Designing User-Friendly Interfaces for Pervasive Gaming Applications[1]

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[1]This chapter is based on an earlier article by the authors

1 Introduction

With the emergence of ubiquitous computing technologies, our physical work and leisure spaces are augmented with computing functionality that unobtrusively assists its inhabitants [1]. While early research activities in the area of ubiquitous computing focused mainly on supporting productiveness and efficiency in work environments [e.g., 2, 3, 4], most current projects aim to foster long-term and low-pace communication and interaction between people in home environments. For example, the ASTRA project investigated an asynchronous awareness system that helped related and distributed households to stay in touch with each other [5]. A similar approach was taken in the interLiving project [6], which aims at developing technologies that facilitate communication between different generations of family members living in different households. Other projects as, e.g., EasyLiving [7] and Aware Home [8] concentrate on more fundamental challenges of intelligent home environments.

In addition to these communication-related aspects, future home environments also address fun and entertainment as important driving forces for the permeation of ubiquitous computing technologies in the home. As mentioned above, ubiquitous computing is concerned with the integration of information technology into our everyday lives, thus bringing the computer back to the real world. This inclusion of real-world aspects in entertainment applications opens up a large space of possibilities to create novel interaction experiences that bridge the gap between virtual and physical worlds.

However, it still has to be investigated if future users of such technologies will adopt their full potential or if contemporary forms of entertainment and gaming are already sufficient. From a user interface perspective, we can clearly perceive that computer games focus the users' attention mainly on the computer screen or 2D/3D virtual environments, and players are bound to using keyboards, mice and gamepads while gaming, thereby constraining interaction. By bringing more physical movement and social interaction into games, we might be able to utilize the benefit of computing systems while at the same time make the games accessible for ordinary people including elders, who were not socialized with playing computer games and who, consequently, do not participate significantly in contemporary computer entertainment. The formative study presented in this chapter hence investigates, if there is a demand for future home entertainment technologies that emphasize the

physical realities of the players, and if yes, how such technologies will have to be designed in order to have a maximal impact with different target groups.

2 Scenario-Based Evaluation of User Requirements

2.1 Introduction

The evaluation described in this chapter was part of an empirical cross-cultural study [9] conducted at six different sites in five European countries in the context of the EU IST-IP project Amigo, Ambient Intelligence for the Networked Home Environment (http://www.amigo-project.org). While the goal of this evaluation was to elicit feedback from a target user population on concepts for intelligent home environments, this chapter concentrates on novel game concepts. It is aimed to obtain feedback from potential users on the usefulness and attractiveness of different game concepts for smart home environments.

2.2 Materials and Methods

In order to get quantitative as well as qualitative feedback, the evaluation was subdivided into two parts with distinct methods and measures. For both parts, a scenario-driven approach was chosen to elicit feedback from a target user population. In the first part, the participants had to evaluate a fictitious scenario regarding its usefulness and attractiveness. In the second part, single aspects of the scenario were discussed in a structured focus group session. To explain individual components of future innovative game concepts to the target users a scenario was used (see Table 1 for core scenario elements).

Table 1. Scenario elements describing the functionality of a future gaming system.

Scenario Element	Description
Element A	It asks for parental permission.
Element B	It downloads and shows game play lists.
Element C	It adapts the lights and the sounds of the home to the environment of the game.
Element D	It displays a video wall to show the game and other players.

Scenario Element	Description
Element E	It lets the game player interact with body movements.
Element F	It recognizes friends at the front door and lets them join in the game.
Element G	It recognizes and integrates the game devices of the friend.
Element H	It downloads the profile of the friend.

Scenario Evaluation

To collect quantitative feedback on the different concepts, the scenario was visualized and shown to the participants in an exhibition-like setup. The participants were asked to rate each scenario element regarding its usefulness and attractiveness and to list the advantages as well as disadvantages of each concept. The stimulus material consisted of visualizations of the scenarios, with a corresponding text as an introduction. Two neighboring rooms were furnished as a reception room with tables and chairs, refreshments, paper, pencils and as an exhibition room showing the visualization of the scenarios. In the reception room, the participants received a general introduction and a short instruction on the tasks that they had to perform in the exhibition room.

The participants were instructed to form small groups with 2 to 4 people. When they entered the exhibition room, each group was instructed to assess the scenario and its elements. After fulfilling these tasks the group moved to the next scenario. The participants were asked to rank the elements for each scenario according to their perceived usefulness and to list advantages and disadvantages of the elements.

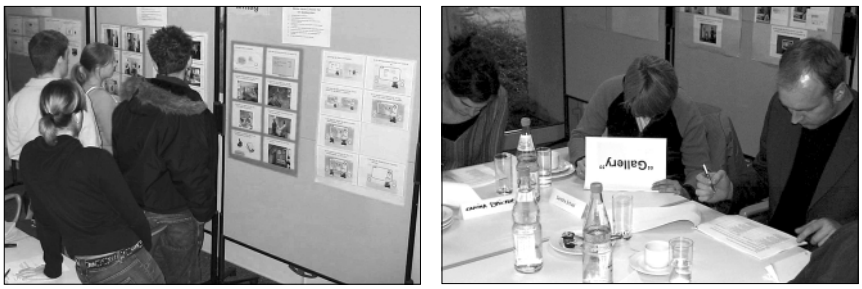

Figure 1. Presentation of stimulus material (left) and assessment of scenario elements (right).

Focus Group

The goal of the focus group discussion was to get qualitative feedback on the concepts described in the scenario and to investigate the expectations and needs for future gaming applications. The discussion was guided by structured questions focusing on the specific aspects of the scenario. The participants first were asked about their current entertainment preferences and then they were asked to develop ideas on how to improve the entertainment experience in the future. The discussion was supported by a metaplan technique. All ideas and comments of the participants were collected on cards, than clustered and labeled by the participants, and finally rated concerning importance.

2.3 Participants and Schedule

The evaluation was conducted with N=10 participants of two different age classes (see Table 2). One group consisted of three men and two women aged between 16 and 25 and the other group consisted of two men and three women aged between 32 and 38.

Table 2. Overview over participants.

Group	Participants	Gender	Age
Group 1	1	male	15
(15 – 25 years)	2	female	24
	3	male	23
	4	female	15
	5	male	25
Group 2	6	male	35
(32 – 38 years)	7	female	32
	8	male	35
	9	female	32
	10	female	37

The overall schedule for the quantitative and qualitative evaluation session is shown in Table 3

Table 3. Schedule for the evaluation (3 hours).

Group	Activity
5 min	Arrival, introduction and explanation
10 min	Warming up
15 min	Presentation of scenarios
20 min	Questionnaires
40 min	Lunch break
50 min	Focus group discussion
10 min	Coffee break
20 min	Clustering and rating of the focus group results
10 min	Unwinding, cooling down, debriefing

3 Evaluation Results

3.1 Quantitative Results

The questionnaires provided different types of data. In the following sections, the results of the ranking tasks are presented, first regarding the usefulness of the scenario elements, and then regarding their attractiveness. In the subsequent section the general feedback as well as the list of advantages and disadvantages are illustrated.

Usefulness

In the first part of the questionnaire, the participants had to rank the scenario elements regarding their usefulness (1 being the most useful scenario element, 8 the least useful). Table 4 gives an overview over the ranking results.

Table 4. Ranking of scenario elements regarding their usefulness.

Element	Sum	Average	Median	SD
A	28	2,8	2	2,300
B	53	5,3	4,5	1,829
C	36	3,6	3	2,319
D	51	5,1	5,5	2,558
E	42	4,2	4	2,098
F	64	6,4	6,5	1,430
G	40	4	3,5	2,625
H	43	4,3	4	1,767

Table 5 shows the number of participants, which rated each scenario element in one of the first three ranks.

Table 5. Frequency of participants who rated each element in one of the first three ranks.

	Rank 1		Rank 2		Rank 3	
Element	Freq.	Perc.	Freq.	Perc.	Freq.	Perc.
a	4	50%	2	25%	1	12,5%
b	0	0%	0	0%	1	12,5%
c	2	25%	2	25%	3	37,5%
d	1	12,5%	1	12,5%	0	0%
e	1	12,5%	1	12,5%	1	12,5%
f	0	0%	0	0%	1	12,5%
g	2	25%	3	37,5%	0	0%
h	0	0%	1	12,75%	3	37,5%

The evaluation of the ranking task showed that the standard deviation for most scenario elements is rather high. In order to get valid results, the ratings of the first three ranks were accumulated, before prioritizing the scenario elements.

Table 6. Prioritization of scenario elements regarding usefulness.

Priority	Scenario Element	Top 3
1	a) It asks for parental permission. c) It adapts the lights and the sounds of the home to the environment of the game.	70%
2	g) It recognizes and integrates the game devices of the friend.	50%
3	h) It downloads the profile of the friend.	40%
4	e) It lets the game player interact with body movements.	30%
5	d) It displays a video wall to show the game and other players.	20%
6	b) It downloads and shows game play lists. f) It recognizes friends at the front door and lets them join in the game.	10%

Attractiveness

In the second part, the participants had to rank the same scenario elements regarding their attractiveness. See Table 7 for an overview of the results.

Table 7. Ranking of scenario elements regarding their attractiveness.

Element	Sum	Average	Median	SD
A	48	4,8	6	3,155
B	50	5	5,5	2,160
C	25	2,5	2,5	1,354
D	48	4,8	4	2,486
E	37	3,7	4	2,163
F	62	6,2	6	1,549
G	45	4,5	5	2,121
H	45	4,5	5	1,900

Similar to the previous part, Table 8 shows the number of participants, which rated each scenario element in one of the first three ranks.

Table 8. Frequency of participants who rated each element in one of the first three ranks.

	Rank 1		Rank 2		Rank 3	
Element	**Freq.**	**Perc.**	**Freq.**	**Perc.**	**Freq.**	**Perc.**
a	2	25%	1	12,5%	0	0%
b	0	0%	2	25%	1	12,5%
c	3	37,5%	3	37,5%	3	37,5%
d	0	0%	2	25%	4	50%
e	2	35%	0	0%	1	12,5%
f	0	0%	0	0%	0	0%
g	2	25%	0	0%	0	0%
h	1	12,5%	2	25%	1	12,5%

Table 9 shows the prioritization of scenario elements, based on the accumulated ratings of the first three ranks.

Table 9. Prioritization of scenario elements regarding attractiveness.

Priority	Scenario Element	Top 3
1	c) It adapts the lights and the sounds of the home to the environment of the game.	90%
2	d) It displays a video wall to show the game and other players.	60%
3	h) It downloads the profile of the friend.	40%
4	a) It asks for parental permission. b) It downloads and shows game play lists. e) It lets the game player interact with body movements.	30%
5	g) It recognizes and integrates the game devices of the friend.	20%
6	f) It recognizes friends at the front door and lets them join in the game.	0%

Advantages and Disadvantages

The discussion of advantages and disadvantages mainly reflected the quantitative results from the ranking tasks. The feedback on the different scenario elements could be clustered into three domains:

Adaptiveness of the Environment. The idea of adapting light and sound to the current game situation was the concept most often addressed by the participants of both age groups. Adapting the physical environment to the virtual game atmosphere was regarded as one of the major building block for an enhanced gaming experience and increased realism.

Enhancement of the Social Situation. The idea of extending traditional video games into the real world and thereby enabling rich social interactions between the players was regarded as an attractive feature for new gaming applications. In this context, easy integration mechanisms for additional players and devices were widely appreciated. Being used to the small effort necessary to participate in traditional board games, the integration of players and control devices into current video games, seems to be a major problem for the average user.

Automatic Control and Security Mechanisms. Although the topic of automatic security and control mechanisms was addressed quite often, the expressed opinions regarding the usefulness of such mechanisms varied considerably. Most users, and especially those with children, liked the idea of automated age control, and regarded this feature as useful assistance in protecting children from inappropriate game content. In contrast, others feared that such autonomous control mechanisms this might lead to a depletion of social contacts and an erosion of parental authority. Although automation was widely appreciated in order to minimize the installation effort for game devices and players, the majority of participants feared that too much automation might lead to a loss of control. Especially functions like the automated access control (scenario element f) raised serve concerns among the participants.

3.2 Qualitative Results

For clarity, the feedback gained during the focus group discussion is subdivided into five groups.

Needs and Requirements

Most participants felt satisfied with existing entertainment devices and remarked that it would be hard to convince them of the benefits of a new entertainment

system. Both groups were rather satisfied with traditional board games and therefore quite reserved concerning the need for new entertainment systems. Especially the group of older participants mentioned, that new systems has to be really innovative to be of any interest. A simple improvement of existing features would not be enough to convince them. The younger group was more open for innovations, but noted that existing systems cover all their needs. Hence, the acceptance of future entertainment systems will strongly depend on their functional quality. The older participants further remarked that new systems are likely to be interesting in the first moment, but that classical board games might be favored in the long run.

Basic Qualities

The participants cared most about the compatibility, extensibility and usefulness of the system. They clearly want a flexible system with upgrade options. Both groups remarked that it has to be possible to take the system with them if they move into another house. They would only buy a new system if it offers various functions and a possibility to extend it, so that they will be able to use it for a long time. During the rating task, both groups generated a cluster labeled "extensibility". This cluster included multiple items claiming options to add new functionality, possibilities to integrate further game parts, as well as an update opportunity for the operating system. All participants agreed that future entertainment system must combine various functions. Similar to modern game consoles, which offer possibilities to watch DVDs, to communicate and to listen to music, a new entertainment system must also combine various functions related to entertainment. The group with the older participants also remarked that the system must save power. They asked for low power consumption in general as well as an automatic stand-by function, which automatically turns off the system if it is not used for a certain period of time. There was also a common agreement, that such systems must not be too expensive. A price comparable to the price of today's games consoles was considered as appropriate.

System Design Goals

All participants agreed that there has to be a simple way to disable automatic control mechanisms completely. Generally, it was regarded as very important that the user is always in control of the system and never the other way round.

Most participants emphasized that the interaction must be easy, quick and intuitive. Some suggested an interface with speech input and output. Therefore, intuitive interaction mechanism mentioned for all situations, ranging from the setup of the system, over its configuration to the daily interaction. In addition, the system shall save time by supporting activities the user would do anyway. Another requirement was to have service persons to deliver and install the system, to give some basic training on how to configure and use each feature, and to be available afterwards to help if problems occur. Furthermore, the system shall not require any maintenance after being installed. Both groups used traditional tabletop games as a benchmark to judge new entertainment systems. Participants in both groups noted that the game board should remain as a physical object. This requirement was explained with the rich social situation while using tabletop games. The participants claimed that they want to play together with their friends, although the system shall offer the opportunity to function as an additional player. One participant explained that real game pieces and game boards would enable a haptic experience and generated an atmosphere on their own, which he appreciated very much. Another participant suggested that the system could add sound or special effects to traditional board games or represent the game board in form of a projection. Another topic, which was addressed by many participants, was security and safety. Most participants were concerned about (software) attacks from outside as well as about potential accidents caused by malfunctions of the system.

Content Design Goals

As mentioned above, both groups emphasized the social aspects of playing games. Generally, the system should help to foster a sense of community between users. This must be considered for each application, no matter if it is a game, a communication system or a movie. Games must offer a single-player mode as well as a multi-player mode for various numbers of players. The system must be able to replace missing human players as well as an option to control non-player characters. All participants expect that future entertainment systems provide better graphics and a more realistic game world than current systems do. Although this was mentioned as a clear requirement, one participant remarked the ambivalence. On the one hand the participants would appreciate an immersive game world, but on the other hand they fear that this may cause losing contact to reality.

Features
Generally, the participants want a useful combination of features realized in independent components. The users should be able to decide on their own, which features they need and than be able integrate them into the system. But the system should only focus on entertainment. Completely different features of smart home environments, like for example housekeeping functionalities, should not be integrated in the system. Future gaming applications should be able to control the physical environment, e.g. light or sound, in order to adapt the room to the current game situation. The system should also include new technologies, like 3D projections and speech interfaces. Furthermore, the systems should improve traditional board games with additional feedback in form of acoustical and visual effects, and provide an option to simulate additional players. Finally, the applications should represent remote players, who play from a different location, like they were in the same room.

3.3 Resume of the Evaluation

The focus groups showed that an entertainment system must be designed with care to convince people of all ages. Furthermore, all features must be useful and the system must provide an added value to existing entertainment systems. Mediating personal communication and connecting people is regarded as a very sensitive topic. A feature to connect distributed people is only appreciated if the contact would be less intensive or non-existing without the system. But if a direct interaction between people is possible, the system must never replace that. The major goal of an entertainment system is to support a rich social situation with as much direct interaction between users as possible. Additionally, the system should provide a more realistic entertainment experience for games as well as for movies or other content.

4 Derived Design Implications

Given the results of both parts of the evaluation, implications for the design of a future home entertainment system can be derived.

Support for Graphical and Physical User Interfaces

Entertainment applications traditionally make strong use of graphical output to support the immersion into the game. Many of the innovations both in 3D rendering algorithms and rendering hardware are in fact driven by the highly competitive games market. As the participants of the study noted, game applications need to provide both rich graphical output to appeal to the users and additionally integrate non-standard physical interfaces that support the social dynamics of the involved players and link between physical and virtual worlds without requiring exclusive attention. Hence, different forms of interaction, different user interface concepts, and multiple and heterogeneous devices are required as well as a content-adapted presentation including the ambient light and sound condition in the immediate environment.

Flexible Device Configuration

As indicated by the participants of the formative evaluation, the setup of interaction devices in a future game session can vary greatly, depending on what is available at a user's site. Solutions tailored to one specific site that is mostly static in its configuration might make sense in a business context, but since home entertainment naturally aims at mass market deployment the developer of a ubiquitous computing game cannot anticipate the device setup of the end user. One user might possess a certain interaction device, while another user owns a different one. When both participate in the same game session, they should be able to bring their own devices and make use of them. As the participants of the study note, this should involve basically no integration overhead. Accordingly, the game application should be able to operate on a minimal device setup, e.g. a single desktop PC, and adapt to a myriad of additional input and output devices.

Runtime Adaptability

In a home entertainment setting, interaction situations are very little structured with participants joining and leaving at any time. Due to this dynamic nature of the interaction situations, interaction devices need to be flexibly integrated and be added and removed at any point in time, which the participants of the study explicitly point out. Since it cannot be taken for granted that private devices are always available in sufficient quantities (see flexible device configuration),

the gaming application must also be capable of dynamically reassigning private devices to different users. In addition to the device configuration, also the game applications themselves need to be adaptable during runtime regarding their modeled rules and game mechanics. This relates to the notion of "house rules" that allow participants of the game to change certain game mechanics as a result of their own playing history. The runtime adaptability of traditional tabletop games is one of the reasons for their continuing success despite the technical superiority of computer entertainment. This point clearly relates to the participants' notion of traditional board games as benchmarks for future gaming systems.

User Interface Orchestration

Lights and sound should be adaptable to the contents of the current entertainment application. Obviously, the orchestration of user interfaces is a crucial point in ubiquitous computing gaming applications. For dramatic reasons, it is important to make effective use of the various mostly output devices in a smart space. For instance, story-telling elements such as the infamous cut-scenes from contemporary computer games demand for large public displays to have the intended immersive effect. When heterogeneous interaction devices with different interaction characteristics are integrated in a smart home environment, it is essential to utilize each single device in accordance with its interaction affordances. Hence, a coordination infrastructure needs to be aware of device characteristics in order to distribute user interfaces among interaction devices.

Appropriate Modeling of the Social Space

As the participants of the study remarked, it is essential for a future entertainment system to support the interaction between humans in their natural environments, instead of forcing humans to communicate via a computer. Consequently, when dealing with multiple users, an inherent distinction between private and public information must be made. Notes taken in a negotiation meeting, for instance, must not be directed to a public display. For entertainment applications, it is often favorable to further introduce multiple degrees of privacy for game events, so that different degrees of shared, public and individual knowledge in the social space can be utilized by a game application to foster cooperation and competition between human participants. The gaming platform must therefore inherently

address information representation and information flow to ensure that the social space is appropriately provided with information form the virtual domain (cf. user interface orchestration).

5 Conclusions

This chapter presented a formative evaluation on future home entertainment systems. A scenario describing a future gaming environment was used to illustrate new game concepts and interaction techniques. In a two-step evaluation process, the scenario was presented to a target user population of two age groups. In order to elicit from the participants on the different scenario elements, questionnaires as well as a structured focus group discussion were employed. The user feedback was used to define a set of design requirements for future home entertainment systems.

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