerman, 2004). A common feature of the models in HCI is that most of them spring from empirical evaluations or studies of actual users or players performing the specific interactions or phenomena that the model is focusing on. The empirical observations about user/player behavior is then analysed and structured into some kind of

⁶The terms model and framework are often used interchangeably in the HCI literature since they both describe some sort of more general principle, theory or rule for a specific phenomenon, often based on extensive empirical research.

model or framework (or heuristic, or checklist, or abstraction; many names are used when describing the outcome), which focuses on describing the aspects of the object(s) of study in a way that translates the specific findings from the specific evaluations/observations into a structure that describes the general phenomena revealed in the specifics of the situation that generated the findings.

A model in HCI can be very useful in many ways. First, it can be used in order to better understand an HCI phenomenon when approaching it. An example is to use Nielsen's (1993) ten usability principles in order to approach the issue of understanding why no one uses your recently designed bookkeeping system, despite all its technical superiority. Second, the model can serve as a platform for evaluation of specific systems in the category for which the model have been developed. An example is the Heuristics for Evaluating the Playability (HEP) model developed by Desurvire et al. (2004), which describes the most important aspects of a computer game design from a playability perspective - how different factors contribute in making the game fun. The model can be used as a foundation or checklist for evaluation of computer game designs, while at the same time it says something about what factors in the multifaceted character of computer games are of most importance for the player experience.

When it comes to pervasive games, there are currently no comprehensive models focusing on the player experience or playability of pervasive games. In order to start filling this gap, this thesis is an attempt to produce a model of playability for pervasive games.

In the work resulting in this thesis, I have had the privilege to study three different pervasive games/pervasive game prototypes in order to produce a playability model for pervasive games. The games were studied in eight phases of empirical evaluation and were played by totally 92 persons (81 players and 11 evaluation experts).

The ***SupaFly*** game (see paper 1 and 2) was studied in two phases with 58 participants and a total period of 5 weeks of game play. The ***Pervasive Treasure Hunt*** game (see paper 4) was studied in two phases with six expert evaluators and two weeks of game play. Finally, the ***Furiae*** game (see paper 4 and 5) was studied in four phases with five expert evaluators and 23 players interacting with the game for totally 4 weeks (and a night of playing a card game prototype...).

The games have been studied with a multitude of established methods for playability evaluation (see part 2 for an elaborated description of the methodological approach) including Playtesting (with questionnaires and focus groups) in the wild and in laboratories, collective Playtesting (role playing sessions with an early card game version of the Furiae game) and traditional Focus group sessions (evaluating specific design alternatives). The focus throughout the empirical studies was always on finding the criteria that people spontaneously (without any specific questions, instructions or heuristics to follow that focus the attention) use when asked to assess the quality of their game play experiences.

The work has resulted in the *Pervasive GameFlow model* for understanding Player experiences in and playability for pervasive games.

Purpose of the thesis

The purpose of this thesis is to identify and explore the mechanisms in pervasive game designs that are of most importance for creating enjoyable Pervasive gaming experiences, and further to translate the findings of the exploration into a playability model for pervasive games. Related to the overall purpose of the thesis are a number of specific research questions, which I have worked with throughout my thesis project:

- To what extent are the players of pervasive games using or realizing the potential of pervasive games to deliver game play in virtually every possible contexts of everyday life? That is, how are they putting the anytime, anywhere and mobility aspects of pervasive games to practice?
- How do the players perceive and handle pervasive games that offer constantly ongoing game play and are ready at hand to be picked up at any given time?
- What is the reach or impact of the novel pervasive aspects of pervasive games? How important are they for the players?
- How should we evaluate these new kinds of computer games, considering that they challenge our notion of when and where computer games are played?

Focus of attention: The individual gaming experience

In order to make it easier for the reader to understand the scope and limits of the work conducted in the thesis, I will here elaborate my research position concerning gaming experiences.

In computer gaming, an experience is something that arises when a player interacts with a game (Salen and Zimmerman, 2004). The game designer does not directly create the experience that the player has, but creates the rules (and all other elements) of the game which the player inhabits, explores and manipulates. In this process, the phenomenon we call Player experience arises. The experience is mainly shaped by the particular configuration of rules and other attributes designed by the game designer, but can of course be influenced by elements outside the game design, opening up a multitude of possible perspectives on Player experiences (for example social, psychological, and societal to mention a few).

The focus of this thesis is on the individual experience occurring when a player interacts with a Pervasive game; the fundamental situation described by Salen & Zimmerman (2004) and quoted above. Without this point of interaction between the game and its player(s), all other aspects of pervasive game play becomes irrelevant, since the foundation of all computer game play consists of an individual interacting with the computer game interface in some way or another. It is also this particular point of interaction and aspect of the player-game interface that the designer(s) of the game has most influence on, but also has a great responsibility for, since it affects the player experience so fundamentally. Therefore, it becomes of great importance that the activities performed when designing the specific features that enable the interaction between the player and the game are successfully supported.

The social nature of pervasive games easily draws attention to the social dimension of playing pervasive games as an important one for understanding Player experiences. The boundary breaking character of pervasive games (expanding the notion of where and when computer games are played) often challenges existing social conventions and rules in social contexts, which is of great interest and of great importance to study. The social dimension clearly adds important aspects for game designers to understand and changes the foundations for game play radically (see for example Montola, 2005).

In this thesis, as stated above, the focus is however on the individual experience occurring when a person plays a pervasive game. The focus is on understanding what factors and aspects of the designed experience are of most importance for making it an enjoyable one and how successful design of those aspects can be supported. This approach does not imply in any way that the social or any other complementing dimensions are of less importance for the pervasive gaming experience; they represent different and complementing perspectives on the pervasive gaming activity. Even in the approach pursued in the thesis, focusing on the individual experience, social aspects are acknowledged, since the presence of other players is recognized and viewed as an important part of the gaming experience. The weight given to other players in the gaming session is however slightly reduced in my approach. Other players are, important parts of the overall game design that creates the foundation for the individual experiences that occur, through their presence, in the shape of avatars or other mechanisms. The specific social interaction between the individual player and other players is in this approach treated as one of several important aspects of pervasive game designs, and not specifically singled out and studied in detail.

However, adopting a focus on the individual experience does not imply a focus on the internal mechanisms of the player, as might be assumed. The focus of this thesis is not on the internal, psychological mechanisms that allow people to have an experience. It is on the mechanisms in the game that are of importance for the player experience and what criteria the game design needs to fulfill in order to be able to deliver a good foundation for a good player experience.

In the figure below, I have tried to summarize my research position in relation to player experiences:

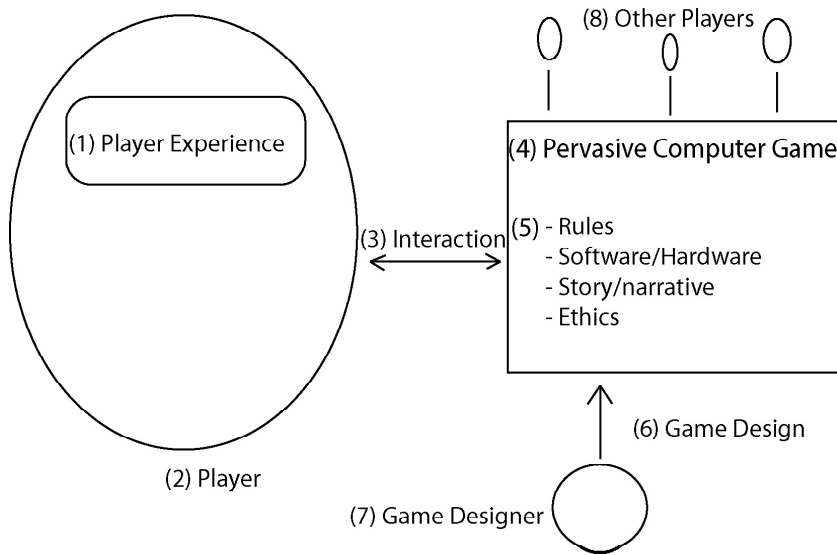


Figure 1: The Game Designer (7) shapes the Pervasive computer game (4), by defining and designing the components of it (5). The individual player (2) interacts with the game (3). The interaction (3) enables an individual Player experience (1) to occur (psychological, internal).

The individual player experience (1) is an internal, psychological phenomenon in the mind of a player (2) who interacts with a computer game, in this particular case, a Pervasive Computer game (4). The pervasive game (4) can be (depending on which perspective we take) viewed as many different but related things (5): an entity consisting of a collection of rules (chosen and implemented by the game designer (7)), the software and the hardware on which it runs, the story that the game enables the player to co-create (the narrative of the game), the ethical, political or other ideological values that the game upholds (reflecting the values and moral of the game designer or someone/something else) and much more.

For the purpose of the thesis, the perspective I will pursue is to assume the game to be first and foremost an interactive system in the shape of a collection of rules, determining the design of the code (software) of the game and decided on by the game designer. The computer game is a system with the main purpose of entertaining the player by supporting interactive sessions in which the player participates; a system whose character is designed (6) explicitly by the game designer (7) and with the major goal of creating experiences of fun.

The game designer (7) is responsible for designing the fundamentals of the game system; that is, all the rules and other aspects of the game that fundamentally shapes how the player must act in order to play the game, but also what kind of experience the player will have when playing the game. This activity is to be considered in its broadest sense; the design process when creating a game implies, to various degree depending on the complexity of the game, to shape a complete world for the player to interact with. Shaping the character of the game means not only specifying the rules of the game, but also creating the fundamentals of the player experience. The game designer can be one person, but in most commercial cases consists of a team of people with different roles in the production of the game.

Other people can also affect the player experience; other players in the game (8), but also people who are in the near surroundings of the game play experience, without actively participating in it (demonstrated by pervasive games such as for instance *Prosopopeia* (Björk et al., 2006)). Of fundamental importance in this situation, however, is that the game play session undertaken by the single player determines how the presence of other people is interpreted. This implies that the game system, shaped by the game designer, to a large extent decides how the individual player will interpret the presence of others and what kind of interaction with other people will occur in the game play situation. The situation where an individual player interacts with a pervasive game is therefore not only of importance because it represents the least activity necessary in order for any computer game to be put to action (if not one single person plays the game, no player experiences occur) but also because it is the situation that decides how the social interaction in (and surrounding) a pervasive game is pursued. Social interaction in pervasive games is triggered by the game system, which stimulates and instructs the players to interact with each other; an interaction that gets its meaning from the game system.

The individual player experience is thus both important and very relevant to study with respect to player experiences, and serves as a point of departure for the work in this thesis.

Structure of the Thesis

The thesis is intended to be read as a whole; an intention that has affected the structure of the manuscript in a very specific way. Each of the five papers on which the thesis is based have a functional role to play in the thesis structure and have therefore been integrated in what traditionally is described as a cover paper. The structure can be summarized as follows:

- In the cover paper, the introduction (part 1) presents and motivates the purpose of the thesis.
- In part 2, the background for the work conducted is presented, focusing on describing pervasive games more thoroughly by providing theoretical definitions and practical examples of pervasive games.
- Part 3 discusses the methodological strategies and methods used in the empirical parts of the thesis work.
- In part 4, the theoretical foundations and central theory of the thesis work are presented, together with some notes on the theoretical background.
- Part 5 describes the overall research process and how the work resulting in the papers and the thesis were actually carried out.
- The collection of papers follows part 5, and is intended to be read as contributing chapters with a functional place in the thesis structure.
- Part 7 summarizes the most important results in the papers, and presents some additional findings not addressed specifically in the papers.
- Part 8 provides a discussion of the main contribution of the thesis, the Pervasive GameFlow model and its applicability.
- Part 9 provides a future outlook and suggests future work implied by the outcome of the thesis.

Part 2: Background

In this part, background aspects and perspectives of importance for the thesis work are elaborated. The intention is to provide the reader with a more detailed view of the foundational concepts, phenomena and terms on which the thesis work is built. Some of the background aspects are discussed briefly in the collection of papers, but this is complemented here by a more elaborated discussions.

Pervasive Games

Pervasive games are a very multifaceted genre of computer games, building on a rich variety of concepts, technologies and platforms. This section describes my definition of pervasive games and is further intended to both position the games studied in the thesis with respect to the existing genres of pervasive games, and to elaborate and clarify the concept of pervasive games. The section therefore provides the reader with some of the alternative definitions of pervasive games as well as some specific examples of pervasive games.

For the purpose of my own work on pervasive games, I have defined pervasive games as computer games building on three fundamental aspects⁷:

- Anytime, anywhere gaming: games that allow the player to play at any given time, in all possible settings
- Integration between physical and virtual worlds: games that use physical spaces and places as meaningful parts of the game world and/or using virtual objects/layers to enhance the physical world in some way
- Social interaction as driving force in the game play: games that allow the players to formulate and pursue their own game play, in collaboration with others; games that not only “allow” social interaction between players but make interaction meaningful and necessary in order to successfully play the game.

This definition can be seen as an aggregate of other definitions in the literature (e.g. Björk et al., 2002, 2006, Montola, 2005, Montola et al., 2006 etc.), since the definition acknowledge the three perhaps most distinguishing

⁷Also described in the introduction of the cover paper

aspects of pervasive games, aspects that are shared and highlighted in one way or another by the games presented in related work (e.g. Magerkurth et al., 2005). It is a definition focusing on the general and the common in pervasive games compared to each other, as well as it points to how pervasive games separates themselves from more traditional computer games.

The rest of this part starts out by positioning the games studied in the thesis with respect to existing genres of pervasive games; each of the games is discussed and related to one or several of the existing pervasive game genres as well as the three major characteristics of pervasive gaming (mentioned above). The part continues with some theoretical definitions of pervasive games, followed by an overview of practical examples of pervasive games, forming a combination that hopefully will provide the reader with an elaborated understanding of what pervasive games really are about. The part concludes with a short introduction to the ubiquitous/pervasive-computing paradigm, of which pervasive games are one of several application domains, in order to give the reader some insight into the technological fundament on which pervasive games rest.

Positioning SupaFly, Pervasive Treasure Hunt and Furiae

In the table below, we see an overview of the three games studied in the thesis, with respect to how they relate to the fundamental characteristics of pervasive games and the existing subgenres of pervasive games:

Game	Fundamental Characteristics			Sub genre(s)
	Anytime, anywhere gaming	Social interaction as driving force	Integration of Physical and Virtual	
SupaFly	Yes (large extent)	Yes (large extent)	Yes (medium extent)	Location aware, Cross Media
PTH	Yes (large extent)	Very moderately	Yes (large extent)	Location aware
Furiae	Yes (large extent)	Moderately	Moderately	Cross Media, Location aware

Table 1: Summary of the character of the games studied; to what extent they draw on the three major dimensions of Pervasive gaming and to what subgenre(s) they belong.

The SupaFly game is mentioned as an example of a location aware game by Magerkurth et al. (2005), which explains the connection to the location aware genre. Even though the game has obvious features that support this classification, there are also other aspects of the game that could be used to motivate placing the game in the cross media genre, as it integrates the web and mobile phone technology in order to give the players complementary access to the game world (See paper 1 for a more elaborated description of SupaFly). Further, if we add the three most prominent features of pervasive games in general (anytime, anywhere gaming, social interaction and integration of physical and virtual worlds) to the base for the classification, we see that the game actually can be classified in several valid ways. The game tries to build on all three aspects to quite a large extent, but social interaction and anytime, anywhere gaming seem to be more fundamental to the game play than the integration of physical and virtual worlds. To summarize, the game can be said to be a location aware game with elements of cross media gaming that draws more on social interaction and anytime, anywhere gaming aspects of pervasive games than the integration of physical and virtual worlds, even though that aspect is also quite prominent in the game design.

Pervasive Treasure Hunt (See paper 4 for a more detailed description of the game design) is a rather straightforward location aware game, since the most important feature of the game play draws heavily on the spatial position of the players and their movements in the physical world. As the players chase virtual treasures placed at physical locations, they move around in the physical world and their positions are most important for the game play. Considering the three general dimensions of pervasive games, we see that the Pervasive Treasure Hunt game is to a large extent drawing on integration between the physical and virtual worlds, and this is the most important feature of the game design in terms of the extent to which it affects the game play (chasing virtual treasures at physical locations). Other players are important, in that they are opponents on the high score list and provide the competition in the game, but the social interaction between players is rather low and restricted to the presence level (the players are aware of each other on the high score list and as radar blips) as the players have no in-game support for communication. The game can be played anytime, anywhere, which also becomes almost a prerequisite for playing the game at all; as a player you need to go out in all possible contexts, searching for treasures, at whatever time you choose to do so, in order to play the game. To summarize, the game is a location aware game drawing heavily on the integration between physical and virtual worlds and can (and must) be played anytime, anywhere.

Furiae (Paper 5) is in many senses a cross media game, since it uses the web and mobile phones to provide access to the game. However, the game can be played in exactly the same way on the web as it can be played on mobile phones, thereby distinguishing the game from other examples of cross media games that often use the different media channels and technology in a more complementary way. In that sense, the classification as cross media becomes looser, even though the game meets the basic definitions of the genre. Some specific situations in the game require the players to meet physically and play the game on mobile phones within close range (about ten meters, Bluetooth range) but can also be solved by playing with people over the web. This complicates the classification process a bit further, as the game play can depend on the physical locations of the players and thereby is Location Aware to various degrees. Considering the three general dimensions of pervasive games, the game draws heavily on the anytime, anywhere dimension (it can be accessed from the web and mobile phones at any time the player chooses) but more loosely on the social interaction dimension (player community forming is intended but was rather absent in the actual design when the game was studied for this thesis) and in most senses does not use the integration of physical and virtual worlds at all. To summarize, the Furiae game is a cross media game which draws heavily on the anytime,

anywhere dimension, to some extent is Location Aware, but to very moderate degrees makes use of the social interaction and integration between physical and virtual worlds dimensions.

With the position of each of the three games studied in place, we move on to the theoretical definitions and practical examples of the existing genres of pervasive games; two subjects which when elaborated will make the positioning of the three games even more understandable.

Pervasive Games: Theoretical Definitions

The term “pervasive games” has been used to denote a very complex and diverse collection of computer games, eluding easy definitions (Montola, 2005). Björk, Montola, Waern and Ericsson (2006) states that the term pervasive games is typically used to describe games that use computer and internet technology in order to blend virtual game experiences with game experiences in the physical world, or games that take place in the ordinary world and where gaming and real life are mixed in interesting ways. Another way to put it is to say that pervasive games are generally games that blur the boundaries between the game world and the real world, and where the game blends with reality (Nieuwdorp, 2007). These rather vague and inclusive ways of describing pervasive games are actually very true to the object the authors are trying to define. The genre of pervasive games is today a very heterogeneous genre of computer games, as we will see in the game examples in later sections of this part. However, the fundamental ambition to expand digital and virtual computer games into real life physical contexts and settings is present to some degree in most computer games and computer game prototypes claiming to be Pervasive.

Currently, and due to the development and maturing of the research field of pervasive and ubiquitous gaming, the term “pervasive games” serves as a collective name for a number of different (sub) genres of computer games (such as alternate reality games, augmented reality games, cross media games, mobile games, location-based games, mixed reality games, adaptronic games etc.), all sharing some fundamental denominators, which more or less separate them from traditional genres of computer games (Magerkurth, et al., 2005, Kampmann Walther, 2005). Even though this way of classifying and structuring the current multifaceted body of pervasive games in many ways reflects a consensus within the pervasive gaming community of researchers and developers, there are complementary ways of defining and describing pervasive games that need to be considered, since

they shed light on various aspects of pervasive games beyond the most obvious level of subgenre classification.

In the following sections, some of the most established and widespread definitions of pervasive games are described. In many senses, the definitions share the same view of what a pervasive game really is, but they approach the phenomenon from different perspectives, focusing on complementary aspects of pervasive games and therefore all add valuable insights to our understanding of what the phenomenon of pervasive games really is. By combining the different views described below, we get a rich picture of what pervasive games are and thereby also an insight into how they differ from traditional computer games.

Of great importance for the development of pervasive games into the current state of the genre is the work presented in Björk, Holopainen, Ljungstrand and Mandryk (2002). The authors make an early acknowledgment of a (at that time) growing interest among researchers in a new kind of computer gaming which builds on various Ubiquitous Computing technologies in the design of computer game prototypes. They chose to call this kind of computer games ubiquitous games as they:

“...explore the possibility of taking the functionalities that ubiquitous computing offers and apply them to computer games” (Björk et al., 2002)

It is fair to say that the work of Björk et al. (2002) has been of fundamental importance when it comes to establishing pervasive and ubiquitous games as an important genre of application of ubiquitous and pervasive computer technology. The establishment of ubiquitous computer games as a field of research has paved the way for much of the following research attempts and the evolution of pervasive games into the genre it is today.

Expanding the Magic Circle of Play

In later works we see an ambition to define and understand pervasive games from the perspective of the Magic Circle - Huizinga's (Huizinga, 1955, referred in Montola, 2005, Salen & Zimmerman, 2004, Björk et al., 2006, etc.) classic metaphorical definition of play. According to the idea of the magic circle, participants in a game make contractual agreements that certain activities, performed in certain places, by the players, are to be considered as meaningful parts of the game and not as parts of ordinary life outside the game. These contractual agreements make up different kinds of boundaries for the game, separating the structures and context of play from those of ordinary life surrounding the game. According to Montola (2005), a

regular game is played in certain places, at certain times by certain people (players). These attributes are defined before the game starts and changes to these attributes do not generally imply changes in the formal game system, but rather in the social gaming process derived from the particular gaming situation in which the game is played. The magic circle of a game is therefore the contractual agreements resulting in boundaries of the game; boundaries that define the game spatially (locations of play), temporally (times for play) and socially (defining who the player is and what conventions the player is expected to follow). Pervasive games, according to Montola (2005), challenge these spatial, temporal and social boundaries by intentionally trying to expand them. Spatial expansion, in short, means that the socially constructed location of the game, both physical and virtual location, becomes unclear or unlimited. Montola (2005) argues that perhaps the most result of this with most impact, from the player perspective, is that the game becomes playable anytime, anywhere - both in terms of access points to the game (in physical settings) and in terms of channels being used to distribute game content to the players (media channels, etc.). Further, temporal expansion means that the game expands from the explicit game sessions; the game becomes constantly ongoing, interlaced with ordinary life. The game becomes a constantly ongoing process existing in parallel with other everyday activities, impinging on the players attention from time to time, or being accessed by the player at chosen moments. Finally, the social expansion of gaming becomes perhaps most obvious when one of the most fundamental aspects of game play, namely playership, is challenged. When the participating people meet a game expanding the social dimension, it no longer becomes clear who the other players in the game actually are. As the boundaries concerning where and when the game is on are questioned, players can expect to encounter other players at any given time, resulting in a situation where unexpected people will make unexpected actions at unexpected times. The relationship between the role of the players and the game becomes blurred and the social expansion allows the game to include people to various degrees, and also to have people participate in the game with various degrees of awareness that they actually are part of a game. Playership is altered from being a clear-cut situation where you either are a player or not, to a much more complex situation where player agency can be pursued by people to different degrees and at different levels of awareness.

Following the argumentation by Montola (2005), pervasive games are defined as:

“... a game that has one or more salient features that expand the contractual magic circle of play socially, spatially or temporally.” (Montola, 2005)

When pervasive games are played, the exploitation of the boundaries of the magic circle typically results in games being played in physically unrestricted or undefined areas where players constantly come across non-players potentially unaware of the game going on. By enhancing the physical game space with virtual contents (or vice versa), only visible to the players, pervasive games create an enchanted space with unknown properties, where the games can run over longer periods of time, thereby stretching the spatial dimension of the play, blending playful activities with everyday activities, resulting in a somewhat controversial situation where the distinction between players and non-players in the contexts where the gaming appears becomes blurred (Björk et al., 2006).

The Atomic Formalisms of Pervasive Games

In an extensive attempt to approach the basic formalisms and most fundamental aspects of pervasive games, Kampmann Walther (2005) proposes a theory of pervasive gaming, revolving around a possible space for pervasive game designs defined by four axes marking the domains of pervasive games. The four axes, described in detail later in this section, provide the foundation for a somewhat broad definition of pervasive games:

“pervasive games implies the construction and enactment of augmented and/or embedded game worlds that reside on the threshold between tangible and immaterial space, which may further include adaptronics, embedded software, and information systems in order to facilitate a “natural” environment for game-play that ensures the explicitness of computational procedures in a post screen setting” (Kampmann Walther, 2005)

The definition offered above, according to Kampmann Walther (2005), focuses on essential qualities of pervasive computing, which pervasive games stress. The qualities are: 1) the explicitness of computational tasks, meaning that actions are carried out in ways that go beyond the traditional screen-based environment and by using embedded computational technologies, metaphorical data manipulation (as in the case with screen based interaction) is complemented and eventually replaced by simulated and natural interaction and manipulation of things and physical objects. 2) The overall importance of physical space, meaning that objects obeying the laws of physical space become open to digital manipulation and as a consequence take on a double meaning; they are both objects outside the game world and at the same time objects in the game world. So far, the theory is rather robust and it mostly reflects what can already be understood as consensus in the area of pervasive game research.

In order to advance this somewhat broad definition of pervasive games, Kampmann Walther (2005) introduces the four axes of pervasive games:

1. **Distribution:** pervasive games are in various degrees built on mobile and embedded technology, linked together in ubiquitous network infrastructures with wired cores and wireless edges, resulting in a digital environment that is always on, always available and unobtrusive.
2. **Mobility:** mobility in pervasive gaming contexts includes computing mobility, network mobility, user mobility and context-aware (smart) and cross platform services.
3. **Persistence:** this factor is related to the notion of temporality; persistence means total availability at all times, i.e. some kind of omnitemporality.
4. **Transmediality:** the transmedial aspect of pervasive games challenges the traditional roles of the sender, text and receiver in media communication. The user is active beyond the role of the passive receiver and becomes a co-producer of content as the current media and media channels allow the users to co-create content and recycle/reuse different material in a circular kind of storytelling.

The four axes defining the possible space of pervasive games are further illustrated in the figure below:

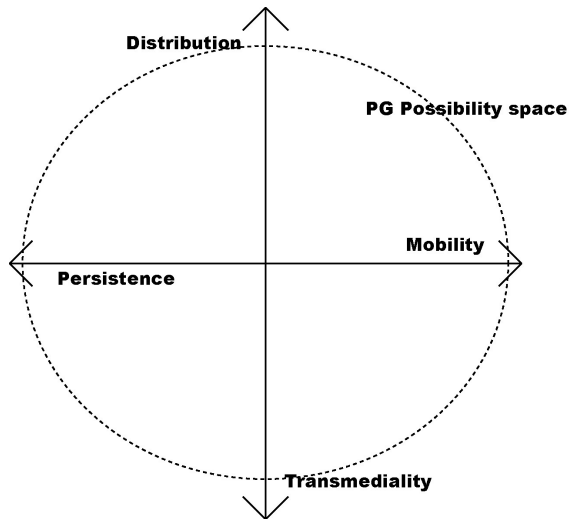


Figure 2: The four axes of pervasive games, defining the pervasive game possibility space -the jagged circle (Kampmann Walther, 2005).

The model resulting from the combination of the four axes focuses on important aspects of pervasive games and the foundational prerequisites for pervasive games to exist. It is especially useful in that it differentiates pervasive games from more traditional computer games and elaborates the dimensions of most obvious importance for making this distinction. This makes the model a helpful tool when analyzing the nature of pervasive games on a theoretical level. The applicability of the model, however, becomes more vague when it comes to providing support for more practical analysis and classification of examples of pervasive games. If one is trying to place a particular pervasive game within the possible space of pervasive games, depicted by the four axes, problems arise immediately from the unclear relationship between the four axes. In Kampmann Walther's graphical illustration of the model (see the figure above), the two axes of Distribution and Transmediality are placed at opposite poles from each other, on either one single or two interconnected axes, depending on how you interpret the model. Further, Mobility and Persistence are placed in the same way. The resulting space of possibility for pervasive games becomes rather difficult to interpret given that an observer will approach the model with the purpose of placing an existing design, or idea for a design, of a

pervasive game in the defined space of possibility. Does the model imply that games that to a large extent build on mobility (thereby probably “scoring high” on the Mobility dimension which probably would lead to a place far to the right on the Mobility-Persistence axes) are automatically less prominent on the Persistence dimension? What if a game stresses both the Transmediality dimension and the Distribution dimension to a high degree at the same time? How would the model deal with that kind of game?

The problematic questions mentioned above are mainly a consequence of the somewhat confusing graphical illustration of the model and its four axes. A different illustration bringing out the fact that the axes are interrelated and co-dependent in terms of how they affect the character of a game and its resulting game play would definitely serve the theory better. When we consider the different axes and what they really mean, we see that the “Distribution” axis describes the characteristics of a computational environment that allows the phenomena described by the “Mobility”, “Persistence” and to some extent the “Transmediality” axes to occur. What is described as “Distribution” enables “Mobility” of players and data, and in turn the creation of games that implement the phenomenon described by the “Persistence” axes - total availability of the game at all times. The axis of “Transmediality” describes the relation between the sender and receiver in this new kind of media communication, which in the contexts of computer games should be interpreted as the relation between game designer and player. As Kampmann Walther (2005) points out, the player becomes active in producing the content and a co-creator of the game play. It is not clear if the co-creating role of the player is something revealing itself when the games are designed (as some sort of participatory design) or when the games are played. When this phenomenon is related to how the players actually play a game, it becomes a characteristic of the game play behavior. By this line of reasoning, the conclusion will be that the Distribution axis is foundational for the other three axes to occur, and the other three axes describe interaction behavior, style of game play and the relation between player and designer in a way enabled by the “Distribution”. On the other hand, the phenomena described by the four axes are all interrelated when it comes to enabling pervasive game play. The potential of the phenomenon described by the “Distribution” axes is only revealed if the other three axes are put into practice in a game, making the situation more complex and less technologically deterministic.

Following this line of thought, without actually presenting any alternative solution beyond the reasoning above, we may conclude that a more appropriate graphical description of the four axes would point to these relations more clearly. Instead of erroneously putting the axes in opposition

to each other, the four axes should be presented in a way that more clearly demonstrates their relations as described in the paragraph above.

Pervasive Games: Practical Examples

As noted in the previous section, the genre of pervasive games is rather vague in terms of its definition and how various authors interpret different concepts; this is a natural consequence of the novelty of the research field and complexity of the phenomenon studied.

In order to make it easier to understand the essence of the pervasive games genre and the specific games currently claiming to be part of it, this section therefore continues with an overview of some of the most established subgenres of pervasive games. In the body of published research concerning pervasive games, we find a number of different ways of classifying and characterizing different games and game prototypes, sometimes contradicting each other, sometimes labeling subgenres of games differently even if the games belonging to the genres seems to be very much alike. The overview presented here is in no way claiming to be superior to other attempts to present the field of pervasive games and gaming prototypes, but is to be considered as a complementary one, serving the purpose of this chapter to provide the reader with an idea about what pervasive games really are. In this overview, the names of the subgenres are following the outline suggested by Magerkurth et al. (2005), who presents a more detailed outline of various pervasive game subgenres and examples of games.

Affective Gaming

The sub genre of affective gaming (e.g. Hjelm, 2003, Sykes & Brown, 2003, Gilleade & Dix, 2004, Magerkurth et al., 2005, Nijholt & Tan, 2007) begins from the idea of capturing and using emotional aspects of the player in computer game play. In order to provide emotional input to computer games, the genre uses various kinds of physiological measurements, such as galvanic skin response (GSR), heart rate or brain activity (EEG), as either information for user modeling (changing the state of the game in relation to the emotional state of the player) or as direct input to the game (letting the emotional state of the player control the events occurring in the game).

Brainball (Hjelm, 2003) is an example of a game that uses human brain activity (in the form of EEG signals) to control a game. Two players play against each other and their respective brain activity, measured by EEG, decides how a physical ball moves on a table between them. The idea is to

relax as much as possible, and thereby make the ball move towards your opponent.

Affective games represent one of the most extreme (but also in a sense narrow) applications of the pervasive gaming vision. The experimental integration of physical and virtual worlds often occurring in affective games has served as inspiration for many other pervasive games and thereby helped push forward the pervasive gaming vision.



Figure 3: An illustration of the BrainBall game (Hjelm, 2003)

Augmented Tabletop Games

By combining traditional board games with various kinds of pervasive technologies, the genre of augmented tabletop games (e.g. Mandryk et al., 2002, Cooper et al., 2004, Magerkurth et al., 2005, Tse et al., 2006, Peitz et al., 2006) makes an attempt both to enhance the experience of playing traditional board games and to create new and exiting game designs and experiences drawing on the meeting between the physical tabletop domain and the digital, virtual reality domain. Suggested game designs often use

digital technology in order to provide player support of various kinds, often for extensive sets of rules (as in the case with different augmented role playing games) or for enhancing player interaction on different levels, improving the social experience when playing the game.

The STARS platform (Magerkurth, et al. 2004a, 2004b, 2005) is an example of technology developed in order to provide a foundation for the design of augmented tabletop games. It consists of a dedicated setup of hardware devices such as public displays and personal digital technologies (such as PDAs), as well as an interactive table that can detect different kinds of playing pieces and their positions. The platform has so far been used to implement, for instance, an augmented version of *Monopoly*TM. In the STARS version of Monopoly, the shuffling and stacking of cards have been eliminated through digitalization, and interesting elements have been added to the game play by making the bank notes digital, thereby enabling different kinds of statistics for player performance to be easily calculated. Further, enabling and approving transfer of money between provides a foundation for secret alliances between players aimed at making the leading player weaker. Another example of a game implemented on the STARS platform is the Dragons and Dungeons style role-playing game *KnightMage*. In the game, players search a dungeon for treasures and equipment, while trying to avoid and survive encounters with monsters. The players have to cooperate in order to survive, but must at the same time compete for treasures.

Another example of an augmented tabletop game is *False Prophets* (Mandryk et al., 2002). In this hybrid board-video game, players move physical playing pieces on a digital game board projected onto a touch sensitive table. The major goal of the Gameplay is to find out who your friends and enemies are in the game, by abstracting clues and information from the physical-digital game setup. The playing pieces have a button for simple interaction and the players use a handheld computer in order to perform more complex tasks and commands. The tokens and pieces are moved around the table as players discover the dynamic game board and find out more about their opponents. The physical distance between the player tokens decides what digital information the players can observe; being far from each other reveals less information than being closer.

Location Aware Games

Location-aware games (e.g. Magerkurth et al., 2005, Capra et al., 2005, Benford et al., 2006, Flintham et al., 2003, Lankoski et al., 2004, Chang & Goodman, 2004, Crabtree et al., 2004) push the envelope even further than augmented tabletop games when it comes to integrating the physical world with the digital, virtual one. They all make use of existing, everyday world settings in combination with pervasive technology in order to create gaming experiences that integrate the physical and the virtual worlds.

One of the earliest games in the location-aware genre is *Pirates!* (Falk et al., 2001), which takes place in an archipelago setting where each player is the captain of a ship. The game play consists of various missions including trading, fighting and finding treasures. When a mission is completed, the player receives points that translate into a ranking and from the trade money is made, which in turn can be used to upgrade the ship. The game is implemented on handheld computers, connected via a WLAN network. Each computer is fitted with custom-made technology for dealing with proximity, thereby allowing calculation of each player's position in the physical room. The game uses a physical, pre-defined indoor location as game world, and the players must move in the physical setting in order to move in the game world.

Can You See Me Now? (Benford et al., 2006, Flintham et al., 2003, Crabtree et al., 2004) is one of the most frequently mentioned pervasive games in the current literature. The game is played in a combination of a physical world setting and a virtual, online model of that same setting. Physical (professional) runners in the physical world setting are represented in the virtual world, at places corresponding to their location in the physical world. The professional runners try to catch a maximum of 15 online players who log on to the virtual game world. In order to approach an online player, the runners need to transport themselves in the physical settings. Their positions are logged by GPS technology, and they communicate with each other by use of walkie-talkies. The runners receive information about the virtual game world and the virtual players by the use of handheld technology using the IEEE 802.11b - WiFi protocol. The virtual players have access to all conversations made by the runners through streaming media, and can also send text messages to the runners by SMS.

FIASCO (Chang & Goodman, 2004) is another example of a Location-Aware game that combines the physical and virtual worlds in a game about claiming

and owning territory. By performing stunts of various kinds (consisting of an object, an action and a theme) at specific locations in city streets, the players claim, battle for and eventually own different locations on the game map. All locations are represented on the digital, online game map, representing New York city, made available on the web. Players collaborate in order to plan, perform and record a stunt; the stunt is then uploaded to the game website and rated by the gaming community of players. The highest rated stunt submitted for a certain spot on the map will be rewarded with ownership of that particular spot.

Songs of North (Lankoski et al., 2004) is a Finnish pervasive game building on ancient folklore and shaman hymns. By use of a shaman drum (represented on a handheld computing device), the players access the parallel world of the old Finnish pantheon. The spirit world is invisible, but the player can hear sounds from it and get pictures of bones displayed on the skin of the drum, representing different objects in it. By drumming (selecting key combinations on a numeric game pad) the player performs actions in the game world. In order to move in the game world, the player needs to move to various places in the physical world, where the spirit world then will become accessible for the player.

Augmented Reality Games

Perhaps the most technically challenging genre of pervasive games is the Augmented Reality (AR) genre (e.g. Magerkurth et al., 2005, Cheok et al., 2004, Thomas et al., 2002). The common theme for AR games is that they place virtual objects in a physical game world, objects that are visible to the player by some kind of mediating technology. The real world view of the players becomes augmented with virtual 3D objects, presented to the player by use of head-mounted displays (often in the shape of glasses with see-through projections combining virtual objects with a stream of video representing the real world view), projections of virtual objects onto physical world surfaces, or by use of handheld mobile computers (providing the player with a “window” into the virtual world, combining camera picture from the physical world with representations of virtual objects). The ambition of most AR games is to provide the player with complete freedom to move around the physical game world, as the game often uses a range of different technologies and strategies for tracking the movement and orientation of the player (Magerkurth, 2005). The player is not, as in the case of traditional computer gaming, immersed in a virtual game world, but moves around in a physical game world enhanced by virtual objects.

ARQuake (Thomas et al., 2002) is one of the most well known early examples of AR games. The game translates the virtual game world of the computer game *Quake* (ID Software) into an indoor/outdoor game, as the virtual game map is replaced by a physical world setting in which the player physically moves around. Monsters and other items in game objects are represented by virtual objects and presented to the player by use of head-mounted displays, and the player uses a plastic haptic feedback gun in order to fight with the monsters.



Figure 4: A person playing ARQuake and a screenshot from the heads up display (Thomas et al., 2002)

Human Pacman (Cheok et al., 2004) is another much-quoted example of an AR game. As the name implies, the game builds on the classic computer game Pacman, but differs in that the virtual game world maze is replaced by a physical equivalent. Players move around in the maze, taking on the roles of Pacman and Ghosts. Both Pacman and Ghosts see virtual objects (cookies etc.) placed in the game world by use of head-mounted displays and the locations of the players are continuously tracked by the gaming system, allowing for a virtual representation of the current game state to be derived. The virtual representation of the current game state can be accessed from the web, which opens up a new role in the game; that of the Helper. Anyone can log on to an ongoing game and in real time send text messages to the player performing the Pacman role in the game.

Alternate Reality Games

Currently, one of the most well developed sub genres of pervasive games is the Alternate Reality genre (e.g. Jonsson et al., 2006, McGonigal, 2003). A typical feature of Alternate Reality games is that they use a range of media technology to provide the players with hidden clues in their ordinary, everyday world. The games often include and make use of everyday settings, objects and events which the players can visit, giving an impression of the game as “being for real”.

Prosopopeia (Jonsson et al., 2006) is an example of a quite sophisticated Alternate Reality game. The game builds on a pre-written story in which the players participate by taking on specific roles; in that sense, the game is a role-playing game enhanced by pervasive technology. Twelve players participate in the game, which is played continuously for 52 hours. During this time, a ghost story develops as the players take on the roles of authentic but dead people who all have been friends of a special main character, a woman, who now is trapped between the human world and the next. The players have to find out where the ghost woman is and how they can help her on to the next world. They receive clues and information from the ghost world by various devices of both game specific (tailor made equipment, such as the EVP machine which can be used to contact the ghost world) and ordinary everyday character, such as cell-phones and e-mail. The game world thereby becomes a mixture of everyday world settings and places and game specific devices used to integrate the everyday world with the ghost world. The game enhances the everyday world settings with a parallel dimension, which creates a feeling of contacting a co-existing reality for the players. A string of messages and instructions send the players out on a journey through scenic environments and events (such as real world

cemeteries, docks and even a new age festival), ending at an abandoned mental hospital where they finally set the ghost free.

Cross Media Games

Cross media games (e.g. Lindt et al., 2005, 2006) are a sub genre of pervasive games that most often use a combination of current media and technology, both traditional and pervasive in character in producing the game play. Different technologies provide different ways to participate in the game, as the multiple media channels and technical devices offer complementary ways to receive information and perform actions in the games.

Epidemic Menace (Lindt et al., 2005, 2006) is an example of a cross media game that focuses on a story taking place in the academic world, where a mad scientist for some reason has released a lethal virus at a University campus. The players get together in teams and make use of different technology and media in order to locate, identify and destroy the virus. Some technical devices are used in order to locate the spatial position of viruses, other complementing devices are used in order to identify what kind of virus the players are facing and still other devices are used in order to capture or destroy the virus at hand. At the same time as the players have to coordinate their actions in order to neutralize the virus before it becomes too widespread and strong, they need to find out who has released the virus and why.

With this description of the multifaceted genre of pervasive games and its subgenres in place, we move on to the foundations for the exploration of pervasive games performed in the thesis work - the empirical methods.

Part 3: Foundations for Identification and Exploration - the Empirical Methods

As the title of the thesis suggests, I have explored pervasive games in order to identify what aspects and factors are of most importance for the player experience - that is, to identify the mechanisms of player enjoyment in pervasive games. This identification, exploration and modeling process rests on three specific steps, of which the first two (identification and exploration) have been performed by extensive empirical studies of three different pervasive games. The remainder of this part of the cover paper describes the empirical methods used; methods that have allowed me to perform the exploration and identification.

To be specific, I have studied three different games by use of five usability /playability evaluation methods. In the following sections, I first provide an overview of how the methods have been applied in the evaluations (on what games, in what stages of the games' production cycles and in which paper(s) in the thesis collection the results have been presented). Thereafter, some specific methodological considerations and motivations made in order to perform the empirical work are presented.

In table 2 below, a summary is presented of how the different methods have been applied in empirical evaluations of the three pervasive games studied in the thesis.

	Playtesting, Think Aloud		Playtesting, Retrospective Surveys		System Logs	Expert Eval.	Presented in Paper(s)
	Individual, Lab sessions	Collective, Controlled environment	Questionnaires	Focus Group			
SupaFly	Yes (web part, late prototype)	No	Yes (web based, full game late prototype)	Yes (late full game prototype)	Yes (less used)	Yes (workshop and in Playtests)	1, 2
PTH	Yes (early digital prototypes)	No	No	Yes (early to late full game prototypes)	Yes (less used)	Yes (in all stages)	4
Furiae	Yes (early digital prototypes, web and cell phone parts)	Yes (early paper prototypes)	Yes (late digital prototype)	Yes (early and late digital prototypes)	No	Yes (in all stages)	4, 5

Table 2: Overview of the methods applied; on what games, in what stages of the production process (described between brackets) and in what papers the game evaluations are used.

General Methodological Strategies

Due to the particular character of pervasive games and the specific preconditions concerning the game play for the games included in the thesis, some general strategies were formulated in order to guide the empirical work. The intention with this was to make sure that the empirical evaluations of the games were conducted as correctly as possible, in a way that provided as good data as possible about the players' experiences, given existing frames of opportunities and constraints and in relation to the purpose of the thesis.

First, the novelty of the genre implies (as mentioned in the introduction) that very few people today have an everyday relation to pervasive games. Few people have so far had the opportunity to play pervasive games in their everyday world and consequently few people have had an opportunity to

develop any personal taste or opinion about pervasive games and pervasive game features; very few know what they like and dislike in pervasive games. Since the players' personal opinion about pervasive games and their features is of central importance for the purpose of the thesis, it became a necessity to give the people included in the empirical evaluations and studies performed an opportunity to form and create a personal opinion about and/or taste concerning pervasive games. The more elaborated conceptions of what good pervasive games are and how they would fit their everyday world contexts the participating players managed to formulate, the better the quality of the data collected about their experiences during evaluations would be. Therefore, one of the major strategies in the empirical evaluations has been to allow the participating players to have access to the evaluated games and prototypes in their normal, everyday worlds, for quite long periods of time.

Second, and related to the argument above, the somewhat fragile situation of people getting acquainted with new technology introduced into their everyday lives called for some specific considerations to be made. When introducing new technology in order to study the use of it, the researcher needs to be very careful and give the participating people plenty of time and space when they learn the new technology and try to make sense of it. The pervasive games and prototypes studied in the thesis (SupaFly, Pervasive Treasure Hunt and Furiae, described in the papers) use practically any everyday situation imaginable as potential contexts for game play (they can all be played anytime, anywhere), allowing the player total freedom to choose when and where he/she should play the game. This means that many of the more private settings of people's everyday lives, most of them related to leisure time and its contexts, can potentially be used for game play. Studying the players in these private settings without compromising their integrity becomes rather problematic and excludes a number of different methods related to ethnographical research. Therefore, a general strategy in the empirical studies performed has been to make as minimal intrusion in the participants everyday life as possible.

Third, since the genre of pervasive games is rather new and in many ways different from that of traditional computer games, it becomes somewhat unclear to what extent existing methods of empirical evaluation of computer games can handle them. Since the methods used today (see for example Davis et al., 2005, Desurvire et al., 2004) all are developed by studying traditional computer games, we cannot foresee exactly what to expect from them when applied to pervasive games. It is currently not clear in what situations and at what stages of pervasive game development we should use the methods available. Therefore, a major strategy in the thesis work has been to use a quite explorative approach and to apply a number of different

existing methods in different evaluation situations, ranging from early stage paper prototype testing to beta testing of the games implemented on their technical platforms and played in their intended usage settings by people in their target audience.

Methodological Background

An important part of the empirical studies performed in the thesis work is based on existing methods for playability evaluation. This section provides a short overview of some of the most widespread and applied evaluation methods for playability, and serves as a methodological background for the thesis. After the methodological background, the specific methods used in the empirical evaluations performed are explained.

The literature provides a number of different methods and approaches for ensuring good playability in computer games. Some of the methods are very similar but go under different names, some are strictly defined while others are less defined labels for denoting various activities striving for a somewhat similar goal (such as Playtesting or user testing).

Retrospective Surveys

According to Davis et al. (2005), surveys are often used in order to tap the players' perception of games; especially in order to get general feedback about common features of different genres of computer games, such as what the players actually think about different features in, for instance, driving games. Surveys and questionnaires are often used in the same manner, describing a method where the players' opinions are collected retrospectively (Davis et al., 2005) by use of some kind of pre-designed questions. The limitation of this method, is mainly that the players are reflecting on past experiences and not on a present one, with all the bias that may come from remembering things and experiences, and further that it is very difficult to create scientifically sound batteries of questions (Federoff, 2003).

Playtesting/ User Testing

Perhaps the most frequently used approach to generating data about player experiences and the playability of a computer game is the Playtesting/User Testing method for user/player centered evaluation of game designs. Playtesting is basically someone playing a "playable" (in some way interactive prototype or build) version of a game design, or part of a game design and reporting on his or her experience with it (Federoff, 2003). Methods such as the "Think aloud" method (Federoff, 2003, Lazzaro &

Keeker, 2004, etc.) where the players verbalize their thoughts while interacting with the game are frequently used in Playtesting. The ultimate goal of a playtest is to provide game designers with such feedback from the testers that they can redesign the game in a better way (Davis et al., 2005). Playtests are usually documented in some form, such as notes taken by the evaluator or in the shape of video/audio recordings, sometimes in combination with screen captions from the playing session. As the method calls for surveillance of player activities during the tests and the material being used for the sessions (prototype versions of the game or parts of the game) often is in a rather fragile state, the most common approach to pursuing Playtesting in commercial settings is to invite testers to a controlled facility and conduct the tests there. The same goes for most research oriented Playtesting, as these sessions are often conducted in special usability or user studies lab facilities in order to provide good means to control and record the sessions.

A large scale method for obtaining player feedback on a game that is still under development is the Beta testing method (Davis et al., 2005), which basically is a version of individual Playtesting where the participants get access to the game prototype and play it in their everyday environment for a period of time, before they present feedback in some form. The participants are volunteers, and are most often players whose dedication makes them somewhat problematic as a test group, since they rarely represent the target audience. Beta tests are often focused on finding bugs in the software and problems in the game world, but can also provide feedback on the game play.

Playtests can provide information about many aspects of the gaming experience, depending on the actual design of the test procedure. In addition to this approach, more traditional usability evaluations (focusing on task performance, efficiency etc. in user tests) are performed in order to get feedback about how the players perform on various tasks of importance for the gaming (Federoff, 2003).

Focus Groups

Another method for obtaining player feedback on game design is the Focus group method (Davis et al., 2005) where a group (usually 6-12 people) from the target audience of a game is brought together in a session where they discuss and provide feedback on various aspects of a game concept or game prototype. This method is often used in the initial phases of a game design process, and is then often referred to as *Concept testing* (Federoff, 2003).

Heuristic or Expert Evaluation

In addition to user/player-centered evaluation in the shape of various methods for Playtesting, where people representing the intended players of the game participate, there are methods for Heuristic evaluation or other kinds of expert evaluation of computer games.

Heuristic or Expert evaluation (Federoff, 2003, Wiberg, 2003, Nielsen, 1993) are terms used to describe methods for evaluating games (and other software) without the participation of players/users. Instead, expert evaluators (usability, playability or other kinds of experts) perform an inspection of the game, using a checklist referred to as a heuristic. Heuristics are common standards describing aspects and requirements that the game should meet or avoid in order to be of high quality. During a heuristic evaluation, one or more evaluators step through the game or game prototype and compare it in terms of the heuristics, assessing whether the game meets or fails to meet the aspects on the list.

In the literature, we find evidence that heuristic evaluation, originally developed for traditional usability evaluation, can be applied for improving entertainment software such as entertainment web sites (Wiberg, 2003) and computer games (Lazzaro & Keeker, 2004, Desurvire et al., 2004, Federoff, 2003), even though the specific heuristics used must be elaborated in order to fit the entertainment functionality better (Wiberg, 2003, Desurvire et al., 2004). Examples such as Malone's (1982) heuristics for instructional games, Desurvire et al.'s (2004) heuristics for evaluating playability (HEP), and Federoff's game heuristics (Federoff, 2003) show that heuristics for game design and evaluation of playability, even though some basic aspects of usability are often included, differ in fundamental ways from heuristics for usability. In heuristics for the evaluation of playability, aspects such as game interface (Federoff, 2003), game mechanics (Federoff, 2003, Desurvire et al., 2004) and game play (Federoff, 2003, Desurvire et al., 2004) are of central importance, implying a focus on the player experience and finding obstacles for good player experiences in the game design.

In the next section, the specific evaluation methods used in the thesis work are explained.

Exploring Pervasive Games Empirically- Specific Methods Used

Each method used for the empirical research in the thesis is here briefly described, and motivated in relation to the strategies mentioned in the beginning of this part and related to the specific games evaluated and the stage of development in which the method has been applied. The focus is on describing how the methods have been applied in empirical evaluation and not so much on the methods themselves. For a more elaborated description and discussion about the specific methods, see Part 3 of the cover paper and Paper 1, 2, 4 and 5.

Playtesting

The most frequently used evaluation method performed in the thesis work is the Playtesting method; a commonly used, standard method for user centered evaluation of computer games (see for example Federoff, 2003, Davis et al., 2005).

Basically, Playtesting (or user testing as the method often is called in traditional usability evaluation) means that players representative of the intended target group play a prototype (early or late; ranging from paper based to digital beta versions running on computer technology) and give their opinions and feedback about how they perceive and experience the game. The feedback can be given either during the game play session when the players experience the game prototype, or retrospectively in some sort of interview or questionnaire. In the evaluations performed in this thesis, as we will see later on in this section, both approaches have been applied at different stages of the games' design processes.

Since the Playtesting method provides the player with hands-on experience of the game that he/she is about to evaluate, it is very well suited for the purposes of this thesis. In most cases described in the literature (see for example Federoff, 2003, Davis et al., 2005), the method is applied in shorter sessions taking place in some sort of controlled environment (for instance in a usability lab or in-house setting of a game development company). The players play some part of a computer game prototype for one or several hours while being logged as they verbalize their thoughts during game play or respond to some sort of survey or interview after playing the prototype, get some sort of reward, and then leave.

For some evaluations in this work, mainly on early, fragile prototypes of the games studied, the method has been applied with an approach rather similar

to this standard procedure. Other evaluations, however, have used a slightly modified version of the method, in line with the first strategy described in the previous section (allowing the players to develop some sort of personal taste concerning pervasive games),

The modified way of conducting Playtesting has simply meant that the players participating in the evaluation, instead of playing the game intensely for some hours in a lab, have been allowed to play the game for a longer period of time (ranging from a minimum of three days up to three weeks) in their everyday environments. The intention with this was to allow the players to form a more elaborated personal opinion about what pervasive games really are and how they are to be related to the everyday world in a meaningful way. By allowing the players to play the prototypes whenever, wherever they chose to, they have had an opportunity to explore different settings and contexts for game play and thereby at least had a theoretical opportunity to explore both how the specific prototype behaves in different settings. They also have the opportunity to get a glimpse of what it would mean to play and experience pervasive games in a broader sense, as if they were already a part of their everyday lives.

In the evaluations performed, the Playtesting method was applied with two different techniques of collecting the feedback from the players, performed in four different ways.

Playtesting with Think aloud

Data collection (of player opinions) during the evaluations performed with Playtesting have used the “Think Aloud” method (see for example Nielsen, 1993, Wiberg, 2003) in two different ways; single player sessions in a traditional usability lab and group play sessions in a controlled environment. In both approaches, the comments from the players have been recorded in a standard way using audio tape recorders, and in the lab sessions complemented by video recordings of the screen activities.

Single player sessions in lab environment

This standard approach has been used mainly for evaluating quite early digital prototypes of the games Pervasive Treasure Hunt (early versions of the mobile game interface implemented on java enabled cell phones) and Furiae (early digital versions of mobile and web game interfaces running on java enabled cell phones and in a standard web browser), but also on the web part of the SupaFly game. Players from the intended target groups but also expert evaluators (usability specialists with experience of computer game

evaluation) have played prototype versions of parts of the games, while they verbalized their opinions and gave feedback about what they experienced.

Due to the unstable nature of early game prototypes (high risk of technical crashes) and the rather primitive state of the game play implemented (working basic mechanics but less developed story, game worlds, episodes, objects and features) this approach turned out to be rather effective and fruitful as a means to capture early player experiences and generate feedback. The results gave important insights into the players' perceptions and experiences of the fundamental game mechanics of the games and provided the design teams developing the games with important feedback about features and design solutions that enabled refinement and improvement of the game designs.

Further, as the game prototypes were all in states very far from being implemented and played in the way the final versions were intended to be played, it became of less importance to let the players play the games in their intended usage contexts. The minimal set of features and working game mechanics would, in these early stages, not suffer too much from being isolated for play in lab environments. This is because many of the particular design features of importance for upholding the pervasive aspects of the game play (such as other players, working communication, cooperative tasks and quests, integrated game maps bridging the physical and virtual worlds, etc.) were not developed and/or implemented at the time for the evaluations.

Considering the general methodological strategies discussed earlier, the evaluations performed with this approach was not following the first strategy (allowing extensive, player controlled game play) since the evaluations presented the players with rather short game play sessions in a controlled lab environment. The requirements of the second strategy (minimal intrusion in people's everyday lives) are easily met due to the fact that the game play sessions were conducted in an environment far from the participants' private, everyday contexts.

Group sessions in controlled environments

In the development of the *Furiae* game, I had the opportunity to design and conduct the absolutely first evaluation of the first game prototype produced by the design team. A paper prototype version in the shape of a role playing card game, simulating and demonstrating the fundamental game mechanics, fighting system and foundations in collaborative team play was developed, and evaluated by experienced role-playing game players. The players gathered in a controlled environment (a meeting room at the game design

company), and played the card game while all the game play and the conversations they had during the play session were recorded on audiotape.

The evaluations turned out to be useful to the design team as the feedback generated by the players quite easily translated into design suggestions, which in many cases led to concrete changes in the design. The initial attempts of the players to understand the consequences and ideas behind the pervasive features of the game mechanics also gave interesting insights into how the players created an initial understanding of what the pervasive game would be like when fully implemented. As they had very little experience of pervasive games they continuously asked questions and tried their very best to grasp what this concept might look like in the future game.

In light of the general strategies discussed earlier, this methodological approach, as also was the case with the individual lab setting version of playtesting, was not that much in line with the first strategy. However, the collaborative process of playing the game with other players and the group discussions performed in order to make sense of the game led to rather elaborated ideas about the good and bad aspects of the game design. On the other hand, it was rather well aligned to the requirements of the second strategy, as the game playing sessions took place in an environment separated from their normal everyday contexts, during a specific and limited time frame.

Playtesting with retrospective surveys

The second major approach performed by use of the playtesting method was to combine initial periods of game play (from three days to three weeks) with retrospective surveys focusing on the experiences generated during the game play periods. This approach was used in evaluations of digital prototypes of all three games (SupaFly, Pervasive Treasure Hunt and Furiae), performed in later stages of the design processes, generally when the games were considered to be in Beta stage (ready to be released to test players and played outside the game development projects).

In the initial game play periods, the participants had full access to the game prototypes in their everyday settings and could play the game whenever, wherever they wanted and decided to do. The main reasons for this setup was in line with the first and second general strategies described above. The players got an opportunity to play the game in its intended usage contexts and get an elaborated idea about how the game fit their everyday practices, without the risk of violating the integrity of the players. No observations or

reporting of experiences were made in their private settings, but retrospectively after the game play sessions were ended.

After conducting the initial period of game play, the participating players reported their experiences in Focus group interviews and/or Questionnaires.

Focus group interviews

Focus group interviews (see for example Templeton, 1994, Davis et al., 2005) were conducted in evaluations of all three games studied, with various tasks and procedures. For the SupaFly game, a focus group with usability experts was conducted in order to help the designers to decide which of several design alternatives to use for some specific features that were to be added to the game. For all three games, focus groups were conducted in order to create frameworks for assessing the quality of the pervasive game design. These latter focus group sessions followed an echoing set up (Clark & Duimering, 2006) where all good and bad impressions that the participants had were reported and sorted in a way that resulted in a local framework for evaluation of pervasive games, with a focus on features of importance for a positive (fun) game play experience.

Questionnaires

All three games were evaluated by use of retrospective questionnaires, which the players filled out after they had completed a playtesting period. The late version evaluations included large numbers of players (the final evaluations of the SupaFly and Furiae games performed with working, digital prototypes) and used web-distributed questionnaires (web forms). The evaluations based on fewer participants, performed in earlier stages of the game development cycles, used papers based forms. The specific questions in the questionnaires ranged from quite broad questions about game play behavior and impressions of the games, to more narrow questions focusing on specific aspects of the game play experience of the particular game that was being evaluated. For the more general questions, the players often answered by formulating free text answers; the more narrow questions often had closed alternatives to choose from. A common feature of all questionnaires, though, was that all questions allowed the players to write down a free text comment or remark for each of their answers.

System Logs

A quite formal method for gathering data about people's use of a particular software application is to study the system logs corresponding to the period

of the evaluation. In both the SupaFly and Pervasive Treasure Hunt cases this approach was adopted for the later evaluations of digital versions of the prototypes. The system logs, in both cases, provided interesting information about the quantities of actions performed by the players and about the game play behavior with respect to the time of day that the games were played and to what extent the players played the game. This information is indeed very important for the complete picture of the game play pursued during the evaluations, but in respect to the purpose of understanding player experiences the method turned out to be less fruitful. The data collected by system logs did not in any of the two cases provide any particular information beyond what the complementary methods offered, which helped in improving the understanding of the experience of the participating players.

Expert Evaluations

Perhaps the most widespread method for expert evaluation today is the heuristic evaluation approach (see for example Desurvire et al., 2004, Wiberg, 2003) where expert evaluators inspect a design by following a set of heuristics. Since no established heuristics for evaluation of pervasive games existed when I started out my empirical work, heuristic evaluation was not an option. Expert evaluators (usability and playability experts) were instead included in the evaluations in another way, by letting them perform both lab tests of early digital prototypes of the Pervasive Treasure Hunt and Furiae games, they served as extremely qualified test players in a stage of development where the game prototypes required a lot of patience, due to the immature status and tendency to crash randomly.

In one very specific situation during the development of the SupaFly game, a workshop was performed with usability specialists in order to provide the design team with decision support in the process of deciding between varieties of design for some specific features that were to be implemented in the game. For the purpose of the development of that game, the approach worked quite well as the design team expressed that the feedback was quite useful and helpful for them, but when it comes to increase the understanding of player experiences, the workshop provided less.

From Identification and Exploration to the making of a Model

I have now outlined the empirical and methodological foundation of my thesis work; a foundation that has allowed me to explore pervasive games in order to identify mechanisms of player enjoyment. With this foundation in place, I am almost ready to engage in the work of making a playability model for pervasive games. But, before that, the third part of the process needs to be established - the modeling part.

In a model-making process, a theoretical foundation helps the researcher to analyze, interpret and understand the empirical findings in a way that allows for more general knowledge to be abstracted from the particularities of the empirical findings. In the next part, I have therefore outlined the theoretical foundations of my work - the theory that allow me to transform and integrate my empirical findings into a general model for playability in pervasive games.

Part 4: Fundamental Theories for Modeling the Mechanisms of Player Enjoyment in Pervasive Games

This part describes the theoretical foundation of the thesis and reflects the different theoretical perspectives that have affected and inspired the work conducted. It starts out by discussing the core concept of the thesis work, namely user experiences.

User Experiences

User experience (or simply UX) is one of the most important issues to handle successfully in computer game design. Games are heavily depending on their ability to provide positive and good UX's in order to be meaningful and relevant for the player; that is, to be fun enough to be played. Failure to produce positive experiences and fun will most likely reduce any computer game to something boring and irrelevant, and without the ability to provide foundations for fun, computer games lose most of their purpose, meaning and appeal.

Over the years, various perspectives on UX have been articulated within the HCI area. A large number of them have been rather instrumental, focusing on aspects of design that improve productivity-focused goals of a system. Lately, however, we see a shift towards alternative, more entertainment-focused views of what it means to address UX and how we should consider UX in design.

UX in Computer Games

Even though games in many senses appear to be something completely different than productivity software, there are some similarities between the two. Just like productivity software, games have menu systems for choosing different options, input/control devices for controlling the interaction and various interfaces for bringing status information to the user (Davis et al., 2005). The similarities imply that some methods and approaches for assessing and improving the UX in productivity software, especially methods of evaluation and for obtaining user feedback, may also be used in order to improve the UX of computer games (e.g. Davis et al., 2005, Wiberg, 2003). On a more fundamental level, however, games and productivity software are rather different from each other. Productivity software is most often used with a primary concern to solve some kind of task in an easy, quick and

effective way, whereas games are played with the purpose of experiencing enjoyment and fun (Davis, et al., 2005). According to Davis et al. (2005), games must be challenging and innovative and requires the user to learn a set of very specific rules, which most often only applies to the specific game being played. These differences call for specific attention from the person pursuing the process of assessing UX in games, and the methods and concepts developed for assessing the UX in productivity software requires some special consideration before they can be applied in game design and evaluation.

Lazzaro and Keeker (2004) summarize what they consider to be the major differences between games and productivity software neatly in a table:

Productivity	Games
Task completion	Entertainment
Eliminate Errors	Fun to beat obstacles
External reward	Intrinsic reward
Outcome-based rewards	Process is its own reward
Assumes technology needs to be humanized	Assumes humans need to be challenged
Intuitive	New things to learn
Reduce workload	Increase workload

Table 3: The Main differences between games and productivity-focused software (Lazzaro & Keeker 2004).

The table may not give a complete overview of all major differences between games and productivity software concerning all major aspects of importance for comparison, but it presents a rather neat foundation for discussion and some of the aspects in the table will be further elaborated in this section.

The remainder of this section gives a brief overview of how UX is handled in computer game design. Initially, some of the aspects that demonstrate how games and productivity software differ are presented. Further, the concept of playability is described; a concept developed in order to deal with UX and the quality of the player experience in computer gaming.

Work vs. Fun: Motivational aspects and Usage

The distinction between work and recreation is a fundamentally important aspect in explaining the difference between games and productivity software. As Thomas and Macredie (1994) notes, we make a clear distinction between work and recreation (or work and leisure/fun) in western culture. This implies that people distinguish between what activities and settings they consider to be work and what is recreation/leisure. As we will see in the next section, the motivational aspects for pursuing various activities in these two settings are rather different and not necessarily compatible or reusable interchangeably.

Intrinsic Motivation and the Transient Nature of Computer Games

The activities performed in recreational contexts, such as playing computer games, are often characterized as motivated by so called intrinsic motivation (Thomas & Macredie, 1994). Intrinsic motivation means that the motivation is not depending on any reward outside the activity itself, but that the reward is in performing the activity or in the successful termination of the activity (Bruner, 1966 in Thomas & Macredie, 1994). Malone (1982) makes a distinction between software systems used in order to achieve an external goal, which he calls Tools (text editors, programming languages, etc.), and software used for their own sake with no external goal, which he calls Toys (e.g. Games). The phenomenon is also addressed by Cowley et al. (2008) who define the activity of playing computer games as an autotelic activity, meaning that the activity is undertaken purely for its own sake.

According to the heuristics for designing enjoyable user interfaces presented by Malone (1982), intrinsic motivation can be described as consisting of a number of different components or perhaps more correctly, the following components describe an environment that supports intrinsic motivation to occur and flourish. The components are:

- **Challenge:** The activity needs to have a goal with an uncertain outcome, the player/user needs to get performance feedback about how close he/she is to reaching the goal and if the system does not provide an explicit goal, it must allow the user to easily construct own goals.
- **Fantasy:** The interface of the system must embody emotionally appealing fantasies and the interface should embody metaphors with reference to other systems (physical or other) that the user/player understands.

- **Curiosity:** The system should provide an optimal level of informational complexity, it should be novel and surprising without being too complex and difficult to interpret, sensory stimuli (sound and graphics) should enhance the fantasy of the player/user and, finally, an element of randomness as humor should be used in making the environment optimally complex.

When these aspects are addressed successfully in design, intrinsic motivation can be considered to be supported and the user/player is likely to experience enjoyment when interacting with the system.

An important aspect of the motivational effects of computer games is that they are transient in nature; that is, the initially evoked motivation can quickly diminish (Thomas & Macredie, 1994). Once the player has mastered a game and become totally competent in playing it, the game loses its motivational value. As long as the player's impression is that the novelty of the game is upheld, the motivation for playing the game can be sustained for longer periods of time. Aspects like gradually increasing difficulty of the game and correct pacing of the player development are important features that can be used in maintaining the impression of novelty.

According to Malone (1982), good tools (productivity software) and good toys (e.g. games) are similar in that they both can draw on fantasy and curiosity, but they are rather different in their respective requirements for challenge. Tools depend very much on external goals for motivation, and cases where external goals are boring and routine can, according to Malone, sometimes be compensated by toy-like features of challenge in the system.

To summarize, we may conclude that computer games are depending on intrinsic motivation in order to be played, and therefore need to be designed in such a way that the system itself manages to provide such an appealing experience that the motivation within the player is supported and maintained.

Experiences in Computer Games

In the context of computer games, a variety of perspectives on the user experience issue can be found. For instance, Clark and Duimering (2006) take on a social science perspective and present an empirical study of how players experience the First Person Shooter (FPS) genre of computer games as behavioral settings. They consider games to be complex, context

dependent, goal directed activities and their results reveal interesting observations about the players' mental models of the FPS genre of computer games. The results further reveal that the most important and salient aspects of FPS games, from the players' perspective, are those perceived by the players to be most relevant to the goal attainment in the gaming.

Fabricatore, Nussbaum and Rosas (2002) present a model of the main elements and qualities that determines the playability of a computer game according to the players. The model mirrors player preferences for the specific genre of Action games, and was developed by use of a method following the Grounded Theory paradigm, where player experiences and opinions about the elements that makes a game a good game in this genre were identified.

Salen and Zimmerman (2004) present a model of how players experience a game, focusing on the mechanics of the events and processes involved when experiences occur. The model is an abstraction of some of the fundamental elements of another model of the psychological processes involved when players experience a game, presented by Sutton-Smith (Sutton-Smith 1986, in Salen & Zimmerman, 2004). Salen and Zimmerman's (2004) abstraction is based on three parts or relationships: Players make internal decisions, player take action and the game creates output. The relationship between the three is described in figure 5 below:

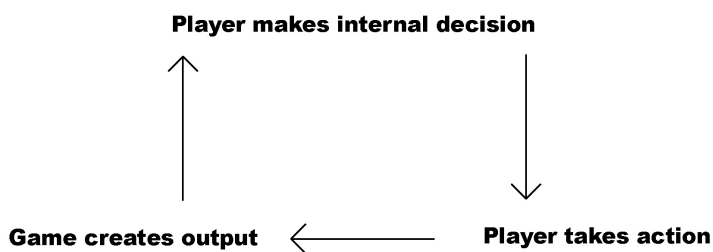


Figure 5: How players experience a game; the focus is on the game mechanics (Salen & Zimmerman, 2004).

Playability- Usability of Computer Games

In the literature concerning traditional computer game design we see a number of different ways to address UX issues. The main strategies are often inspired by and tightly related to usability methods for evaluation and design. As noted in the previous sections about methods, “Playtesting” is a common term used to describe activities focused on improving aspects of importance for the player experience, such as the balance in the game or how the game feels to play (Newman, 2004). Playtesting as an approach to game design has inspired the development of the playability concept; a concept used to deal with user experiences and usability in computer games.

One of the most influential people in the game design area, Chris Crawford, describes playtesting as:

“Ideally, Playtesting is a process that yields information used to polish and refine game design. In practice, Playtesting often reveals fundamental design and programming problems that require major efforts to correct”
(Crawford, 1982)

He further considers playtesting to consist of two parts: the Playtesting that a game designer performs on his/her own, and the Playtesting that is performed when the game is handed over to external playtesters (Crawford, 1982).

Depending on the state of the development process, a game can be playtested in two major ways according to Newman (2004): in-house playtesting during initial development phases (where rather few players test different designs, platforms and other parts of the game in a controlled environment), and later on public beta tests (including larger numbers of people playing an almost finished product in their private settings).

As the area of game development has evolved, we see a number of different examples in the literature where methods and approaches to playtesting have been studied and developed, with the ambition of improving the ways in which UX is handled in game design. Terms like “game usability ” or “usability of computer games”, often collectively referred to as “playability” are used in order to describe various methods, procedures and approaches to design, evaluation and general understanding of UX issues in computer game development (e.g. Cornett, 2004, Fabricatore, Nussbaum and Rosas, 2002, Davis et al., 2005, Desurvire, Caplan & Toth, 2004, Federoff, 2003). What unifies the playability approaches is that they all have a user-centered perspective on game design and on game design support, implying that the

user experience and how to design, evaluate and understand user experiences of good quality is the main focus and central aspect of importance.

Flow and GameFlow: Optimal Player Experiences

The goal of computer gaming is to create experiences of fun, enjoyment, pleasure, immersion, etc. It becomes rather obvious that the experiences created in computer gaming can be explained by a specific theory or model of optimal human experience, called Flow (Csikszentmihalyi, 1990). Researchers have acknowledged a natural link between Flow and games (Cowley et al, 2008), even though the similarities in Flow and Play (as the activity of playing games often is denoted) can be argued to agree in nature but not in scope - that is, computer games can but do not necessarily give Flow (Cowley et al., 2008).

After carefully considering the reservations concerning the similarities in the relationship between Flow and Play, the possible mapping between the experiences in computer gaming and the experience described as an optimal experience in Flow still makes the Flow theory a very promising theoretical point of departure. Therefore, this section provides a discussion of Flow theory and its relation to computer games as well as an extended motivation of why Flow theory, or more correctly the application of Flow called the GameFlow model (Sweetser & Wyeth, 2005), is used as a theoretical foundation in the thesis.

The theory of Flow (e.g. Csikszentmihalyi 1990, 1996) was originally introduced as a way of understanding optimal human experiences; experiences that generate happiness for the person having them. Building on a wide base of empirical work which analyzed the activities of a wide array of people throughout the world (ranging from clinical surgeons to mountain climbers to assembly factory workers and more), the theory sets out to identify the common characteristics and cornerstones of an optimal experience. The theory identifies eight important characteristics of an optimal experience: a task that can be completed, the ability to concentrate on that task, clear goals associated with the task, immediate feedback, a sense of control over actions, deep involvement that removes awareness of the frustrations of everyday life, sense of self disappears and, finally, the sense of duration of time being altered (see Csikszentmihalyi, 1990 for a more elaborated description of the eight components of flow). The findings of Csikszentmihalyi's work conclude that the feeling of Flow is the same for people throughout the world, independent of social class, age, nationality, gender, or even the task at hand.

The ability to capture the fundamental essence of what people throughout the world describe as optimal experiences of happiness have made the Flow theory a very popular and applied one, and there are a number of different examples where Flow has been applied in order to understand different human activities (see below for examples from the computer gaming area). The broadness and general applicability together with rather straightforward and easily interpreted fundamental elements are probably the most important strengths of the theory and could partly explain the popularity of the model. However, the same aspects that make the model well suited to understanding the general characteristics of optimal experiences and how these can be identified in a specific activity, makes the model rather blunt as a tool for understanding the specifics of an activity that generates an optimal experience.

In the case of computer games, Flow theory can identify whether or not a player has an optimal experience and can further relate that experience to other optimal experiences occurring in other activities. In this case, Flow is well suited to helping us understand in what way the activity of playing computer games is similar to other activities creating optimal experiences. Importantly, though, Flow theory in its original shape does not really help us in determining in what way specific mechanisms and/or elements in computer game designs are of importance for the player experience.

Without a mapping between the theory of Flow and the specific elements and mechanisms in the activity and context of the activity that we are interested in, Flow theory becomes a rather useless tool for design. In order to serve as a model for the design of computer games, Flow theory needs to be complemented with specific mappings between the understanding of an optimal experience and the elements and mechanisms in game design that creates the player experience. Precisely this kind of mapping is provided by Sweetser & Wyeth (2005) in the shape of their GameFlow model, and this is the major reason and motivation for using the GameFlow model as a point of departure for constructing the model of playability for pervasive games pursued in this thesis.

In related research we find a number of different examples where the combination of Flow and computer games has been studied, of which a few is briefly presented below.

Voiskounsky, Mitina and Avetisova (2004) have studied how Multi User Dungeon (MUD) gamers are affected by experiences that initiate Flow. Their empirical investigations reveal evidence that MUDers experience Flow

while participating in MUD games, and they suggest that Flow is one of the factors in the long-time attractiveness of MUDs for the players.

Chen (2007) provides an overview of Flow theory with focusing on how the concept can be applied in the design and analysis of computer games in general. The paper suggests some guidelines (on a very general level) for how to design for Flow in computer games, such as “mix and match the components of Flow” and “offer adaptive choices, allowing different users to enjoy Flow in their own way”. The conclusion is that enjoyable experiences in computer gaming can be explained as experiences of Flow, and that game designers therefore needs to create games that keep the players in the Flow zone in order to be successful.

Cowley, Charles, Black and Hickley (2008) present an ambitious approach towards an understanding of Flow in computer games. They point out that Flow is currently used in order to understand game play experiences, but that the fundamental connection between the Flow concept and an operational description of game play is rather unclear. They provide a practical and integrated approach for analyzing game play in a way that allows for more fundamental reflections about the capacity of Flow for Computer games. Their approach is based on the definition of computer games as information systems⁸, which results in an understanding of Flow as the optimal operation of an information system.

The overall conclusion to make from related research on Flow and computer games is supporting the assumptions made in this thesis: Flow can be used in order to understand Player experiences in computer gaming, but some kind of mapping between the Flow concept and the domain, consisting of specific mechanisms in computer gaming, is needed in order for this approach to be applicable.

⁸Their view on computer game play as operating an information system is quite in line with Salen and Zimmerman’s (2004) definition of player experiences (see “Experiences in Computer Games”, in the pervious section).

Theoretical Background

In order to fully understand the meaning of the user centered approach to pervasive games pursued in this thesis, as well as the origins of pervasive games, one must know something about the technological foundation on which pervasive games are built. In this section, addressing the theoretical background of the thesis, the technological foundation of pervasive games is briefly addressed.

The Ubiquitous and Pervasive Computing Paradigm - the Technological Foundation of Pervasive Games

It all started out in the late 1980's, when Mark Weiser presented his vision for the future development of computing technology and usage, the *Ubiquitous Computing* vision. The vision was presented and developed in a series of papers and articles describing an idea about "invisible computing" (Greenfield, 2006), where computing power and micro processors embedded in the environment set the user free from the restrictions of the desktop computing paradigm. The goal of the Ubiquitous Computing vision, which became a research program at Xerox PARC, directed by Weiser, was to:

"Achieve the most effective kind of technology, that which is essentially invisible to the user"
(Weiser, 1993)

According to Weiser, the desktop paradigm of computing, manifested in the personal computer (PC) was too complex and its applications too hard to use, requiring too much attention and making the users isolate themselves from other people and activities (Weiser et al., 1999 in Nieuwdorp, 2007). An embedded technological infrastructure, allowing the user to have constant access to computing power, would then enable "calm computing" to take place, a term denoting the state where users perceive computers and computational devices as something idle in the background, metaphorically invisible to the users (Weiser et al., 1999 in Nieuwdorp, 2007). Beyond the promise of an ever-present computational infrastructure, the vision of Weiser suggests new paradigms of interaction, expressed in three major themes in ubiquitous computing: *natural interfaces* (supporting common forms of human expression beyond mouse and keyboard interaction), *context-awareness* (adapting systems to input from the physical realm) and *automatic capture of live experiences* (Abowd and Mynatt, 2000).

When computational power would be placed in every thing and in every place, all connected in large networking structures, people would start using

and interacting with the systems enabled by these ubiquitous technologies in a fluent way, much more natural than in the existing PC interaction (Greenfield, 2006). The range of everyday situations, behaviors and objects which then potentially could be enhanced and improved by computational technologies is vast, implying fundamentally new ways for people to interact with information, with each other and with their everyday environments.

Pervasive computing is a term originally used by IBM in the late 1990's to describe their vision of the future in computer usage, with emphasis on commercial usage and access to services and information anytime, anywhere (Nieuwdorp, 2007). The major goal of the vision was to provide people with quick access to services, especially in the e-business area. Mobility and wirelessness was two fundamental enablers of the original vision, which soon became somewhat vague due to the introduction of internal (within IBM) alternative interpretations of the concept (Nieuwdorp, 2007).

The pervasive and ubiquitous computing areas are understood by many researchers as parallel or even interchangeable (Nieuwdorp, 2007), which has led to a rather confusing situation considering what the two concepts stand for and how they differ from each other. In the literature, there are a number of examples where parts of the Weiser/Xerox PARC ubiquitous computing program are referred to as examples of pervasive computing. Both concepts include a social aspect, as they focus on the user and how the user should be "set free" from the restraints of traditional personal computing devices, which may be part of the explanation for why the concepts could be interpreted as interchangeable or parallel (Nieuwdorp, 2007).

In contrast to the way of relating the concepts described above, some authors have chosen to separate the two concepts rather distinctively. Lyytinen and Yoo (2002) consider Ubiquitous computing to be founded on four dimensions, resulting from two separate characteristics of computer systems and devices (see figure 6 below): the level of *embeddedness* and the level of *mobility*. Lyytinen and Yoo (2002) define pervasive computing as computing with the ability to obtain information from the environment in which it is embedded and use that information in dynamically built models of computing, implying that the environment in some sense becomes intelligent. Further, they consider pervasive computing to score low on the mobility dimension, but high in the embeddedness dimension. Ubiquitous computing, according to Lyytinen and Yoo (2002), means computing where mobile devices incrementally build models of their various environments and configure their services to the user according to these models. Thereby,

ubiquitous computing is characterized by high mobility and high level of embeddedness.

This seemingly straightforward approach to the concepts is actually rather difficult to understand due to some inherent ambiguities. Lyytinen and Yoo (2002) use the term ubiquitous computing both as an overall concept with four dimensions of which *pervasive computing* is one, *traditional business computing*, *mobile computing* and finally *ubiquitous computing* the other three. This approach makes the Pervasive computing concept both a subdomain of ubiquitous computing (one of four dimensions of ubiquitous computing), and a complementing dimension of ubiquitous computing on the same level, and at the same time. This way of relating the concepts to each other is surely somewhat confusing and definitely needs to be refined.

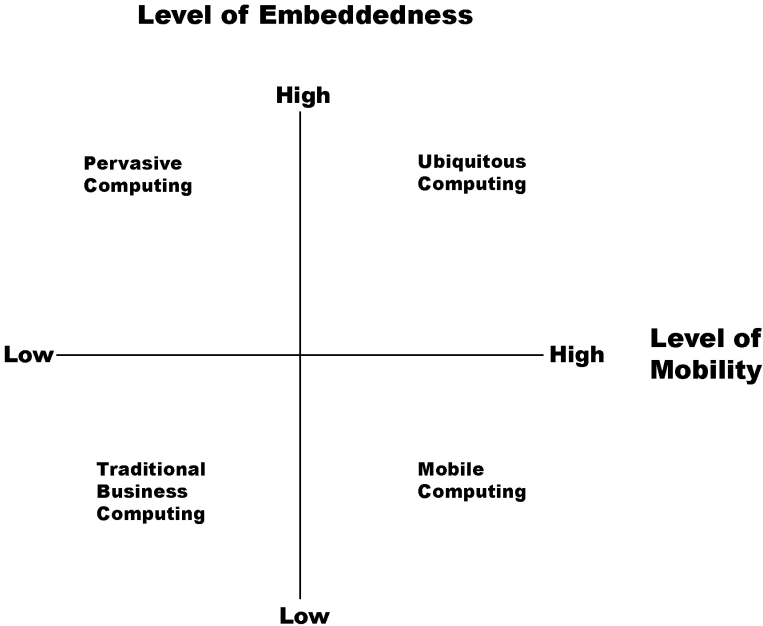


Figure 6: The Dimensions of Ubiquitous Computing (Lyytinen & Yoo, 2002).

Despite the ambiguities in the descriptions of the two concepts, we may conclude that both ubiquitous and pervasive computing can be used as

concepts to describe the technical foundation and line of thinking upon which pervasive games are based. Relating the discussion above to the other parts of this cover paper, two things becomes apparent. First, the vagueness concerning definitions and ways of interpreting the pervasive and ubiquitous computing concepts reveals itself also in the discussion about definitions and perspectives on pervasive and ubiquitous games. Second, there are similar fundamental ideas behind both the ubiquitous and the pervasive computing concepts. When the concepts of ubiquitous and pervasive computing are put into practice in pervasive games, the games often make the similarities and close relations between the two concepts stand out, rather than demonstrate any differences between the two.

With both the empirical and the theoretical foundations in place, we can now move on to the very process of integrating the empirical findings in a theoretically grounded model. This process of making the integration, to create the model, is described in the next part, focusing on the research process.

Part 5: Modeling the Mechanisms of Player Enjoyment

The overall purpose of my research process have been to create a model of playability for pervasive games- a model focusing on the mechanisms that are of importance for creating enjoyable player experiences. This purpose has saturated the entire research process, which has been conducted with the goal of generating a model that integrates empirical findings and theory.

The particular research process conducted in the thesis work is elaborated in this part of the cover paper. The process builds on two major fundamentals: collaboration with professional designers and the process of developing a model. Here, I elaborate what these two fundamentals have meant and describe the research process that they are both a part of.

Exploring Pervasive Games - Research in Collaboration with Industry

In terms of research, to explore is to approach a phenomenon with an open mind and with great care for how the phenomenon reveals itself when observed. Exploration can be guided by some sort of “road map” in the shape of a theory or a model, but can also be performed by an approach where empirical findings are used in an inductive way in order to build some kind of new theory or model. In my particular case, I have used an approach somewhere in between these two standpoints. My empirical work starts out with exploration of pervasive games, performed with evaluation methods that allow an empirically driven “bottom-up” approach and great care for how the object of study reveals itself. When the empirical findings were identified, a theoretical foundation in the shape of a model for understanding player enjoyment was used to abstract and integrate the empirical findings in a generally applicable model. This latter part meant that the empirical findings no longer drove the process, but that theory was used in order to interpret, classify and reflect on the empirical findings, that is, to make the findings even more understandable and also to enable them to be translated into more generally applicable knowledge about the phenomenon.

Pervasive gaming appears as a consequence of pervasive game design. A pervasive game needs to be designed and implemented in order for pervasive gaming (and its resulting experiences) to occur. This fundamental fact is very important for exploration of pervasive games and gives a researcher interested in exploring pervasive games two choices: to design and

implement one or several pervasive games on their own or to collaborate with someone else who has the ability to design and implement one or several pervasive game(s). Both approaches have benefits and tradeoffs; with personal control over the design process you have a final say in what is implemented but are constrained by your personal resources in the game development process. By collaboration with others, you lose some influence over what kind of games are made and control over the design process, but on the other hand can gain a lot in the shape of other people's experience, professionalism and other resources when it comes to designing and implementing games. In my case, and with the focus I have pursued in my work, I made the choice to find allies with better resources in the game developing area than my personal assets could provide. This choice had the benefit of allowing me to focus on the evaluation and exploration of the games when they had reached their intended players, instead of focusing too much on the design and realization of the games. The context for my exploration of pervasive games has therefore been the collaborative settings in which I have worked together with other people (described below) in order to evaluate Pervasive gaming experiences.

I had the opportunity to follow two separate commercial pervasive game development projects to various extents. The two game design companies⁹ that I collaborated with, provided access to their game prototypes before they were released to the public, and allowed me to plan and perform evaluations on both early and late prototypes of their games.

In 2005 I also participated (taking on the role of producer and project manager) in a small-scale student exam project with the purpose of developing a pervasive game prototype. The student project gave me a brief insight into the whereabouts of game designers and provided an important opportunity to approach a game design project from the perspective of a producing member of the development team; a perspective rather different, in my experience, from the one of the engaged but yet independent researcher following a commercial design team.

In the first commercial development project (the SupaFly case, reported in Paper 1 and 2), I was included in a late stage of development when an advanced game prototype existed and could be released to test players for evaluation. From early spring 2003 to winter 2004 I worked closely with the design team for approximately 14 months in order to perform a large-scale

⁹ It's Alive! AB (The SupaFly game) and Resolution Interactive AB (The Furiae game)

evaluation of the game design, conducted in three phases. I had close contact with the professional game development company that produced the game and had access to the lead producer and game designer in order to plan and perform an evaluation of the game prototype under as authentic circumstances as possible. During the evaluation project I had the opportunity to discuss methodological issues, design support, how to handle results from evaluations in the design process and many other aspects with the design team. The discussions provided me with an insight into how they performed their work and allowed me to reflect on the obstacles and difficulties of a pervasive game design process.

In the second commercial game development project (Furiae, reported in Paper 4 and 5), I had the unique opportunity of following the design of a pervasive game from its early start to its Beta version. Between spring 2006 and fall 2007 I followed the design project closely and had access to the whole design team. I initially became involved in the design project when the first paper prototype of the game was produced and I performed the first evaluation on the earliest version of the game. I continuously followed the design project and performed evaluations on various versions of the game prototype on four different occasions, the last one performed as a large-scale evaluation of a Beta version of the game.

To summarize the importance of my collaboration with commercial game designers, it is clear that the access to sharp pervasive game prototypes and games, running on digital platforms, accessible in people's everyday contexts by their everyday technology has enabled me to perform empirical evaluations of pervasive player experiences in a way that has taken my work far beyond what studies with small scale prototypes tested in lab environments would have done. Since my focus is on player experiences and not on the boundaries of the technology, the evaluation of less innovative but more easily accessible (compared to a lot of the prototypes in the related literature) pervasive games suited my thesis purpose very well.

Identifying and Modeling the Mechanisms - from Empirical Findings to a Model of Playability

Perhaps the most important fundament of my research process has been the development of a model, the Pervasive GameFlow (PGF) model. In this section, I will therefore elaborate what kind of process I have performed in order to construct the PGF model, since it is the main contribution of the thesis.

A common way of reporting general knowledge about phenomena in the area of HCI is to structure and organize theoretical and/or empirical findings from one or several sources into general models. The sources can be either purely theoretical, purely empirical or a mixture of both, and this approach has in the past proven to be a successful way of reusing the knowledge of what made a specific system, or even a whole paradigm, successful (Dix et al., 2004). By abstracting the essential details of successful design and then turning the abstractions into models of various kinds¹⁰, we end up with knowledge that can be applied outside the context in which it was generated and can be used again and again in new situations of design and evaluation.

As in the case of HCI in general, the playability area also has a history of making general knowledge about playability (e.g. Desurvire et al., 2004), user preferences (e.g. Fabricatore, Nussbaum and Rosas, 2002) and player enjoyment (e.g. Sweetser & Wyeth, 2005) available in the form of models. A common theme in playability research is to use playtesting as a benchmark (Desurvire et al. 2004) for the user experiences in playability evaluation. Playtesting focused on capturing player experiences is most often used in order to build up heuristics, frameworks or guidelines for successful computer game design, and also for validating existing or new models of various kinds. The underlying rationale behind the general process of abstracting knowledge from empirical evaluation and then turning this knowledge into a more generally applicable model of some kind is recognized by Wiberg (2003) who used a very similar approach in her research concerning evaluation methods for entertainment websites.

Two of the most important qualities shared by successful models in the HCI area are:

- **Applicability**; the model's ability to handle the broad empirical variety of systems and products for which it is intended (general enough to cover them all in a satisfactory way) and further, how easily it can be picked up and used by anyone interested in applying it.
- **Sustainability**; the ability of the model to "survive" the evolution of the application area for which it is intended, or the lifespan of the model.

In the last part of the cover paper (the Discussion), these two qualities will be discussed in relation to the results of this thesis (the PGF model).

¹⁰ Such as heuristics (Nielsen, 1993), golden rules (Shneiderman, 1998) or principles (Norman, 1998)

In the thesis work, I have applied a process of abstracting empirical and theoretical findings concerning Pervasive Player experiences into a playability model for pervasive games. Considering related work on playability models, very few, if any, authors describe the actual process followed when constructing the model itself. I will here make an exception and in figure 7 below, I have described the process I have followed and its particular steps:

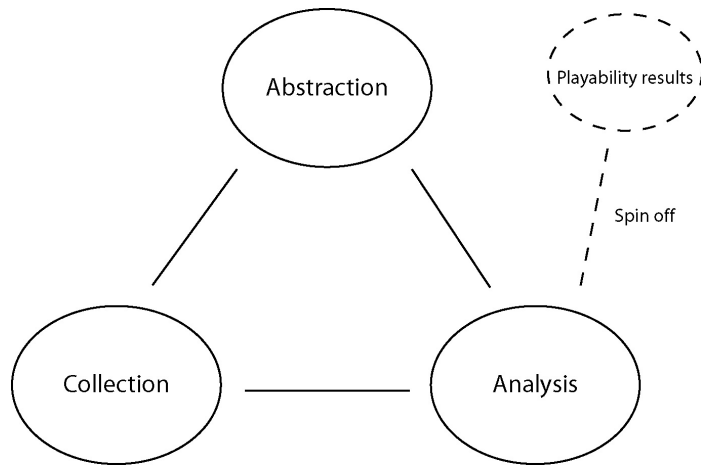


Figure 7: The modeling process consisting of three major parts and one secondary spin off product (the playability results for the specific game evaluated).

The process described in figure 7 is not to be interpreted as a circular or a linear process. Instead, it describes a process where the two parts *Collection* and *Analysis* provide the foundation (and therefore are placed at the bottom of the figure) for the *Abstraction*. *Collection* and *Analysis* have been performed repeatedly throughout the empirical research process, sometimes even in parallel (as when the focus group sessions were performed). The spin off product, *playability results*, represents the specific results or outcome when applying playability evaluation methods to specific pervasive games. These outcomes are actually dual, since the general phenomena underlying the specific remarks or reported statements have been identified in the *Analysis* and *Abstraction* parts of the process (and later used to build the model), while at the same time and in the shape of the actual, specific remarks (“This menu is too complicated” or “I did not understand the fighting system” as hypothetical examples) they have been translated into

specific playability problems related to the specific game, and communicated to the design teams. To summarize and clarify this, we may conclude that the empirical evaluations resulted in general findings about general aspects (mechanisms) of importance for the playability of pervasive games, at the same time being specific results concerning specific playability issues in the particular game design used in the evaluation.

Collection

This part in the process aims at identifying and collecting what will be the basic building blocks of the model. In the collection step, empirical data is collected by use of playability evaluation methods. In this case, the empirical data consisted of player experiences, as reported by players who had played pervasive games. The intention in this step was to identify and record empirical observations in a way that allows a multitude of different perspectives and preferences to be represented in the material.

Analysis

In this part of the process, the empirical material collected in the first part is structured in a way that makes it manageable for further use in the model constructing activity. Common themes in the data are identified and a first structure of the findings is generated in line with the themes identified. Still, the process is very much empirically driven, starting from the empirical material and the similarities in the reports from the participants.

Abstraction

The third part of the process deal with the final refinement of the empirical findings into more general conclusions concerning the phenomena studied. In this step, the outcomes of the analysis (the empirical results) are translated into the format of a model. At this point, they can either be compared and related to existing models, theories or frameworks in order to contribute to those by complementing them, validating them or dismissing them (in whole or parts of them), or they can be used to construct a completely new model. In any case, this is the stage in the process where the specific observations about specific player experiences are finally transformed into general conclusions about playability and player experiences.

As mentioned above, in addition to producing the Pervasive GameFlow model, the process has also generated specific playability results for the game that was used in the evaluation. These results are of course included in

the empirical material that the *Analysis* step addresses, but have also been communicated to the design teams in their original form, as they were valuable input in the ongoing design projects.

So far, I have used the term “mechanisms” somewhat vaguely and inclusively. “Mechanism¹¹” is a term that can be used in a variety of different ways in different domains, with a variety of meanings. In my approach, I use the term to denote some kind of bridging points between pervasive game design and pervasive player experiences, that is, the many interplaying aspects and factors in the pervasive game design that are of importance for how the pervasive player experiences the game. The specific theoretical point of departure I use (the GameFlow model), means that the mechanisms of pervasive player enjoyment are the same phenomena that the GameFlow model refers to as “criteria”. Each criterion in the GameFlow model describes a relatively simple or complex aspect of computer games in terms of positive and negative characteristics (to design for or avoid) that a particular game may have as a result of the game design process. These criteria then, taken together, provide a rich picture of a multitude of phenomena that interplay in creating the player experience, and can therefore be considered as the mechanisms of player enjoyment in pervasive games.

From GameFlow to Pervasive GameFlow

In the literature, the current approaches to playability (e.g. Cornett, 2004, Fabricatore, Nussbaum and Rosas, 2002, Davis et al., 2005, Desurvire, Caplan & Toth, 2004, Federoff, 2003) are either very strictly related to the empirical material used in the studies in which they have been produced (specific games, or genres of games), with negative consequences for the general applicability of the results, or closely related to traditional usability, in that they focus on the aspects of computer games that are the most similar to traditional software.

Because of this, Sweetser & Wyeth (2005) criticize the common agenda of playability research for focusing too much on three aspects of usability in

¹¹ The term is often used in engineering contexts, describing a system or structure of moving parts that performs some function for instance in a machine, or in philosophy where it stands for the attempt to explain phenomena in mechanical ways, or in psychoanalysis where it describes the ways in which psychological forces interact and operate (Collins Dictionary and Thesaurus, 1992)

computer games; *interface* (controls and display), *mechanics* (interacting with the game worlds) and *Gameplay* (problems and challenges), instead of more explicitly addressing the most important factor for successful games, player enjoyment. As a reaction, they address the issue of player enjoyment in computer games by relating different heuristics for successful computer game design and evaluation of computer games from the literature to the psychological concept of Flow (Csikszentmihalyi, 1990), ending up with a model of player enjoyment in computer games which they call GameFlow. GameFlow is a rare example of how a general theory of fun and enjoyment (Csikszentmihalyi, 1997) can be related to specific findings in the literature about successful computer game design (both results from empirical evaluations and more theoretical findings), with a focus on player enjoyment. The GameFlow model is therefore not only has a nice, comprehensive structure that summarizes current state of research concerning player experiences and enjoyment in computer games very well, but also a very suitable and promising point of departure for the work conducted in this thesis that has served as a foundation for the model constructing work described earlier.

In the process of developing the Pervasive GameFlow model, the original version of GameFlow was initially theoretically analyzed with respect to how well it seemed to capture factors of importance for pervasive gameplay. The analysis departed from specific characteristics of pervasive gameplay that on a general level seemed to challenge existing notions of what computer games are. The analysis resulted in suggestions for modifications to the GameFlow model to cope with pervasive games, presented in the shape of the first draft of the Pervasive GameFlow model (see paper 3). The Pervasive GameFlow model was then empirically validated and further refined (see paper 4 and to some extent paper 5) in the process described in the previous section.

The next section describes the overall research process and its specific relation to the published papers.

The Research Process as Papers

In this section, the major findings in relation to the overall research problem are described for each paper briefly, followed by an explanation of how the paper relates to the research process and how the outcome of the paper relates to the overall progression of the research.

Paper 1- Pervasive Gaming in the Everyday World

The purpose of the first paper was to investigate how commercial game designers in a commercially driven game development project may implement the pervasive gaming concept and what needs and requirements the players express when experiencing this new kind of computer game for the first time. The focus is on how the players perceived and made use of the game concept, in order to investigate to what extent players and designers share the same vision about how these games should be designed to create enjoyment and fun.

The study reported in the paper reveals that there is a gap between the designers' vision of how the possibilities and promises of pervasive gaming should be implemented and what the players consider to be attractive game play in this specific genre of games. A lack of experience on the designers' part reveals itself clearly, as they fail to foresee, acknowledge and successfully handle some of the fundamental needs and requests expressed by the players in the evaluation.

The first paper demonstrates the need for a better understanding of player preferences in the genre of pervasive games. Since the genre is relatively new, few commercial game designers have had the possibility to develop professional experience of good and bad design, and the need for design support focusing on how to approach and handle player experiences and preferences becomes obvious. The first paper therefore establishes the need for some kind of model focusing on playability and player experiences.

Paper 1 reflects the second step of the method or process performed in the thesis (see the summary below), by illustrating and verifying that there is a research problem in the shape of a need for better understanding of player experiences, needs and requirements in pervasive gaming.

Paper 2- Investigating the Applicability of Usability and Playability Heuristics for Evaluation of Pervasive Games

In order to address the need for a better understanding of player experiences in pervasive games as demonstrated in paper 1, the second paper investigates to what extent traditional usability and playability heuristics for design and evaluation of software and computer games can be applied to pervasive games.

By far the most common traditional way to address user experiences in software and game development within the HCI discipline has been to apply the usability and playability concepts, and the study presented in paper 2 reveals that to a large extent the problems reported in the evaluation of the SupaFly pervasive game prototype actually can be related to existing usability and playability heuristics. But some important exceptions call for further research. In the evaluation, with 58 participants and three standard usability evaluation methods, a total number of 16 issues (problems related to Player experiences and Playability) were identified. Of these issues, six was at least partly not recognized by traditional usability and playability heuristics. Three of these six were completely unique to pervasive games, but were all essential issues for pervasive gaming since they address fundamental pervasive game play activities.

This result implies that usability and playability heuristics are a promising point of departure for understanding players experiences in pervasive games, but that they are insufficient in their traditional form and need some kind of elaboration in order to grasp fully the unique character of the pervasive gaming experience. Therefore, the second paper opens up a possibility to contribute to this by providing a new model of playability for pervasive games, and could be said to further clarify the need for the Pervasive GameFlow model.

Paper 2 corresponds to the third step in the research process conducted in the thesis by exploring the currently available options for addressing the research problem (understanding player experiences in pervasive games) and investigating to what extent the current body of research addresses this problem. The results of paper 2 reveal that the current traditional options (usability and playability heuristics) represent promising and fruitful approaches but that elaborations are needed in order to address the unique features and characteristics of gaming that this new genre presents, thereby identifying a space of possible contribution for new research.

Paper 3- Pervasive GameFlow: Understanding Player enjoyment in Pervasive Games

The third paper adds to the understanding of pervasive player experiences by presenting a first outline for the Pervasive GameFlow model (PGF). The model departs from Sweetser and Wyeth's (2005) GameFlow model of player enjoyment in regular computer games, which maps existing heuristics and aspects of importance for player experiences found in the literature (aspects and heuristics from game evaluations, from usability heuristics and from playability heuristics), with the theoretical concept of Flow, describing optimal human experiences.

The PGF model elaborates the GameFlow model by analyzing what eventual additions or exclusions of elements and criteria of the GameFlow model need to be performed in order to cover aspects of player enjoyment derived from the major fundamental characteristics of pervasive games. In order to better cover pervasive game play, the model is complemented with 10 additional criteria in seven of the total of eight elements of the original GameFlow model as presented by Sweetser & Wyeth (2005). The additional criteria are all derived from implications of the three major elements in pervasive games- social interaction as driving force in the game play, integration of physical and virtual worlds and anytime, anywhere gaming.

The analysis pursued in paper 3 is purely theoretical and calls for further empirical validation and elaboration of the resulting Pervasive GameFlow model in order to assess its quality and correctness.

Paper 3 represents the first attempt to theoretically address the research problem and to make a research contribution in the shape of a theoretical model of player enjoyment in pervasive games. The first draft of the PGF model can be interpreted as a theory (or rather, a working model) of player enjoyment in pervasive games; a theory that needs further testing in order to be verified or dismissed.

Paper 4- Pervasive GameFlow: A Validated Model of Player Enjoyment in Pervasive Gaming

The purpose of paper 4 is to deepen the understanding of pervasive player enjoyment by empirically validating the Pervasive GameFlow model (PGF) described in paper 3.

Two separate pervasive games were empirically evaluated and the problems and experiences reported by the participants of the evaluations were used to

investigate the extent to which the suggested PGF model captures the issues of importance reported by the players. 94% of the criteria in the model (47 of 50) were validated and some additional elaborations of the model were performed. This step represents the first attempt to validate the PGF model and to make the status of the model more solid.

Paper 4 represents the first step of empirically validating the theoretical contribution of the thesis. The PGF model presented in paper 3 is empirically validated and thereby initially established as a working model of playability for pervasive games. The outcome of the empirical validation is an elaborated version of the theoretical PGF model, and this resulting model represents one of the major contributions of this thesis.

Paper 5- Elaborating Eight Elements of Fun: Supporting Design of Pervasive Player Enjoyment (sub)

The final paper presents an evaluation of the commercially developed cross-media game *Furiae*. The evaluation was performed to further validate the applicability of the PGF model for understanding player enjoyment in pervasive games, and the validation in this paper focuses on the relative importance of the elements in the PGF model for describing the specific player experiences derived when playing pervasive games belonging to the specific genre of cross-media games.

Paper 5 concludes the validation of the PGF model in the thesis. The results provide a more detailed picture of the relative importance of the elements in the model for dealing with player enjoyment in cross-media games. They also provide concrete support for designers of cross-media games, since the outcome of the study presented in the paper can be used to prioritize the elements when applying the model in design.

Summary of the Research Process

The overall research method pursued in this thesis and described in relation to the papers above, is summarized here as a series of steps. Each step of the process is described and related to the papers, demonstrating how the research method has been used as a strategy for conducting and presenting the research described in the papers.

- Step 1: Identifying a research problem (presented in the Introduction of the cover paper, the initial reason for starting the work described in the thesis).
- Step 2: Verifying the research problem; assessing to what extent the presumed problem exists and what relevance the problem has for the intended area of contribution. (Paper 1).
- Step 3: Investigating the current state of research and the currently available options for addressing the research problem, thereby also identifying a possible space of research contribution (Paper 2).
- Step 4: Formulating a theoretical solution to the research problem; finding and reformulating a theoretical model or framework that contributes to solving the research problem and that makes a contribution to current research (Paper 3).
- Step 5: Empirically testing the theoretical model and thereby validating its correctness. (Paper 4, paper 5)
- Step 6: Concluding the research process by identifying what intended contributions were made, and also pointing out the unexpected results - which also says something important in the context of the research question and area. (Conclusions in the cover paper)

After formulating the steps pursued in the overall research process and how these steps relate to the papers, the method and process can be described in the following figure:

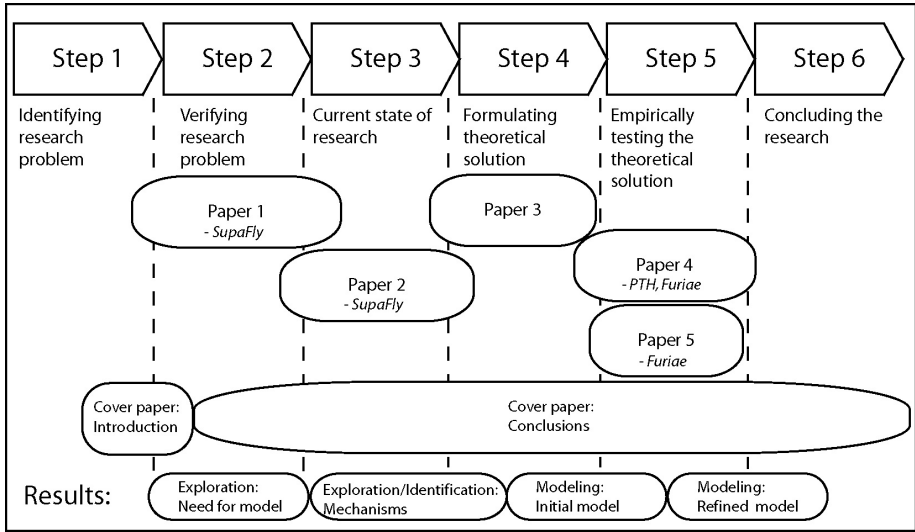


Figure 8: The figure shows how the steps of the research process have led to the papers, and how the papers and steps relate to each other. The cover paper provides the purpose of the thesis as well as framing the thesis work. In *italics*, the three games studied are related to the papers in which they are addressed.

With the foundations and overview of the research process in place, it is time to go into detail and focus on the exploration, identification and modeling that have been performed in the published papers, The next part of the thesis contains the collection of papers; a collection describing a journey from an initial state of broad exploration of pervasive games and their player experiences, to a state where all the findings eventually can be summarized in a validated model of Pervasive player enjoyment - the Pervasive GameFlow Model.

Part 6: The Collection of Papers

Paper 1- Pervasive Gaming in the Everyday World

The first paper demonstrates the need for a better understanding of player preferences in the genre of pervasive games. Since the genre is relatively new, few commercial game designers have had the possibility to develop a professional experience of good and bad design, and the need for design support focusing on how to approach and handle player experiences and preferences becomes obvious. The first paper therefore establishes the need for some kind of model focusing on playability and player experiences and it represents the first step in the exploration of pervasive games.

The paper was originally published in IEEE Pervasive Computing, Vol. 5 No. 1, 2006.

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Paper 2- Investigating the Applicability of Usability and Playability Heuristics for Evaluation of Pervasive Games

In order to address the need for a better understanding of player experiences in pervasive games as demonstrated in paper 1, the second paper investigates to what extent traditional usability and playability heuristics for design and evaluation of software and computer games can be applied to pervasive games. The results suggest that usability and playability heuristics are a promising point of departure for understanding players experiences in pervasive games, but they are insufficient in their traditional form and need some kind of elaboration in order to fully grasp the unique character of the pervasive gaming experience. Therefore, the second paper identifies a possibility to contribute by providing a new model of playability for pervasive games and could be said to further clarify the need for the Pervasive GameFlow model. Further, the second paper pursues the exploration of pervasive games, but also begins to perform an identification of aspects of importance for player experiences; the mechanisms of player enjoyment in pervasive games.

The paper was originally published in Proceedings of ICIW'08: Third International Conference on Internet and Web Applications and Services, Athens, Greece, 8-13 June, 2008. IEEE Computer Society Press, 2008.

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Paper 3 - Pervasive GameFlow: Understanding Player enjoyment in Pervasive Games

The third paper adds to the understanding of pervasive player experiences by presenting a first outline for the Pervasive GameFlow model (PGF). The PGF model elaborates the GameFlow model by analyzing what eventual additions or exclusions of elements and criteria of the GameFlow model need to be performed in order to cover aspects of player enjoyment derived from the major fundamental characteristics of pervasive games.

The analysis pursued in paper 3 is purely theoretical and calls for further empirical validation and elaboration of the resulting Pervasive GameFlow model in order to assess its quality and correctness. The third paper is mainly concerned with identification of the mechanisms of player enjoyment in pervasive games, but it also presents the first, important step in the process of modeling the identified mechanisms.

The paper was originally published in *ACM Computers in Entertainment*, Vol. 5, Issue 1, 2007. © 2007 ACM Inc. Reprinted by permission.

Paper 4 - Pervasive GameFlow: A Validated Model of Player Enjoyment in Pervasive Gaming

The purpose of paper 4 is to deepen the understanding of Pervasive Player enjoyment by empirically validate the Pervasive GameFlow model (PGF) described in paper 3. Two separate pervasive games are empirically evaluated and the problems and experiences reported by the participants of the evaluations are used in order to investigate to what extent the suggested PGF model captures the issues of importance reported by the players. This step represents the first attempt to validate the PGF model and make the status of the model more solid.

The outcome of the empirical validation is an elaborated version of the theoretical PGF model, and this resulting model represents one of the major contributions of this thesis. This step can be related to the modeling process, as it goes one step further in refining and validating the model suggested in paper 3.

The paper was originally published in Magerkurth, C & Röcker, C. (eds.): Concepts and Technologies for Pervasive Games: A Reader for Pervasive Gaming Research, Vol. 1. Shaker Verlag, Aachen, Germany, 2007.
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Paper 5 - Elaborating Eight Elements of Fun: Supporting Design of Pervasive Player Enjoyment

The final paper presents an evaluation of the commercially developed cross-media game *Furiae*. The evaluation was performed in order to further validate the applicability of the PGF model for understanding player enjoyment in pervasive games, and the validation in this paper focuses on the relative importance of the elements in the PGF model when it comes to describing the specific player experiences derived when playing pervasive games belonging to the specific genre of cross-media games.

Paper 5 concludes the validation of the PGF model in the thesis. The results provide a more detailed picture of the relative importance of the elements in the model when it comes to dealing with player enjoyment in cross-media games, but also a support for designers of cross-media games, as the outcome of the study presented in the paper can actually be used to prioritize the elements when applying the model in design.

The paper is accepted and scheduled for publication in *ACM Computers in Entertainment*, Vol. 7 Issue 2 April/June 2009.

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Part 7: Results

In this section, the results are summarized (for a more detailed presentation of these results, refer to the papers in the collection). Then, some of the more general, overarching or unexpected results springing from observations made during the long term studies of three different pervasive games are presented. These results are related to the four research questions stated in the introduction of the thesis.

The Pervasive GameFlow model

Perhaps the most obvious contribution of the research is the Pervasive GameFlow model for understanding player enjoyment, presented in paper 3 and elaborated in paper 4 and 5.

In paper 3, the original GameFlow model (Sweetser & Wyeth, 2005) is theoretically analysed with respect to how it handles important aspects of game play implied by the character of pervasive games. The original GameFlow model, consisting of eight elements and 36 criteria, is elaborated into a first outline for the Pervasive GameFlow model, consisting of the same eight elements as the original model, but adding 10 new criteria. The criteria are:

- **Concentration:** pervasive games should support the player in the process of switching concentration between in-game tasks and surrounding factors of importance
- **Challenge:** pervasive games should stimulate and support the players in their own creation of game scenarios and pacing
- **Challenge:** pervasive games should help the players in keeping a balance in the creation of paths and developments in the game world, but not put too much control or constraints on the pacing and challenge evolving
- **Player skills:** pervasive games should be very flexible and enable the players' skills to be developed at a pace set by the players
- **Control:** pervasive games should enable the players to pick up game play easily in a constantly ongoing game and quickly get a picture of the current status in the game world (in order to assess how the state of the game has evolved since the player last visited the game world)

- **Clear goals:** pervasive games should support the players in forming and communicating their own intermediate goals
- **Immersion:** pervasive games should support a seamless transition between different everyday contexts, and not imply or require player actions that might result in a violation of social norms in everyday contexts
- **Immersion:** pervasive games should enable the player to shift focus between the virtual and the physical parts of the game world without losing too much of the feeling of immersion
- **Social interaction:** pervasive games should support and enable possibilities for game-oriented, meaningful and purposeful social interaction within the gaming system
- **Social interaction:** pervasive games should incorporate triggers and structures (e.g. quests and events, factions, guilds or gangs) that motivate the players to communicate and interact socially

The first draft of PGF consisted of eight elements and 46 criteria, awaiting empirical validation.

In paper 4, the PGF draft was validated in the evaluation of two different pervasive games. The outcome of the process gave a validated version of the PGF model with eight elements and 50 criteria (four criteria added by the evaluations). Of these criteria, 31 (62%) were validated in both games, 16 (32%) were validated in one of the two games, and only 3 (6%) criteria were not validated in the games. All the 10 new criteria added in the first draft of the PGF model (paper 3) were validated and, an additional four criteria were identified in the empirical evaluations. The total sum of 47 (94 %) validated criteria suggests that the PGF model is applicable for assessing the playability of pervasive games.

After performing the validation process in paper 4, the PGF model consists of 50 criteria, of which 14 are new compared to the original GameFlow model; the 10 criteria described above and the following four that were added as a result of the evaluations:

- **Challenge:** Players should experience an appropriate level of challenge set by physical world preconditions (such as distance, locations, etc.)
- **Control:** pervasive games should provide a flexible interaction style that enables gaming in many possible physical settings
- **Control:** Games should make it hard for players to cheat and should uphold the feeling of fairness and equal opportunities for competition
- **Control:** pervasive games should be implemented on technological platforms that are easy to use and manage for the players. The games should make use of as few technological platforms as possible.

In paper 5, the PGF model was applied in evaluation of a specific cross-media game, in order to investigate what parts of the model were of most importance for the particular experience of playing cross-media games. The evaluation revealed that the three elements *Concentration*, *Challenge* and *Immersion* are of most importance for the player experience when playing cross-media games. The results indicate that there are probably differences in how important the eight elements of the PGF model are for different genres of pervasive games, an observation that calls for further research to provide more detailed guidelines on how to apply the PGF model in the design of pervasive games.

The work resulting in this thesis has produced results and contributions on many levels. Since the research process has been striving to produce a model, the resulting Pervasive GameFlow model has a relevance that becomes rather straightforward to assess. Also, since the results concerning the Pervasive GameFlow model have already been published and presented in the papers, this part of the cover paper will not go into much further detail about them. Instead, the remainder of this part focuses on the less expected results and the more general contributions of the research.

As mentioned in the introduction to this part, the process of following design and performing iterations of evaluations on three different pervasive games provides a lot of space for more general, overarching results and contributions. The following sections are focused on results and

contributions beyond those already expressed in the papers - results related to the four research questions stated in the introduction.

User Experiences in Pervasive Games

Besides providing opinions and feedback on the specific game designs evaluated, the players who participated in the empirical evaluations also delivered comments and feedback that revealed important aspects of their newly founded relationship with pervasive games. This kind of feedback has been used to answer the first and the second research questions previously stated in the introduction¹², and the findings presented in the following three sections all deal with these two or parts of these two research questions.

Pervasive Games are played sometime, somewhere

The observations in the empirical evaluations clearly demonstrate that there is no such thing as anytime, anywhere gaming (at least not in its broadest sense); game play is always located somewhere in time and space, mostly in leisure time and space associated with leisure activities (see paper 1 for example). This implies that instead of trying to design games that are detached from their respective interaction situations and focus on making them generally applicable for game play in all possible contexts, the efforts of pervasive game designers should rather be on identifying and understanding the specific contexts and settings where the game is played. Instead of trying to design for the abstract, general and infinite set of usage contexts prescribed by the anytime, anywhere vision, designers of pervasive games need to address a specific set of interaction contexts, possibly specific for each and every game. The really big issue and challenge for designers of pervasive games, in the current state of knowledge, is how to successfully address the usage contexts when general knowledge about how and where people prefer to play pervasive games is very restricted.

There is clearly a need for more research about which specific contexts, settings and situations in people's everyday life worlds they prefer for Pervasive gaming. Future research should strive to identify common features

¹² 1) To what extent are the players of pervasive games using or realizing the potential of pervasive games to deliver game play in virtually every possible contexts of everyday life? That is, how are they putting the anytime, anywhere and mobility aspects of pervasive games to practice? 2) How do the players perceive and handle pervasive games that offer constantly ongoing game play and are ready at hand to be picked up at any given time?

in the character of the contexts where people choose to play pervasive games, in order to build an elaborated understanding of what characterizes a context for pervasive game play. A model for predicting the actual usage contexts of a specific pervasive game design would clearly benefit game designers, and the understanding necessary for creating such a model would clearly enhance the Human-Computer Interaction research community's knowledge of user behavior in pervasive settings.

Mobility and Background Idleness

The anytime, anywhere aspect of pervasive games does in many cases of pervasive game design imply some sort of mobility. Mobile components of games or games played completely on mobile devices are very common in the current body of pervasive games (see examples in Magerkurth et al., 2004). The importance of mobility in Pervasive gaming can not be overestimated; however, the particular way in which mobility becomes important, and what aspects of mobility are most important for the pervasive gaming experience can be clarified on basis of the observations made during the empirical evaluations of the three games studied here.

When confronted with pervasive games as a phenomenon for the first time, it is easy to assume that the "macro mobility" is the most important mobility aspect of pervasive games. This is the ability of the games to be moved around in different quite disparate contexts (an ability shared with for instance cell phones and PDA's) such as at home, in workplaces and in different public spaces. However, as the observations made in the evaluations reveal, the macro mobility of the games is (at least in the case with commercially developed pervasive games building on people's existing everyday technology or similar) quite subordinate to the "micro mobility" of the games. The micro mobility aspect becomes most visible when the games are situated in a suitable context for game play, such as at home during leisure time (see paper 1 for example). When the games present just enough mobility to free the player from a restricted place or setting, such as in front of a computer or game console, interesting game play behavior arises. As demonstrated in paper 1, people recognize and make use of this micro mobility feature when they let the game constitute an idle, background activity or process, impinging on the players' attention from time to time and disappearing into the background of the players' attention in the time in between. The ability to blend in and exist in physically rather limited, social contexts such as the home environment seems, in some cases, to be more important than the ability to be brought to and between disparate, public settings. The micro mobility of the games studied therefore actually helps extensively in creating a game play released from traditional settings for

computer game play, but also serves as part of the foundation that enables constantly ongoing pervasive games.

The most important role and function of macro-mobility in pervasive games is demonstrated in the studies of *Furiae*; it is the ability to provide flexible points of access to and interaction with the game rather than the ability to let the player roam freely over large spaces while playing the game. In the next section, a great challenge presented by the macro mobility of pervasive games - the seamlessness and transitions of pervasive game play - is discussed.

Seamlessness and Transitions

One of the major strengths of the two commercially developed pervasive games studied here is the ability to provide seamless access to game play; start playing the game at a cell phone on your friends TV couch, pick up the game on the cell phone again while on the bus home, and finally in your browser at home (or in another place with web browser access to the Internet). The participants in the studies regarded this ability as highly interesting and very positive, and saw potential opportunities for using this approach in other games as well as the games evaluated.

While trying to pursue this kind of game play, an important design issue is that of allowing smooth transitions of the game play (not merely the player and the technology) between access points where the game is picked up and played. The procedure and actions required by the player to leave and later enter the game again need to be carefully designed, especially when the game is pursuing a constantly ongoing development, independent of any individual player's actions (such as in the case with *SupaFly*; the game world never pauses or stops). These transitions (entering and leaving the game) needs to be designed in a way that gives the player an opportunity to instantly get a clear picture of the current state of the game, and how the game world has developed since the last time the player was there.

Further, the somewhat less complex transitions occurring in game designs such as *Furiae*, where the player actually pauses the game and picks it up later in exactly the same state that the game was left in independently of platform (web or cell phone), also needs to be carefully designed in terms of the actions required from the player. The game needs to make it as easy as possible for the player to enter and leave, without having to make specific saves or in other ways handle the logistical aspects implied by the platform independency of a game, in order to be perceived as truly platform independent by the players.

Another aspect of importance and a challenge for pervasive game design related to seamlessness and transitions, deals with designing for potential changes in the usage contexts. Even though the results from the empirical evaluations performed here indicates that the players mostly play the games in relatively limited settings of their homes, these usage contexts can actually present a lot of different changes to the player, as he or she is involved in the game play. The impact of changing usage contexts of course becomes even more visible when considering game play in public settings but, in any case, it needs to be addressed in design. One of the major challenges of pervasive game design is to enable the player to shift focus and attention between the game and the surrounding environment as effectively as possible, without damaging the experience of game play. Compared to traditional game design, where the ultimate goal is to make the player totally immersed in the virtual game world, pervasive game design requires much more from the designer with respect to this aspect. The designer of pervasive games can and should expect the player to be interrupted a number of times during game play, and should strive to eliminate the negative effects of these interruptions as much as possible.

The impact of the Character of the Application - Games will be Games

In this section, the findings are all related to the third research question¹³ stated in the introduction - the impact of the novel aspects of pervasive games.

An interesting observation from the evaluations is that the participating players put more emphasis on factors related to playing games than on factors related to interaction with pervasive systems. One could easily imagine that the players would focus on the aspects related to pervasive computing and how they experience the pervasive parts of the games to a large degree, since in many cases they had no prior experience of playing pervasive games.

The novelty of the pervasive aspect, however, does not affect the players when they assess the quality of their gaming experiences. Even though the players perceive the pervasive aspects rather positively in most cases, they still assess their quality with respect to how well they fit the overall game play experience and what they perceive as the purpose of the game. The

¹³ What is the reach or impact of the novel pervasive aspects of pervasive games? How important are they for the players?

players judge the pervasive qualities of the games strictly on the basis of how it affects the overall game play.

This observation implies several things. First, that the character of the application is much more important than specific features that build up the application when it comes to how people make sense of and assess the quality of their experience after interacting with the system. Second, this implies a number of constraints when it comes to transferring the results from the studies of pervasive gaming usage pursued in this thesis to other application domains for pervasive features, such as medical systems, educational systems or so on. Since the observations show that the participating players relate the pervasive features and their experiences of them to the overall purpose of the system (to provide game play), it becomes rather difficult to make parallels with other usage situations and make any general claims about pervasive computing interaction and the experiences thereof. In order to say something general about peoples' experiences when interacting with pervasive systems, more evaluations of other pervasive applications need to be made and compared to the results of this study as well as other studies of pervasive game play, in order to assess the general applicability of the observations made here.

Evaluating Pervasive Experiences

The fourth and final research question stated in the introduction¹⁴ is addressed here in terms of general observations and findings (and even recommendations) concerning the evaluation of pervasive games. Throughout the evaluations performed with the three games studied, observations concerning the applicability of different methods to various stages of the design process have been made.

First, it seems that the standard methods for playability evaluation are quite successful also in the evaluation of pervasive games; however, some careful considerations about what method to apply in what stage of development must always be made when evaluating pervasive games under development. The rule of thumb, based on the experiences from the evaluations performed on the three games, is that the closer the prototype gets to release and the more of the features enabling the pervasive aspects of the game design that get implemented in the prototype, the more important it becomes to evaluate

¹⁴ How should we evaluate these new kinds of computer games, considering that they challenge our notion of when and where computer games are played?

the prototype in its intended usage contexts. As soon as the state of the prototype and the game play allowed by it approach a situation where the presence of the pervasive features starts to be noticed by the test players, the game should be released in its intended usage contexts in order to allow the players to fully understand how these features behave in real game play. Playing the game with the pervasive features present without being able to experience them in their intended usage contexts could mislead the players when they make sense of the features, and thereby also potentially produce misleading results.

Second, an interesting observation in the case of *Furiae* is that the social aspects of the game play can actually be addressed quite early in the collaborative sessions of evaluation, by using a paper prototype of the game mechanics. In this particular case, for that particular aspect of pervasive games, a rather controlled playtesting session performed in an environment quite different from the participants' everyday contexts turned out to be rather fruitful. Further research, concerning what specific aspects of pervasive games can fruitfully be evaluated in which stage of the design process, with and without releasing the game to be played in the everyday world for longer periods of time, needs to be performed.

Third, when comparing the results from the evaluations of the three games, it seems (unsurprisingly) that the feedback generated by the participating players increases in complexity and becomes more and more translatable into specifications for re-design, when the players are given longer periods of time for playing the game in the evaluations.

The recommendation, based on the insights from applying evaluation methods in an explorative way during several design projects, is that traditional lab based methods can be used initially in early stages of the design but that the intended usage contexts become more important as the prototype gets more sophisticated. Social aspects of the game play can be evaluated rather early in the development life cycle by using cooperative and collaborative playtesting sessions but that the novelty of the genre definitely requires longer periods of game play in order to enable the participants to provide as qualified and useful feedback as possible.

Part 8: Discussion

Following the purpose of developing a model of playability for pervasive games, some aspects of importance for assessing the strengths and weaknesses of the model developed are discussed here.

Applicability of the PGF model

The term *applicability* in this particular case refers to two specific things: the ability of the model to handle the broad variety of games in the pervasive game genre, and the extent to which the model can be picked up and used by anyone with an interest in understanding playability in pervasive games (such as other researchers than the author, game designers, etc.).

Concerning the first aspect of applicability (to be able to handle a rich variety of different pervasive games), the current status of the PGF model can be labeled as very promising but somewhat unclear. Since the model has so far been constructed and validated by use of three pervasive games representing only two subgenres of pervasive games (Location Aware games and cross-media games), the applicability is high for these two genres, but remains unproven for other subgenres of pervasive games. The validation processes performed (see paper 4) added four new criteria to the model, which makes it reasonable to expect that further validation with games from other subgenres would add more criteria to the model, and also possibly indicate that some of the existing criteria are of less relevance for other genres.

Concerning the second aspect of applicability, the model is still very unproven in terms of how easy it is to apply for anyone else than the author. As the person responsible for the development process and analysis that derived the PGF model in its current form, it is difficult for me to foresee how other people might experience the model when trying to apply it. I am far too familiar with all aspects and meanings of the model and can only speculate about how easy or difficult it is for other people to apply the model. Assessing this kind of applicability is definitely something for future work to focus on. Despite the difficulties, I will however point to some indications of the applicability of the model for design and evaluation purposes, but without going into details. Since the model in many senses (mainly in rhetoric structure and in how the elements and criteria are presented) resembles other heuristics and guidelines in the playability literature, it is fair to expect the model to be at least partly applicable as both design guidelines and as a tool for evaluation (heuristic evaluation or as a checklist when analyzing data from empirical evaluations).

Sustainability of the PGF model

Sustainability refers to the ability of the model to survive the upcoming development in the pervasive gaming area, the lifespan of the PGF model. Is the model something short-lived, focusing on a short-term phenomenon? Can the model handle change and development in the area addressed? These are important questions, the answers to which reveal the degree of sustainability of the model.

The PGF model is to a large extent built on knowledge derived from a body of research that has studied playability for many years. The fundamentals of the PGF therefore to a large extent come from knowledge concerning general aspects of computer gaming experiences; aspects that over time have been distilled out of the rapidly, ever-changing world of computer games. Since this knowledge, focused on what is general in computer gaming experiences over time, has now proven to be of relevance also for the new computer game genre of pervasive games, it is fair to expect that the PGF model will inherit, at least to some extent, the potential to remain relevant for a longer period of time. The trend in commercial game design to use aspects and particular features inspired by pervasive games, when developing games in other genres¹⁵, clearly indicates that criteria dealing with pervasive gaming will be of relevance in the near future, which in turn means that the PGF model has a rather good chance to be of relevance in a longer perspective.

Implications for understanding Flow in Computer Games

The area of pervasive games poses some very specific challenges for our understanding of how to design for Flow.

As optimal experiences currently are described in the literature (e.g. Chen, 2007), the experience depends on the player of a computer game remaining in the "Flow zone", undisturbed by interruptions that breaks the Flow state. Keeping the player in this Flow zone is exactly what game designers are trying to do when they design games with the ambition to create immersion and make the game world as appealing as possible with compelling and immersive graphics, and well balanced tasks building on the players' increasing skills. So far, designing for Flow in computer games has almost exclusively meant to design for deep immersion in the virtual game world.

¹⁵ See part 9 and the discussion about Pervasiveness in games

As the results demonstrate, this historical fact is no longer relevant when considering pervasive games. Designing for Flow in pervasive games does not mean to design games focusing only on how to create compelling, immersive virtual material for experiences mainly derived from interaction in a virtual world of some kind. As the PGF model suggests, pervasive game designers needs to address the issue of how to enable Flow to occur in various mixed reality experiences. This means a shift of focus from controllable, purely virtual game worlds to more complex blends of virtual and physical worlds. It means that factors previously labeled as disturbances or interruptions to the Flow of the player, such as most aspects of the physical world surrounding the player, now inevitably need to be handled in design. Managing to create Flow in computer games by using elements that previously were considered as disturbances that needed to be compensated for, or “designed away”, will most certainly broaden our perspective not only of what game design really is about, how Flow can be designed for in computer games, but also how we should consider the Flow theory itself.

Part 9: Future Outlook and Future Work

In addition to the suggestions for future work presented in the papers and in the previous sections of the cover paper, this section provides an outlook on how the research process around the PGF model may be continued as well as some more general predictions concerning the future of pervasive games.

As discussed in the previous part, the applicability of the PGF model needs to be further investigated. This may be performed in two specific approaches: the model needs to be inserted into commercial game design projects in order to enable studies of how applicable it is for design and evaluation of pervasive games in commercial settings. It also needs to be picked up and evaluated by other researchers in various contexts, in order to reveal its applicability in scientific research, beyond the studies performed in this thesis. Further, the applicability of the model when it comes to dealing with games from other subgenres of pervasive games than those used so far needs to be assessed. The model needs to be validated through the use of a large amount of pervasive games from a multitude of subgenres, in order to see what possible additions need to be made in order for the model to successfully deal with pervasive games as a whole.

From Pervasive Games to Pervasiveness in Games

Studying pervasive games for almost five years, while at the same time following the development of the traditional computer game genres, provides enough observations to make some speculations about the future development of pervasive games. The remainder of the cover paper presents some predictions about the future of pervasive games and the future of the PGF model.

We are probably experiencing the last days of pervasive games as a specific computer game genre; in the future, the games will be described as computer games (or some other term perhaps better describing the activity we today denote as “playing computer games”) and we will discuss games in terms of pervasiveness. The question will perhaps not be how to make pervasive games a successful genre, but rather how to promote and support the use of pervasiveness in commercial game design; How to make the transition of knowledge from the extensive body of research concerning pervasive games into useful guidelines for how to handle pervasiveness in commercial game design.

Concerning the development in the MMORPG computer game genre, as well as other current genres and gaming technologies such as Nintendo DS and Nintendo Wii, not to mention the Apple iPod and iPhone platforms with their gaming apps, we see a number of current examples of how pervasive aspects are incorporated and used in commercial game designs outside the specific genre of pervasive games. This trend demonstrates that pervasive features are something that are used in order to enhance games not meeting the requirements of “traditional” definitions of pervasive or ubiquitous games. The field of commercial computer game design will continue to incorporate pervasiveness in games in a rather slow fashion, adjusted to the end consumer technology and the gaming habits of the end users. Following this line of development, we end up in a situation where pervasive aspects are eventually incorporated in computer games in a way just as natural as any other components of computer games, and very few people will reflect on the fact that they are experiencing features that previously were understood as pervasive. People will simply discuss the pervasive aspects of computer games, as games from a multitude of today’s existing genres are likely to incorporate and make use of pervasive features. This probable evolution will most likely lead to a situation similar to that which Nieuwdorp (2007) depicts; a situation where pervasiveness is discussed as a widespread aspect of gaming and not something exclusively restricted to a narrow genre of computer games.

Future Directions for the Pervasive GameFlow Model

In this concluding section of the thesis, I speculate about how the PGF model will manage the probable transition from pervasive games as a specific genre, to pervasiveness in computer games as the phenomenon of interest.

As pointed out in previous sections describing future work, the PGF model needs to be validated by use of more pervasive games from all subgenres, in order to strengthen the model in terms of its general applicability in the pervasive game domain. As this line of work has already been initiated in the thesis (paper 5), we have preliminary results that allow us to predict that the model will withstand such a validation and still be relevant. A complementary approach to modeling playability for pervasive games, from other theoretical points of departure than Flow theory, needs to be performed, in addition to validating the PGF model with more games,. By comparing the outcome of modeling processes based on other theories with the PGF model, we can get a picture of how general the PGF model is. The mechanisms identified by my approach, based on Flow theory, could then be compared to the mechanisms identified by other theories, which would give an indication of how the PGF positions itself on a theoretical level, but also

provide some insights about what mechanisms and structures in player experiences are so fundamentally important that they also are recognized by other theoretical perspectives.

Pervasive gaming is a very broad and complex concept in terms of aspects of importance for Human-Computer Interaction. Complementing studies with a focus on other phenomena that constitute pervasive HCI should help in placing the important aspects of player enjoyment and playability identified by PGF in a broader context of pervasive HCI.

Clearly, much future work remains to be done to enrich our understanding of player experiences in pervasive games. However, we should also notice that the complementing approaches suggested above will strengthen the PGF model and have the potential to increase its quality, rather than overthrow the model. The process of refining the PGF model has only begun, and even if there is much work still to be performed, the future seems promising. Since the major part of the PGF model consists of general criteria for successful computer game design, which have proven to be of relevance also for pervasive games, these parts of the model will most surely survive the transition from pervasive games to pervasiveness in games. As the additional parts of the model, identified in the work resulting in this thesis, deal with pervasive phenomena in computer games, they too will most likely be of relevance after the change. Given the current status of the model and that the suggested future work is performed as outlined, the model will most likely be of high relevance for understanding playability also when pervasiveness is one of its natural fundamentals.

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