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Game and Entertainment Technologies 2011

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FOREWORD

These proceedings contain the papers of the IADIS International Conference Game and Entertainment Technologies 2011, which was organised by the International Association for Development of the Information Society in Rome, Italy, 22 – 24 July, 2011. This conference is part of the Multi Conference on Computer Science and Information Systems 2011, 20 - 26 July 2011, which had a total of 1402 submissions.

This conference aims to bring together research and practice from creative, social and business practitioners and researchers in this challenging field. The focus of this conference is on design, development and evaluation of games, entertainment technologies and the nature of play.

Known to have been enjoyed since at least 30 BC, games and entertainment are a universal part of human experience and present in all cultures. Games and entertainment activities contribute to the social, emotional, psychological and physical well-being of human society.

As game and entertainment technologies become increasingly more pervasive we are continually challenged in our work, learning and personal life by increased access to virtual spaces and communities that offer opportunities for everyday needs and aesthetic experiences. The ‘Creative Industries’ require design and development structures, techniques and methodologies that enrich, enhance and encourage new interaction modes, metaphors and in-depth co-creation. This conference aims to bring together research and practice from creative, social and business practitioners and researchers in this challenging field.

The focus of this conference is on design, development and evaluation of games, entertainment technologies and the nature of play.

Topics of interest include, but are not limited to the following areas:

- Development methodologies- Design issues
- Controversial issues – we welcome debate and dissension, for example; games as art, entertainment as purely for monetary returns etc
- Special Effects
- Animation
- Mobile and ubiquitous games and entertainment
- Serious Games – applications, critiques
- Philosophical issues
- Prototypes
- Social and cultural uses of/for Play
- Tools and technologies
- Skills, strategy, rules and chance
- Genre
- Immersiveness and engagement
- Research methodologies in creative practice
- Usability and playability
- User/player centered design
- Psychological, social, and cultural differences in perception and participation
- Communities, networks, social interaction and social capital
- Cross-cultural and intercultural approaches
- Assessment of exploratory learning approaches
- Emerging practices

The IADIS Game and Entertainment Technologies 2011 received 56 submissions from more than 12 countries. Each submission has been anonymously reviewed by an average of four independent reviewers, to ensure that accepted submissions were of a high standard. Consequently only 11 full papers were published which means an acceptance rate below 20%. A few more papers were accepted as short papers, reflection papers and posters.

An extended version of the best papers will be published in the IADIS International Journal on Computer Science and Information Systems (ISSN: 1646-3692) and/or in the IADIS International Journal on WWW/Internet (ISSN: 1645-7641) and also in other selected journals, including journals from Inderscience.

Besides the presentation of full papers, short papers, reflection papers and posters, the conference also included a keynote presentation from an internationally distinguished researcher. We would therefore like to express our gratitude to Professor Dimitrios Rigas, Head of the Department of Media Technology & Head of the Innovative Interactive Systems Research Group (IIS), De Montfort University, United Kingdom, for accepting our invitation as keynote speaker.

As we all know, organising a conference requires the effort of many individuals. We would like to thank all members of the Program Committee, for their hard work in reviewing and selecting the papers that appear in the proceedings.

This volume has taken shape as a result of the contributions from a number of individuals. We are grateful to all authors who have submitted their papers to enrich the conference proceedings. We wish to thank all members of the organizing committee, delegates, invitees and guests whose contribution and involvement are crucial for the success of the conference.
Last but not the least, we hope that everybody will have a good time in Rome, and we invite all participants for the next edition of the IADIS International Conference Game and Entertainment Technologies 2012, that will be held in Lisbon, Portugal.

Katherine Blashki,
University of Sydney,
Australia
Game and Entertainment Technologies 2011 Conference Program Chair

Piet Kommers, University of Twente, The Netherlands
Pedro Isaías, Universidade Aberta (Portuguese Open University), Portugal
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KEYNOTE LECTURE

EDUTAINMENT AND GAMES IN ELEARNING

Professor Dimitrios Rigas
Head of the Department of Media Technology & Head of the Innovative Interactive Systems Research Group (IIS), De Montfort University, United Kingdom

ABSTRACT

The use of Edutainment and Games in eLearning has been investigated for several years at the Interactive Innovative Systems (IIS) research group at the Department of Media Technology at De Montfort University. This research presentation will explore usability aspects and empirically derived guidelines for multimodal edutainment and game-based eLearning interfaces.

Multi-platform experiments demonstrated an increased user enjoyment, learning retention and that the Game-based learning interface outperformed other eLearning interfaces. Experiments showed that using multimodal features in addition to game-based approach was more efficient, more effective and more satisfactory compared to the other two investigated e-learning interfaces. The presence of an expressive avatar in an edutainment e-learning interface also increased the users’ interest, motivation, and retention and aided thinking and reasoning.
Full Papers
WEMAKEWORDS –
AN ADAPTIVE AND COLLABORATIVE SERIOUS GAME
FOR LITERACY ACQUISITION

Damir Ismailović, Dennis Pagano and Bernd Brügge
Technische Universität München, Munich, Germany

ABSTRACT
In this work we propose to use serious games for literacy acquisition in early reading. We propose a model for adaptivity of the game to the learner. Furthermore we motivate the importance of collaboration between learners. We show how adaptability, individualization, and collaboration are realized in the serious game weMakeWords. weMakeWords is an adaptive serious game for literacy acquisition that enforces collaborative actions between players where children aged between 4 and 8 are constructing words in teams. Finally we present a preliminary evaluation of game concepts that shows initial promising results.

KEYWORDS
Serious Games, Adaptive Serious Games, Game Based Learning, Collaborative Learning.

1. INTRODUCTION

Oxymorons combine terms with contradictory senses. The term “serious games” is an oxymoron, since it “unites the seriousness of thought and problems that require it with the experimental and emotional freedom of active play” (Abt 1970). “Serious games” as term exists for more than 40 years. In 1960s Clark Abt worked on war-games and simulations for training. In latest research serious games are defined as “Games that do not have entertainment, enjoyment or fun as their primary purpose”. The interest for using serious games in education is based on the increased motivation of students in playing games. It is widely accepted that serious games “are games with a purpose. In other words, they move beyond entertainment per se to deliver engaging interactive media to support learning in its broadest sense.” (Stone 2008, p.9). But even if games use the natural affinity of humans to play in order to facilitate training, education and communication (Zyda 2005), there are no known forms of education as effective as a professional human tutor (Anderson et al 1995, Bloom 1984). The reason for this is the higher adaptivity to the learner (VanLehn et al 2005). In general classrooms, a personal tutor for every student is usually unavailable. The reason because state of the art technology is not able to reach the efficiency of one professional human tutor for each child, is the lack of a focus on the learner (Kickmeier-Rust & Albert 2007).

The contribution of this work is threefold. First, it describes a solution approach to the problem of the missing focus on the individual educational needs of each learner. Second, it presents a first implementation of the solution strategies in the form of weMakeWords. Third, it provides preliminary evaluation results showing that the game concept, adaptivity, and collaboration in weMakeWords tend to be promising.

The rest of this paper is structured as follows. In the second section, the paper introduces an overview of state of the art in adaptivity and collaboration in serious games. The paper then shows our detailed solution approach for the game. The fourth section examines the architecture of the system behind weMakeWords. The fifth section summarizes the preliminary evaluation. The final section presents a short conclusion and future work.
2. **WHAT MAKES A SUCCESSFUL LEARNING GAME?**

The benefits of games for learning have been shown in scientific publications, mostly considering students or school children (Jenkins 2002, Shaffer et al 2005). However, these benefits apply also to professional activities and employees that may use simulations and role-playing to gain learning experience in scenarios that are usually too costly or dangerous in the real world (Corti 2006). The target audience for weMakeWords however is significantly younger. Getting children to play a game is not really a hard task. But the motivation to play weMakeWords may be different from the techniques and methods used in games for an older target market. There are already commercially successful solutions for literacy acquisition (Headsprout 2011), but most of these tools provide no real interactive and engaging experience (Corti 2006).

The adaptive character of learning games has proven to be a very successful feature. With Smart.fm (Smart.fm 2011) the Japanese company Cerego provides an application that uses an adaptive learning algorithm to “optimize the sweet spot between the minimum number of times you have to see an item and the maximum effectiveness of that presentation” (Naone 2009). The ALIGN framework (Adaptive Learning In Games through Non- invasion) is one approach for adapting a serious game presented in (Peirce et al 2008, Kickmeier-Rust & Albert 2007).

Important factors for successful learning when considering the age of weMakeWords’ target audience are usability and game experience. Surprisingly even to date the design of e-learning content is usually aligned with the old paradigm of instruction. Thus the results resemble in most cases a trivia contest, though it would be possible to make use of the characteristics of the new gaming age, namely experimentation, problem solving and collaboration (Squire 2008).

When designing a game, not only the game idea itself, but a broader social context of the game should be considered. In some cases, the social context is as important as the game itself. The potential of computer games as teaching and learning tools is being explored since the 80s. The focus of research recently shifted to the field of learning through multi-player gaming and collaborative learning (Hämäläinen et al 2006). Collaborative learning involves many minds that focus on one problem. Therefore collaborative learning produces an intellectual synergy and stimulates mutual social commitment. Collaboration this way leads often to a better understanding on the part of the learners (Smith & MacGregor 1992). In the context of weMakeWords collaboration refers in particular to the fact that all playing children should have to work together and help each other to be able to reach the game’s goal eventually.

3. **SOLUTION APPROACH**

In this section we illustrate how adaptivity and collaboration can be used to put focus on the learner. We introduce three solution concepts, learning strategies, adaptivity, and collaborative interactions.

3.1 **Learning Strategies**

Participation in weMakeWords presupposes the knowledge about a set of phoneme-grapheme relationships (e.g. the sound “om” and the letters o and m), which can be used to make new words (e.g. “mom”). The biggest problem in learning is to keep the learner motivated enough until the end of the lesson (Prensky 2002). Thus the most important part of a learning game should be motivation. In general one can consider computer games to be useful educational tool because students find them motivating (Denis & Jouvelot 2005). Students are often motivated to learn tedious material when it is required for successful game play (Tychsen et al 2008).
The game idea of weMakeWords: Combining characters to make up words (left) and combining strokes to make up symbols (right)

The first issue regarding collaborative playing is to motivate children to play together while they are not on the same level of knowledge. weMakeWords react to this by using different learning ratios, different word (or symbol) difficulties and different numbers of characters (or strokes) for their word. For example, a child with weak abilities can get an easy word with only three components while children with experience have to build difficult words with up to ten characters. An adaptive watermark should avoid high frustration for the children and increases the possibilities of different grades of difficulty.

Reading is not uniform and contains many cognitive and language skills that develop during childhood. Many factors were evaluated to predict the reading ability of children in the early school years like: age, IQ, receptive and expressive oral language abilities, speech perception, phonological awareness, morphological awareness, awareness of print principles (Burgess 2002, Schatschneider et al 2004). These skills are often grouped into four basic areas (Whitehurst & Lonigan 2001): phonological processing, print knowledge, oral language and home literacy. Together, these four groups explain most of the differences between children in early child reading (Share et al 1984). Children with more of these reading and writing skills, often learn to read sooner than children with less of these skills (Anthony et al 2002, p66).

Recent studies identified two more abilities as potentially strong predictors of reading ability and disability among Chinese children (Shu et al 2006): rapid naming and morphological awareness. Morphological awareness is defined as the understanding that words represent individual meanings and individual characters and syllables represent individual morphemes. Mandarin orthography is considered morpho-syllabic, and thus, it is not surprising that morphological awareness tasks have proven to be the most important factor of early child reading in Chinese (Shu & Anderson 1997).

3.2 Adaptivity

The idea of using intelligent machines in the teaching has not yet led to a learning environment that provides real benefits in practice. The reason that today’s software systems are not as efficient as a human tutor lies in the absence of focus on the learner (Kickmeier-Rust & Albert 2007). To address the individual strengths and weaknesses of children requires being able to interpret their behavior. weMakeWords provides a personalized learning experience through an adaptive engine, capable of interpreting children’s actions.

This component combines interchangeable and combinable methods of artificial intelligence. In this way it is possible to support weak children and to promote stronger ones, but not simply by classifying them. One way of adaptivity can also be achieved by maintaining the individual child profiles. This could be data about the child or the actions carried out during the game. Thus weMakeWords collects as much data as possible in
order to improve the support of individual child. For this reason, every action of every child is recorded.
Using this information, weMakeWords is able to find individual learning strategy for each child.

### 3.3 Collaborative Interactions

In games where players are intended to interact or cooperate with others, they cooperate only when they are required or forced to. They first attempt to individually solve the problem, before resorting to the help of other players (Hämäläinen et al 2006). This seems to be a common psychological issue, where humans in most cases do not know that they need help. It seems important that the game mechanics do not only encourage but also require the players to cooperate with others to solve specific problems.

One way also to provide collaborative rather than competitive interactions is to integrate the collaborative problem solving activities as components of a game as proposed in (Voulgari & Komis 2008). Children should have a collective goal in mind, in order to enable the motivation of playing together.

In recent years, attempts have been made to find a way to assist collaboration in games. In the context of a networked multi-player game, the concept of a Shared Social Space (SSS) for the promotion of collaborative interactions has been introduced (Rauterberg 2003). SSS summarizes the features of a networked multi-player game that promote coalitions. Following the issue “How to support learning in groups!” the authors of (Hoppe & Lrich 1999) found that knowledge and skills distributed among players positively influence collaboration between them. If the players work towards a common goal, and each of them has a different resource, then they must all work together to achieve this goal. Many different available resources can be a positive factor for the quality and quantity of interactions (Fridas et al 2005).

Furthermore, some authors (Sheng-Hui et al 2008) argue that both traditional and digital interactions in game-based learning are important for the education. They propose to take advantage of these two learning strategies and to achieve this through the integration of traditional interactions with digital. This means that in the context of weMakeWords, both types of interaction should be supported in the following sense: Children should be able to interact not only through the game device, but also talk directly with other players.

### 4. WEMAKEWORDS ARCHITECTURE

The concept of weMakeWords is based on an idea of combining characters to make up words. Children should have to work together by sending each other characters they do not need for their own word/picture combination. weMakeWords handles non-alphabetic languages by slicing the symbols into disjunctive ‘strokes’ which, when superposed, would make up the whole symbol. Figure 3 shows a UML class diagram of a language independent playing model for weMakeWords that works for both alphabetic as well as non-alphabetic languages.

![Figure 3. Playing model, representing interactions and learning situations with learning objects (UML class diagram)](image)

The class Situation represents a learning situation, where a child interacts with learning objects by performing actions. The game explains the children’s mission by showing a graphical story and describes what they are supposed to do, i.e. several animals broke out of a zoo and the children have to return them safely. When a child plays the game, characters fly onto the screen and each child has to decide if the characters belong to their own word and picture, or the word and picture of any of their teammates. Figure 4 shows a domain independent UML class model of the child and the child’s profile. The instantiation of this model for weMakeWords has specific skill objects in this domain. Using this model, we are able to represent each child individually and to capture each action the child performs. Using the History we are able to analyze the child’s behavior even afterwards. At this point we are able to observe children’s actions and represent them in a model shown in Figure 4. Using this information it is be possible to determine problems
or aptitudes for every child. Knowing the problems and aptitudes weMakeWords can provide each child with individual learning content.

![Learner Model Diagram](image)

Figure 4. The learner model, representing the child, child’s profile, and actions performed in the game (UML class diagram)

Figure 5 shows a model that provides the functionality of controlling the learning path. The abstract classes LearningPathPolicy and LearningStrategy together with the class LearningPathController implement a strategy design pattern (Bruegge & Dutoit 2009). The LearningPathController is able to control the learning path by using different strategies (e.g. the order of symbols shown to the child).

![Learning Path Controller Diagram](image)

Figure 5. Extensible learning intelligence in weMakeWords (UML class diagram)

5. EVALUATION

In a first approach we implemented the game concept and models as an iPhone application. Figure 6 shows a screenshot of the iPhone application. In this example a watermark of a word is shown on the top of the screen. Each child can construct this symbol with strokes from the middle. The meaning of the symbol is represented through a picture on the right side of the screen. On the left side of the iPhone screen up to four team players are represented through avatars. Using Chinese as one of the languages for weMakeWords had the advantage that we could carry out the evaluation with even older end users. During the whole project, we had the connection with a child psychology practice and we evaluated the ideas first with a real target group. At the beginning we used the technique rapid prototyping with concurrent evaluation (Carlson et al 2003, Gordon & Bieman 1993). Paper based prototypes were validated with the client and constantly evaluated with the end users. In this case the term end user is used for both children and students.

![iPhone Application Screenshot](image)

Figure 6. The prototypical implementation of weMakeWords as an iPhone application. Choosing a blue-bunny avatar (left). Learning the English word for bird playing in a team (right).
5.1 Evaluation Phase 1 (Observation and Interviews)

At the moment when the game play idea was clear, the first evaluation phase started with 10 students. Each student was playing the game with at least one other student or an instructor. First we observed the students while playing and afterwards we interviewed them. In the same evaluation phase we observed 8 children aged 4 to 8 playing the game. Observing the students we found some improvement ideas in usability, e.g. while monitoring how they were sliding the strokes on the iPhone we could improve the interaction method to make this task easier. By interviewing them we found some issues concerning sound and images that had to be resolved to improve the motivation. For example, the students expressed the wish to see the zoo in the background while playing.

5.2 Evaluation Phase 2 (Quantitative Measuring)

In the second evaluation phase, we also observed the players. In this phase we performed the evaluation with 20 children from the child psychology practice in Garmisch and the open house at the Technische Universität München. We also included 9 students from a practical course in this evaluation phase as subjects. We measured the time necessary for the user to learn the game with and without the instructions of a supervisor. In the case when a player was playing without the supervisor we allowed them to talk with teammates and ask questions about how to play the game. Secondly we measured the amount of words the users remembered by letting them paint the words after 30 minutes of playing. Finally, we measured how many players were really playing together with their teammates by sending them strokes through the user interface or by talking to them.

5.3 Evaluation Results

In total we conducted the evaluation with 19 students aged between 18 and 22 years and 28 children aged between 4 and 8 years. The results regarding the time necessary to learn the game are presented in Figure 7.

Table 1. Participants of the evaluation

<table>
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<th></th>
<th>Children</th>
<th>Students</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>17</td>
<td>15</td>
<td>32</td>
</tr>
<tr>
<td>Female</td>
<td>11</td>
<td>5</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>19</td>
<td>48</td>
</tr>
</tbody>
</table>

The illustrated bar “Without Supervisor” represents the experiment in which the participants received a short instruction of parents or the psychologist. One amazing observation was the amount of words the children could actually remember after playing the game. For example, one 4 years old boy could remember all 4 signs presented during a playing session of 30 minutes. Figure 7 illustrates the amount of remembered words in each round. In the game version used for testing 16 terms (animals) were implemented.

Figure 7. Time necessary to learn how to play weMakeWords, with vs. without a supervisor in minutes (left) Average words played vs. remembered measured during a playing session of 30 minutes - in three playing rounds (right)

For evaluating the collaboration we observed the subjects while playing together with teammates and obtained the results presented in Table 2.
6. CONCLUSION AND FUTURE WORK

In this paper we introduced the architecture and prototypical implementation of weMakeWords. This first version of the game was realized, providing a simple adaptive learning strategy and a limited amount of content. We presented the architecture that is responsible for the adaptivity of the serious game, based on behavior observation represented by actions performed by the learner.

We provided a preliminary evaluation of weMakeWords that shows a tendency of the presented approach to be promising. **Two versions of weMakeWords for English and German are now available on the Apple App Store.** With the assistance of our new community in the App Store we will investigate the effects of adaptivity to the learning outcome in serious games like weMakeWords.

In future development of the game concepts, we will put more effort in extending the content. First we will directly extend the content and then develop features to give the user the possibility to add content to the game. For being able to reuse content it could be helpful to research how SCORM4 (Sharable Content Object Reference Model) can be integrated in adaptive serious games.

In relation to adaptivity in weMakeWords, the results are highly influenced by the work done in (Peirce et al 2008) and (Kickmeier-Rust & Albert 2007). We will put further effort in this area by researching different possibilities of adaptivity in educational serious games.

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EFFECTIVE POSE PRESENTATION & DEMONSTRATION IN EXERGAMES

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ABSTRACT
Immersive, full-body active games are gaining popularity in the industry as both a form of entertainment, and a contributing aid in combating the numerous health problems faced by our increasingly obese society through physical activity. In our experience, the biggest issue with active pose-based games is the difficulty in effectively communicating a 3-dimensional pose to a user to facilitate a thorough understanding for accurate pose replication. In a traditional setting, like a yoga class, a physically present moderator would provide coaching to participants who struggled with pose reproduction. However, for obvious reasons, this cannot be implemented in a computer-based training setting. In this work, we present potential methods of providing visual feedback to end users in an effort to effectively and accurately communicate full-body poses for user-replication, without the need for a physically-present coach or moderator. We examine types and levels of feedback using an on-body sensor network system, and address the challenges and issues that arise throughout the process, such as communication barriers, overstimulation (too much feedback), and the inability to decipher pose depth.

KEYWORDS
Exergaming, interface design, visual feedback, Game design, Sensor network, Human-Computer Interaction.

1. INTRODUCTION

Obesity has fast become one of the leading preventable causes of death plaguing industrialized society, with increasing incidence among adults and children. It is viewed as one of the most serious public health epidemics of the 21st century (Barness et. al, 2007). The physical benefits of leading an active lifestyle are undeniable when combating this disease. Children are especially vulnerable to these diseases due to their increasingly sedentary lifestyles (Berkcovsky et. al, 2009). The success of the Nintendo Wii as a fun way of promoting physical activity among all age groups has sparked an outpouring of more physically active games (or “exergames”) being introduced to the market, along with competitor consoles (Hawn, 2009).

With more physically immersive gaming on the rise, new problems with the interface model are introduced – not only is it important to demonstrate what a player must do in a game, but it now becomes equally critical to convey how to do it. Regardless of the input type, be it a camera-based system like the Xbox Kinect, or a full-body accelerometer sensor network system (Crampton et. al, 2007), if the game cannot effectively communicate to the player the positions and moves they must perform to control the game, they will have little success.

One issue that has emerged throughout the development of our own exergames relates to the difficulty in training users to replicate unfamiliar full-body poses. Without solving this problem, users tend to not be successful in games and applications that demand accuracy in performance, such as yoga or karate. Communicating full-body pose and motion information is most successful when presented in-person. However, in a typical game and training context, this is not a realistic option. To create a training application for anything from tai-chi, to dancing, it is imperative that we inform the user when they are performing a pose incorrectly, as well as provide them with an interface that specifically communicates what they are doing incorrectly. In previous work, it has been shown that providing the user with visual feedback would improve their performance (Johnston(b), 2010); the next step is to determine the most effective type of feedback that could be provided.
In this work, we examine the design problems, and solutions, involved in presenting full-body poses to a player within a training application context. First, we will provide a brief overview of the system. Building upon this, we discuss the move from traditional, 2-dimensional images, to a 3-dimensional avatar for pose presentation. We conduct several experiments to determine the effect of adding camera motion and visual feedback on players’ abilities to successfully recreate a given pose, without the help of a moderator/coach being physically present. We also explore different levels of feedback, and what can be considered too much information and thus becomes detrimental to a user’s performance. We conclude with a summary of our findings, and a discussion of future work.

2. BACKGROUND

In a game called ‘Posemania’, which employed a 2-dimensional image-based interface. Photos of people in poses would scroll vertically up the screen and the participants would try to mimic the positions (Whitehead et. al, 2007). For certain poses, particularly those where the front view did not possess the largest cross-section, it was found to be helpful to provide participants with multiple exposures of the pose, such as side & back views, to illustrate important depth cues (Johnston, 2010).

It was found that visual feedback resulted in a higher perceived difficulty as it highlighted minor errors in a body position that the participant otherwise thought to be perfectly accurate. Providing a participant with visual feedback slows down their ability to recreate the pose, as they must process more information. When accuracy is not the ultimate goal, less feedback should be given. Feedback, however, was found to be a promising strategy when a degree of precision is of greater value than speed, like within a training context (Johnston, 2010).

Though other groups have conducted minimal research on this particular topic, there are a few comparable research projects and commercial products. Most closely related is a proposed fitness game for combining motion sensors with arcade-like graphics and gameplay (Buttussi et. al, 2007). The application was controlled through full-body movements replicated by the player. Throughout testing, users who struggled to correctly duplicate the movements requested visual, in-game demonstrations of the motions. The developers introduced a 3D virtual human to demonstrate the movements while audibly encouraging and motivating the user. This avatar would appear when the game engine deemed it necessary based on the user’s performance. They found that using a 3D model for the virtual human allowed them to display the exercise from multiple viewpoints, which may have helped improve the understanding of the exercise. They felt, however, that a more thorough evaluation with users would be needed to assess the benefits of the 3D virtual human (Buttusi et. al, 2007).

Charbonneau et al. used their own application called RealDance to explore three different visual interfaces’ effectiveness in conveying dance sequence information to players (Charbonneau et. al, 2009). Their three methods of computerized feedback were Motion Lines, Beat Circles, and the Timeline. The motion lines interface showed the player which limbs to move based on the appearance of an icon to represent the limb, and indicated where to move the limb by the motion path the icon followed. The beat circles interface also used an icon placed around the avatar to specify which limbs to move. The position of the icon relative to the avatar signified where to move the limb, and the disappearing circle around the icon indicated when to move the limb. The timeline interface used directional arrows on the icons to indicate where to move the limbs; the icons appeared along a scrolling timeline to indicate when to move the limbs, similar to the type of interface used in games like Dance, Dance Revolution (Konami, 2001). They concluded that spatial interfaces, like the Motion Lines and Beat Circles, were superior visual feedback methods than the traditional Timeline interface for full-body, rhythm dance games.

The Sony EyeToy: Kinetic is a commercial fitness game that uses a virtual trainer to provide suggestions to the user on how to correctly perform exercises (Sony, 2010). The trainer is also able to comment on the user’s performance, which it tracks using the Sony EyeToy camera system. The game uses limited visual feedback, like shining auras around the onscreen avatar, to indicate proper performance of a sequence of movements. All of these systems focus more on full-body movement, instead of precise, stationary poses, and only one begins to explore the third dimension with relation to visual feedback and pose demonstration.
For this work, we used a modified version of a dance-based training application (Whitehead et. al, 2007). This application consists of a 3-dimensional avatar performing a dance on-screen. The player would mimic the avatar and follow along to the music. The dance was comprised of 25 individual poses (13 unique – see Figure 3-2) based off of the zombie dance from Michael Jackson’s Thriller. This sequence was long enough that the participants would not be able to memorize the order of the poses with only a few run-throughs.

We adapted the software to present the sequence of poses one at a time, without specific timings. Like before, the participant would attempt to mirror the avatar’s position. The focus shifted from performing the poses within the correct timing, to recreating the poses with as much accuracy as possible. After the avatar had cycled through all of the poses, the success rate of the participant was calculated and stored.

3. EXPERIMENT DESIGN & IMPLEMENTATION

We define a single test cycle as recreating a sequence of 25 poses presented by an onscreen avatar. The participants would have 10 seconds to recreate each pose. If they were able to correctly duplicate the pose, the avatar would advance, and they would receive a point. If they were unable to successfully mimic the pose in the allotted time, the avatar would advance, but without awarding them a point. Each participant completed two test cycles. The first run-through was done without computerized feedback. This established a baseline of the participants’ skill level among the poses. The second trial was one of four variations – a repeat of the initial run (i.e. no feedback), all-at-once visual feedback, one-at-a-time visual feedback, and one-at-a-time visual feedback with the addition of camera rotation. These experimental methods are defined and explained in more detail in the sections that follow.

We measured the effectiveness of every method using the success rate of each participant, as well as observational results of the person conducting the experiment. We also collected information about the age, gender, height, physical fitness level, and gaming experience of the participants to check for correlations with their success rates.

3.1 Participants

There were 60 participants split evenly among the four different experiments. The participants were all first and second year university students, 63% male, and 37% female. The oldest participant was 34, and the youngest was 17, with 19 as the average age. Data was collected on height, physical fitness level, and gaming experience in the form of a post-trial questionnaire.

3.2 Trial Descriptions

All 60 participants had the exact same initial trial run to establish their individual abilities with each pose, and the interface as a whole. During the first trial run, the majority of participants achieved similar success
rates, with few outliers. Three outliers who performed above average attributed their success to how much they play video games in their free time, including full-body systems like the Xbox Kinect, and their strong hand-eye coordination. However, no correlation was found among success rates and overall gaming experience among the participants. More details are presented in Section 4.

3.2.1 Trial 1: No Visual Feedback

The first test variation was used to establish a success rate baseline for participants’ skill levels using the 3-dimensional visual interface for comparison with the other methods of visual feedback. It used a static, front-facing camera, and participants were to mirror the avatar’s poses. The only computerized indication that the participant was not performing the pose correctly was the avatar not advancing to the next pose.

3.2.2 Trial 2: All-At-Once Visual Feedback

The second test variation was a 3-dimensional equivalent to the feedback previously tested using a 2-dimensional interface (Johnston (a), 2010). It consisted of a stationary, front-facing camera, and an avatar whose limbs would light up red if their sensor’s individual error was above the allowable threshold. The brighter the red, the more incorrect that limb’s position was.

The “all-at-once” label refers to the idea that all of the sensors that had some kind of error would be coloured red, and thus providing visual feedback, all at the same time. Given that multiple limbs would likely be coloured simultaneously, the participant would have to choose which to correct first, based on which was the brightest shade of red, or try and correct them all at once.

![Figure 2. Example displays for each of the trials. (a) Avatar with no visual feedback (trial 1) (b) avatar with all-at-once visual feedback (trial 2) (c) avatar with one-at-a-time visual feedback (trial 3) (d&e) avatar front vs. side views (trial 4)](image)

3.2.3 Trial 3: One-At-A-Time Visual Feedback

The third test variation is similar to the all-at-once visual feedback, however instead of all of the limbs providing feedback simultaneously, only the limb with the highest sensor error would be coloured. This allows the participant to focus on one limb, and thus one sensor, at a time. Once the limb has been corrected to where it no longer has the highest sensor error, the new limb with the highest error will become coloured.

By providing the participants with a more specific focus, it minimizes the excessive body movement that occurs from the participant trying to correct all of the errors at once. It supplies them with a more sequential method to correcting flaws and inaccuracies in pose recreation.

3.2.4 Trial 4: Camera Rotation, One-At-A-Time Visual Feedback

The final test variation uses the same visual feedback as Experiment 3, but with the addition of camera rotation. Previous research suggests that multiple exposures were important to show the full dimensionality of a pose – some positions are best viewed from the side, while others, the front or back Johnston (b) In Figure 2d,e, one can see that the bent knees are almost impossible to distinguish in the front view, but become quite obvious from the side.

In a virtual 3D environment, we have the ability to control the camera, so we can provide a full 360° view of a pose. As a result, however, new problems arise. For a front-facing view, it is most natural and clear for participants to mirror the pose (Whitehead et. al. 2007), however for side and back views, a direct recreation is more coherent. When you add in full rotation, such as in Figure 3, starting with the camera facing the front of the avatar, participants will begin by mirroring it, however once the camera begins to move, they become confused and will start trying to do a direct recreation instead. To avoid this, we start and stop the rotation at
a back view instead, so that the participant is no longer required to mirror the pose at any time – they are now to directly mimic the avatar. The camera would complete one full rotation while the avatar is in the pose, starting and stopping at the back-view. Once the rotation was complete, the participant’s 10 seconds to correctly replicate the pose began.

Figure 3. 6 views of a pose taken from a rotating camera

4. EXPERIMENT RESULTS

We compared each participant’s individual success rates to their basic demographic data, there was no correlation found using Pearson’s correlation (Pearson, 1898) between them and any of the questionnaire data (Table 1). This indicates that the successful replication of a pose is more likely reliant on cognitive than physical abilities and characteristics

Table 1. Correlation of traits and success rates, 1 or -1 indicates positive or negative correlation, 0 indicates no correlation.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>0.07</td>
</tr>
<tr>
<td>Gender</td>
<td>0.33</td>
</tr>
<tr>
<td>Height</td>
<td>0.20</td>
</tr>
<tr>
<td>Physical Fitness Level</td>
<td>-0.20</td>
</tr>
<tr>
<td>General Gaming Experience</td>
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</tr>
<tr>
<td>Active Gaming Experience (ex. Nintendo Wii)</td>
<td>-0.01</td>
</tr>
<tr>
<td>Full-Body Gaming Experience (ex. Kinect)</td>
<td>-0.04</td>
</tr>
</tbody>
</table>

**Trial 1: No Visual Feedback**

As expected, there was minimal improvement between trials when no visual feedback was provided during the second run-through. Though some users did perform better by a few poses, which could be attributed to the act of repetition, others did the same, or worse. The overall pose recognition rate was 15%, though the results varied significantly between individual poses. The improvement was random, with 46% of users showing some form of improvement. A $\rho$ value of 0.442 showed the results to be statistically insignificant.

**Trial 2: All-At-Once Visual Feedback**

While there was some improvement seen when all-at-once visual feedback was introduced, the overall results were not consistent across all users. Many found that there was too much information being presented at once, and properly deciphering and processing it took too much time, resulting in confusion. The overall pose recognition rate was 23%, with 65% of participants improving between the first and second trials. The results again were statistically insignificant, with a $\rho$ value of 0.346. Though the colouring helped users
identify the problem areas in their pose replication, they had a difficult time deciding which limb to fix first, and would typically start moving their entire body at once.

**Trial 3: One-At-A-Time Visual Feedback**

The third experiment yielded more consistent results than the previous experiments, with an an overall recognition rate of 43% and an average improvement rate of 69%. Though the results were not statistically significant, with a \( \rho \) value of 0.121, there was still progress over experiment 2. Among the 13 participants for this experiment, only two showed any regression. Unfortunately, since the camera remained stationary, there were still no depth cues as to arm and leg placements in the z-axis, and elements like bent knees went unnoticed. However, the overall understanding of what needed improvement in the participant’s pose replication was higher than in experiment 2. The users had a noticeably better comprehension of the visual feedback, and would focus on one limb at a time.

**Trial 4: Camera Rotation, One-At-A-Time Visual Feedback**

While there was certainly visible improvement in user performances when colour-coded error indicators were added, there was an even greater jump in results when camera rotation was introduced. The number of participants showing improvement was 92%, with 69% of users improving by 50% or more. The overall success rate among the poses was 54%, and with a \( \rho \) value of 0.007, the results were found to be highly statistically significant. The camera rotation made elements like bent knees (see Pose 1 & 5 in Figure 3-2) easily recognizable, and thus resulted in some poses showing substantially high recognition improvement between the two trials.

### Table 2. Summary of results by experiment

<table>
<thead>
<tr>
<th>Trial</th>
<th>Average success rate (%)</th>
<th>% of participants who improved performance level</th>
<th>% of participants who improved or maintained performance level</th>
<th>( \rho ) values (&lt; 0.05 = statistically significant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>15</td>
<td>46</td>
<td>70</td>
<td>0.442</td>
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<tr>
<td>2</td>
<td>23</td>
<td>65</td>
<td>71</td>
<td>0.346</td>
</tr>
<tr>
<td>3</td>
<td>43</td>
<td>69</td>
<td>85</td>
<td>0.121</td>
</tr>
<tr>
<td>4</td>
<td>54</td>
<td>92</td>
<td>92</td>
<td>0.007</td>
</tr>
</tbody>
</table>

### Table 3. Success rates of individual poses by experiment (%)

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Pose</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>11</th>
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<td>31</td>
<td>8</td>
<td>0</td>
<td>15</td>
<td>31</td>
<td>23</td>
<td>0</td>
<td>23</td>
<td>8</td>
<td>8</td>
<td>23</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>18</td>
<td>24</td>
<td>31</td>
<td>15</td>
<td>31</td>
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<td>23</td>
<td>31</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>23</td>
<td>92</td>
<td>8</td>
<td>15</td>
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<td>8</td>
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<td>38</td>
<td>69</td>
<td>46</td>
<td>92</td>
<td>85</td>
<td></td>
</tr>
</tbody>
</table>

### Comparative Results

When comparing the results from all four experiments with the first trial runs, 100% of the poses showed overall improvement when any form of visual feedback was provided. Table 2 provides a summary of overall results mentioned in the previous sections. Adding camera rotation proved to be a pivotal factor in drastically increasing how many participants were able to improve their scores between their two trial runs. The camera rotation strongly addressed the issue of providing participants with multiple viewpoints of a pose, allowing them to fully grasp all of its intricacies and replicate it to the best of their abilities.
The first column lists the average success rates achieved by each group of participants. The second column shows the percentage of individuals in each group who showed some sort of improvement in their success rate between the first trial with no feedback, and their second trial. The third column shows the percentage of participants in each group who either showed improvement, or remained the same between their two trials. The missing percentages account for those individuals whose success rates were lower for their second trial. The final column lists all of the $\rho$ values for the trials.

**4.1 Known issues and Validity Threats**

There are two significant known issues worth discussing. The first is an issue with the training data that was collected to characterize the poses used in the experiment and the other involves representational issues with the avatar pose rendering.

**4.1.1 Training Data Issues**

The pose training data used for the experiments was originally recorded by a small sample group of people, and was used primarily by that group only. As a result, the standard deviations in the data set are lower on some poses than others, resulting in some poses that are easier to replicate, and some that are very difficult. The majority of the poses fall within an achievable, yet challenging range for most participants. There was one pose in particular (pose #14/19 – see Figure 1) that proved extremely challenging and nearly impossible for most of the participants to replicate. We included the scores for that pose for completeness sake, however when culled, the recognition and improvement rates increased favourably. Table 3 summarizes the average success rate of each individual pose across all four experiments.

**4.1.2 Avatar Issues**

Another issue that became clear throughout the experimental process was the importance of the avatar’s pose clarity to the proper interpretation by a participant. The 3-dimensional avatar was posed independently of the training data, and originally used to indicate which pose to replicate in a game where the users had learned the poses ahead of time. It was not posed for accuracy but as a visual stimulus to elicit a player response. Figure 1 shows the onscreen avatar performing each of the 25 poses. Although it provides a general foundation of pose elements, small nuances, like slight wrist rotations, are lost in the overall positioning. This minimal inaccuracy could be a contributing cause in some of the errors made by participants. It is fundamentally important to provide accuracy in the 3-dimensional renderings of the avatar. A potential fix to this in the future would be to use motion capture technology to capture the exact pose as performed by those in the training set and apply the data directly to the avatar itself.

**5. CONCLUSION**

We set out to determine the most effective method of providing a user with visual feedback during the training phase in exergames and physical applications like yoga and karate, with the purpose being to replace a physically present moderator coaching the user. We explored some of the design issues that arise when moving from a 2-dimensional to a 3-dimensional interface for pose presentation. We used the new 3D interface to test the influence of camera motion and visual feedback on the users’ abilities to successfully recreate a pose displayed on-screen. We also tested varying levels of feedback to determine where it becomes a hindrance instead of a benefit.

Moving from a 2-dimensional to a 3-dimensional pose interface allows for full control of the camera, and after conducting all of the experiments, the importance of this feature became exceedingly apparent. Though other elements of feedback, such as error colour-coding, were able to illustrate the specific problem areas in pose replication, the camera rotation provided participants with a more thorough understanding of the pose prior to the replication process, improving some success rates by more than double. By adding rotation, the “game play” aspect is slowed down significantly, however this shouldn’t be an issue when implemented in the training level of a pose-based game. From both the statistical evidence in the success rates, as well as observational evidence conducted by the moderator, it became clear that the participants had a much easier time replicating poses once they’d been provided with a 360° view of the avatar, as opposed to a flat, static,
single view of the same character. If given the opportunity to replay the rotation and, in the future, zoom in on more detailed areas of the pose, it can be predicted that the participants’ understanding of the poses would increase. It can also be concluded that if the participant were to practice, their success rates would continue to improve to the point of perfecting the poses for real-time replication in games. The results of all of these experiments indicate that when given the proper feedback, participants can significantly improve their success rates in pose-based activities, similar to the results achieved with the presence and coaching of a moderator.

Future work will involve design refinements of visual feedback methods during training. Important topics could include determining the ideal position for the camera to stop around the avatar after the rotation to maximize pose comprehension. This could be taken a step further by providing zoom capabilities on sensor areas that appear to provide the greatest difficulty for the participant. Future research could also include working towards providing the participant with more specific instructions on how to fix problem areas in their pose recreation, verbally or symbolically. All of these elements could contribute towards a training system that is as effective, if not more effective, than one that relies on a coaching moderator.

ACKNOWLEDGEMENT

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ARE YOU A GAMER? A QUALITATIVE STUDY
CONCERNING THE PARAMETERS USED
TO CATEGORIZE CASUAL AND HARDCORE GAMERS

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ABSTRACT
The research objective of this paper is to examine the parameters used to categorize male and female gamers as casual and hardcore gamers and the relation between these parameters. Four focus groups were organized, with in total 21 participants. A persona based approach was used as outline for the focus group interviews. Furthermore, this paper looks into several aspects related to gaming like time and gender preferences, to put the categorization into a broader perspective. Average time spent on gaming was used to categorize the participating gamers. Time spent on game-related activities was found to be related to gender. A number of differences between the male and female participants in both the casual and hardcore focus groups were observed. We conclude that categorization of gamers as hardcore or casual is not as straightforward as often assumed in large scale quantitative studies.

KEYWORDS
Categorization, parameters, casual, hardcore, gamers, gender.

1. INTRODUCTION
In the last decade, the game market has grown rapidly and games have become an important part of everyday culture (OIVO 2010; TNS 2009). Games are no longer played only by male adolescents, but by almost everyone, from children to elderly people (De Schutter & Malliet 2009). With such a diverse audience, it is not strange that attempts have been made to categorize gamers into different groups. Such a gamer categorization is relevant to the game industry, as it allows them to design for and market games at a particular part of the gamer population. Knowledge about different subpopulations is important even when the gamer population as a whole is targeted as it helps to assure that a game has features that are engaging for everyone. In addition to the importance for the game industry, a clear categorization is important for the academic world as well. In order to compare different studies that examine multiple types of gamers, it should be clear which parameters were used to categorize the gamers.

Various categorizations have been used. One of the first categorizations is that of Bartle (1996). He categorized the players as either achievers, explorers, socialisers or killers. Schuurman et al. (2008) used gamers’ motivations to make a distinction between the overall convinced gamer or fanboy, the convinced competitive gamer or competitor, the escapist gamer and the pass-time gamer or time killer. The most commonly used categorization is that of the hardcore and casual gamer.

Although most people have some idea what is meant by the terms casual and hardcore gamer, there is no general consensus as to what makes someone one or the other. Various parameters have been used to classify a person as a casual or a hardcore gamer. These parameters are usually related to time such as the average playing time (Van Looy, Schuurman, De Moor, De Marez & Courtois, 2010; Schuurman, De Moor, Marez, & Van Looy, 2008), average length of a playing session (Kuittinen, Kultima, Niemelä, & Paavilainen, 2007), or time spent on game related activities (Consalvo 2009). Sometimes the indication of time is combined with another parameter, for instance, extent of interest in gaming (Fritsch, Voigt, & Schiller (2006), whether games were purchased or not (Schuurman et al. 2010; Van Looy et al. 2010), and attitude towards gaming (Kuittinen, Kultima, Niemelä, & Paavilainen, 2007).
These parameters more or less fit the three dimensions that emerged from a factor analyses that Ip and Jacobs (2005) performed on a 15 item questionnaire developed to distinguish between the casual and hardcore gamer. They called the emerging dimensions playing habits, buying habits, and gaming knowledge and attitudes. This is an interesting study as it examines the parameters themselves, while most of the studies that categorize players do this without explicitly mentioning why a particular parameter was used. Furthermore, the use of different parameters might result in different categorizations and can make it hard to compare studies and target games at specific groups.

When time consumption is used as a parameter, one has to remember that, in general, women play less than men (Greenberg et al. 2010; Lucas & Sherry 2004; Schuurman et al. 2010). Not surprisingly, therefore, large differences in gender distributions are often found between casual and hardcore gamers. For example, the studies examining the hardcore gamer often show that this group consists of more than 90% males (Fritsch et al. 2006; Jansz & Tanis 2007; Schuurman et al. 2010; Van Looy et al. 2010). This should not necessarily be a problem for the categorization when men and women are alike when it comes to gaming. However, this does not seem the case, as evidence exists that men and women differ when it comes to preferences for social interaction in video games (Hartmann and Klimmt, 2006; Lucas and Sherry, 2004), Schuurman et al.’s (2010), for game genres (Greenberg et al. 2010), Lucas and Sherry (2004), Hartmann and Klimmt (2006), and the motive to play games (Schuurman et al.’s, 2010; Hartmann and Klimmt, 2006). These gender differences are often not taken into account when gamers are categorized as casual or hardcore. Although there have been a few studies that focused on gender differences when casual gamers are concerned (Kerr, 2003; Schuurman et al., 2010), in general little is known about the gender differences, especially when it comes to those gamers categorized as hardcore. This may have an impact on the gamer profiles resulting from the categorization. For example, as the large majority of gamers that are categorized as hardcore gamers are male, the profile of the typical hardcore gamer might not hold for the relatively small group of women that are also categorized as hardcore gamers.

In the current study, we aim to examine in detail the parameters that are meaningful in the categorization of casual and hardcore gamers, and the relations between these parameters. Special attention goes out to the relations between gender and the parameters. In the existing literature on the casual and hardcore gamer distinction, the majority of studies have used the quantitative method of the large scale survey. While this is an excellent way to study average differences between groups of people, it might not reveal all details. Therefore, in our view, the qualitative nature of the current study can provide valuable complementary knowledge to the existing literature.

2. METHOD

In order to achieve our research objective, a qualitative methodology was chosen. In particular, we opted for a focus group interview approach to examine the parameters in more detail. The focus group interview (FGI) is a qualitative research method that is often used to explore people’s opinions, experiences or ways of understanding (Fern 2001; Lunt & Livingstone, 1996; Morgan, 1997; Morse, 1994; Vaugh et al., 1996). In our research, it was used for exploratory aims, one of the major strengths of this methodology (Merton, 1987).

2.1 Participants

In four focus group sessions 21 participants took part (age 18 to 37 years). Average self-reported playing time per day and gender were used to assign the participants to one of the sessions. The first session, Focus Group 1 (FGI1), consisted of seven males who had indicated to play more than one hour a day on average. This was also true for the four female participants in Focus group 2 (FGI2). The participants that had indicated to play less than one hour a day on average were invited to take part in the third (FGI3) and fourth (FGI4) sessions. The third session (FGI3) consisted of five males, while five females participated in the fourth session (FGI4). Participants were rewarded with a gift certificate of €30.

Participants were recruited through several channels such as Belgian game forums, social networks, newsletters and handing out flyers in the city, on the university campus and in a student restaurant. The term ‘gamer’ was omitted from the recruitment call, in order not to scare away people that play less frequently. All
potential participants had to fill in an online questionnaire, which was used to gather elementary demographic and game preference data.

Selection of the actual focus group participants was based on average playing time per day, gender and game preferences as indicated in the online questionnaire. Participants that indicated to play more than one hour a day on average were categorized as ‘hardcore gamers’, while those who played less were categorized in the ‘casual gamer’. This parameter for categorization was chosen as it has been used in previous studies (Schuurman et al., 2010; Schuurman et al., 2008; Van Looy et al., 2010). It allowed us to complement the results of these quantitative studies with more in-depth data from our focus group. In addition, both the group casual and hardcore gamers were split up according to gender, to examine possible gender differences. Game preferences were also taken into account in the selection of the actual participants from the respondents of the online questionnaire, in order not to overrepresent players of certain games or game genres.

2.2 Procedure

The focus groups were structured in the following way:

Introductory round: First, the moderator and the practical assistant gave a brief description of the main goal of the research project and the focus group interview. Afterwards they both presented themselves, mentioning name, age and gaming preferences.

Persona presentation: After this short introduction, the moderator presented a persona representative for the attending focus group participants.

Individual reflection: After the persona presentation, we asked each participant to reflect for five minutes on what their general impression was of the persona and what the most resembling characteristics were with themselves. This individual reflection was the starting point for the next stage in the focus group, the actual group discussion.

Group discussion: the group discussion was the main part of our focus group. During the group discussion participants could speak and interact freely with the other participants. The discussion was centered around a persona (i.e. profile of a typical gamer; Chang et al., 2008) that was created on basis of the existing literature on casual and hardcore gamers (Consalvo, 2009; Kerr, 2003; Kuittinen et al., 2007; Lucas & Sherry, 2004). In total, four persona's were developed, a male and female casual and hardcore gamer. In each focus group, the persona was presented that, in theory, represented the participants’ time investment, gaming history, budget for gaming, social component of gaming and their perceived image. The persona gave an overall view on gaming habits and the incorporation in everyday life. The discussion followed the outline of the persona. With the of a slideshow zooming in on specific topics presented in the persona, time investment, gaming history, budget, social interaction, challenge, image, game aspects and cheating were discussed.

Each focus group interview session took about 120 minutes. In order to adequately analyse all data, all focus group interviews were recorded on video and transcribed.

3. RESULTS

The seven participants in FG1, the male ‘hardcore’ gamers, were mainly PC gamers, with a preference for First-Person Shooters (FPS), and to a lesser extent Massively Multiplayer Online Role-Playing Games (MMORPG's) and Real-Time Strategy (RTS). They all expressed a preference for online gaming, preferably with people they know from real-life. On average, these gamers played 19 hours a week. In FG12, four female ‘hardcore’ gamers participated. Contrary to the male ‘hardcore’ gamers, they preferred single-player Role-Playing Games (RPG's) and to a lesser degree MMORPG's. The female hardcore gamers played slightly less than their male counterparts, on average 15 hours a week. The third focus group (FG13) consisted of five male ‘casual’ gamers. These participants played race games, sports games, Flash-games (on Facebook) and sandbox/open world games. They played less than one hour a day. As this was just an average indication of time played, with multiple causes, it will be discussed further in the results section. The last focus group (FG14), consisted of five female ‘casual’ gamers. Respondents in our sample preferred puzzle games, platform games, rhythm games) and Flash-games. Like the male ‘casual’ gamers, they also played less than one hour a day.
In the remainder of the results section, we will refer to these participants as 'casual' and 'hardcore'. However, as this categorization is subject of the current study, these labels should only be interpreted as an indication of average playing time.

3.1 Time

Concerning the time spent on gaming, the following topics were discussed with the participants: how much they play; when they play; and why they play on specific moments. Both female and male gamers from the casual focus groups stated that they played most of the time: a) when they have no other things to do, b) because of boredom or c) when there is an opportunity to play together with a family member or friend. The moment of playing differed a lot; as following two participants’ quotes indicate: “When the kids are asleep” (Female, casual) and “I often play when I need a short distraction when I am studying for my exams” (Female, casual). Also concerning time, one of our male casual gamers stated: “Sometimes I try to complete a whole game, in that case I spend a complete week on gaming” (Male, casual). If time is used to discern the latter casual gamer from a hardcore gamer; this casual gamer could be labelled as a hardcore gamer. However, in general this participant would not play more than one hour a day. Another quote illustrates the same idea: “Sometimes I keep on playing till I unlock all the songs in Rockband” (Female, casual).

In addition, two of the five participants from the female casual group had the feeling they played longer then intended. Also two of the female casual gamers reported that their game behavior changed from summer to winter, with more time spent on gaming in the winter. Thus, the casual gamer can become a hardcore gamer for a period of time (Juul 2009). In contrast, nine out of the ten casual gamers in our study claim that they, in general, did not desire to play more, if they had more time available.

When the participants in the hardcore focus groups heard they were selected because they played on average one or more hours daily, this provoked a lot of laughter: “Yeah, I think I, or we play an hour a day, maybe more... [ironic laughter]” (Several males, hardcore), indicating they played a lot more. However, only three of the seven male hardcore gamers desired to play more if they had more time available.

Similar as the casual gamer groups the time spent on gaming was not fixed for the hardcore gamers. For example, they indicated to play more often during holidays or when they had just bought a new game. Social aspects also had an impact, when, for example, there are raids (World Of Warcraft) or when there are a lot of friends online.

We noted a big difference between female hardcore and male hardcore gamers concerning time spent on game forums on the internet. Female hardcore gamers had no interest in game forums, while the males did. Of the casual gamer focus group participants, only one female and none of the male casual gamers were active on a game forum.

When time spent buying games is seen as a game related activity, three of the five female casual participants sometimes visited a game store, while the others borrowed from friends or family. Among the male casual gamers, only one visited a game store from time to time. The majority of male casual gamers got their games from other sources: illegal downloads, borrowing from friends/family or looking for freely available games on the internet.

When comparing casual gamers (both male and female) with the hardcore gamer groups; a big difference was observed in their view of gaming, the participants in the hardcore groups saw gaming as a normal, valuable pastime activity, and a part of their life, while the participants in the casual groups saw gaming as a way to kill time, but not as part of their life.

3.2 Challenge, Competition and Story

The female casual gamers preferred games that offer an average challenge. They indicated that games should not be too easy or too difficult. However we have noticed a different attitude within the male casual gamer focus group; challenge was more important to them, although games should not be too difficult, because games still have to be fun. For example; one participant really liked to fully completing a game, while another participant liked playing on the highest difficulty level: “I like playing on a high difficulty level but I will lower it when it’s too difficult” (Male, casual). The male casual gamers also liked the FIFA series, mentioning this was an easy game with easy controls, a clear example for them of the balance between challenge and fun.
For female hardcore gamers, the progress throughout the game itself was the main challenge. This challenge does not need to be easy, as with the female casual group. On the topic of achievements, it was mentioned that they were only appreciated when they helped the gamer in completing the game. The female casual gamers did not feel the need to compare their achievements with friends or other players. One of them played an MMORPG but was not interested in all the statistics the game collected. For her there was no need to compete in the game; the main story line was the biggest motivation together with the social contact of the guild (See also Social interaction). She said: “Achievements? Aah, you mean nerd points?! No I do not go for them; some do, but that’s silly” (Female, hardcore).

Looking into the results of the group of male hardcore gamers, we found that challenge was more important to them. Achievements were often obtained in a goal-oriented way: “I try to unlock all the achievements, that satisfies me” (Male, hardcore). The favorite game genre in this group was the First-Person Shooter; our participants stated that you need skills and precision and have to be in total control of your character in order to be successful in such a game. Mastering all the controls of a game is seen as a challenge. However, the controls should be intuitive: “If you notice the controls; then there is something wrong!” (Male, hardcore).

Most of the female casual players indicated to dislike competition. When playing with others, they play cooperative instead of competitive. The majority of our male casual gamers did not play online and are not interested in competing to win from other players. Even the one participant that played FIFA did not like to play against his brother; because this always resulted in losing. As a reason for the general dislike of competition, both the male and female casual gamers said they simply did not spend enough time playing to be competitive. In line with the participants in the casual game groups, the female hardcore gamers were not attracted to competition. They did not feel the need to compare in-game statistics or achievements with other players. Three out of four only played single-player games, while the participant that played MMORPG games did like the cooperative play of the game. In contrast, the male hardcore gamers did like competition. They prefer ranked matches, game statistics and achievements; which they compare with friends and other players. However the competition with friends is the most important aspect for them. “When I see my friends in real life, I like to confront them with their stats from Bad Company 2. It's always fun to laugh with each other!” (Male, hardcore).

Concerning game story lines, the male casual gamers had a preference for single-player games with a story line, like Grand Theft Auto IV. For the female casual gamers, however, the presence of a minimal story line was sufficient information for their enjoyment throughout the game: “If I know that I’m Mario, and I have to save a princess, that’s all I need to know” (Female, casual). Our female hardcore gamers, on the other hand, found the presence of a story line an important requirement for a good game. They liked games with a decent and well presented story, just like the participants from the male casual group. The male hardcore group found the story of a game also important, especially for single-player games. However, most of the time they played online multiplayer games, where the story is usually less explicit and it was therefore not as important for them as in single-player games.

### 3.3 Social Interaction

The social aspects of gaming were very important for our female casual gamers. They found it important to be able to play together in a game, in a cooperative way. For the male casual gamers the social aspect was not that important. Only one of the five played online from time to time.

The female hardcore gamers played mostly single-player games, thereby requiring no help from or interaction with others. Only one of the female hardcore gamers played online with other people. In contrary, most of the male hardcore gamers liked playing online. Four of them stated that social interaction in online games was important for them. For one of the participants, playing online with other friends was a necessity: “I never start a game when I know my friends are not online, I really like playing with them, playing alone is so dull” (Male, hardcore).
4. DISCUSSION

The current study focused on drawing a more coherent picture of the parameters used to categorize gamers as casual or hardcore and the relations with gender differences. In this section, the issues we came across concerning the parameters will be discussed first, after which the results regarding the gender differences will be in looked into.

We used time as a parameter to categorize the participants of our study as casual or hardcore gamer. Our reason for this was that this parameter is often used and can be easily measured in a survey. However, we noted several issues concerning the use of this parameter.

The first issue concerns the ability to accurately self-report time spent on an activity. The perception of time may not always equal to the actual time spent on an activity. This may be especially the case when it comes to gaming. Participants indicated that they sometimes were so engaged in a game that they lost track of time. This was true for both casual and hardcore gamers. The experience of losing track of time is one of the characteristics of flow (Csikszentmihalyi, 1990), a pleasant mental state that game designers often strive to achieve for the players of their game.

Second, we saw that time spent on gaming is not a fixed value. A number of the participants in the casual gamer focus groups indicated that in some periods they would spend much more than one hour a day. A third aspect that should be kept in mind is relation between the time spent gaming and the total available spare time. Some participants indicated that they would like to spend more time on gaming, but that they ran out of spare time. Others indicated that they were able to spend more of their spare time gaming, but that they were not interested in doing so. It would, therefore, be useful to consider using a relative time parameter indicating the part of spare time that is spent on gaming. In addition, participants in similar studies could be asked if they would like to spend more time on gaming than they currently do.

Interestingly, the categorization used in the current study did accurately reflect the participants’ own perception of the term gamer. With the exception of one female, all the participants in the casual gamer groups argued that they did not consider themselves gamers because they did not spent enough time playing. All participants in the hardcore groups did consider themselves gamers.

We saw an interesting gender difference within the group of participants categorized as hardcore gamers, when the time spent on game-related activities other that actual playing time was concerned. Most men would visit game related forums, while none of the females did. This means that in our study the women that we had categorized as hardcore gamers, using the parameter of average playing time, would end up being categorized as casual gamers, when time spent on game-related activities was used as parameter for categorization. It also has consequences for the recruitment of female hardcore gamers through these forums, which was reflected in our unsuccessful attempts to do so, while we had no issues finding male hardcore gamers through these channels. This may explain part of the low female representation in the studies concerning the hardcore gamer (Fritsch et al., 2006; Jansz & Tanis, 2007; Schuurman et al., 2010; Van Looy et al., 2010).

A number of interesting findings regarding gender differences and the casual and hardcore categorization came to light. As was expected, considering the known gender differences concerning gaming, we observed a number of differences between the male and female participants in both the casual and hardcore focus groups. Interestingly, the observed gender differences were not as straightforward as one would expect. We often observed an interaction between gender and the categorization in casual and hardcore gamers. In other words, the gender differences were not the same for the casual gamers and the hardcore gamers.

The most pronounced example of this interaction concerns the game story. We saw a strong contrast between the female casual and hardcore gamers. While a game story was of vital importance for the female hardcore gamers, the female casual gamers did not care much for it. Surprisingly, this relationship was the reverse for men; a strong story line was more important to the male casual gamers than to the male hardcore gamers. A similar result was found regarding social interaction in games. We noted similarities between female casual and male hardcore gamers, for whom social interaction in games was very important, and male casual and female hardcore gamers, who mostly played single player games. Another example of this interaction, is that of different genre preferences between all four groups. Male casual gamers played more games that can be considered hardcore games than the female casual gamers. In addition to this result being an example of gender differences, it also shows that the type of game is not an appropriate parameter to categorize gamers (Consalvo, 2009; Kuittinen et al., 2007).
Concerning competition, an interaction was also observed, although this interaction was not as strong as in the previous two examples. We saw that the gender differences for the hardcore gamers reflected that found in the literature (Lucas & Sherry, 2004). The casual gamers, both male and female, were not interested in competition, however.

Challenge was the only topic for which the results clearly reflected the gender differences in the literature with men generally liking more challenging games than women (Schuurman et al., 2010). This does mean that when casual and hardcore gamers are compared, it should be kept in mind that, when gamers are categorized as casual and hardcore based on average playing time, the resulting groups of gamers may not be homogeneous when it comes to preference for challenge.

4.1 Limitations and Further Work

In addition to the gender differences concerning gaming variables, other differences may also play a role. The participants in the current study were of a limited age range and from the same cultural background. However, there is evidence that these variables may play a role to differences in gaming variables as well (Greenberg et al., 2010; Kohler, 2010; Noble et al., 2003). Furthermore, an issue that we did not look into, and that seems to have attracted little attention in the literature, is what meaningful parameters such as average playing time to categorize casual and hardcore gamers. For example, when time is concerned, how many hours a day does one have to play to be categorized as a hardcore gamer? Examining these questions should further extend the knowledge concerning the casual and hardcore gamer categorization.

5. CONCLUSION

The research objective of this paper was aimed at drawing a more coherent picture of the parameters, and the relation between these parameters, that are meaningful in the categorization of casual and hardcore gamers. Special attention went out to the relations between gender and the gaming variables. The parameter of average time spent on gaming to categorize the participating gamers. We noted a number of issues concerning this parameter. Self-reported gaming time may not be very accurate, may vary due to circumstances, and should be seen relative to a person’s total spare time.

The relations between this parameter and other possible parameters used to categorize gamers were also examined. We saw that the time spent on game-related activities was related to gender. This means that we would have had a different categorization when we would have used this time-related parameter. In particular, it would mean that most of the females that were categorized as hardcore gamers in the current study would have been categorized as casual gamers. The issues concerning the parameter time, and the relations found between the other parameters and gender, show that there is no clear line distinguishing the casual from the hardcore gamer. It provides an argument for the use of an instrument containing multiple dimensions, such as Ip and Jacobs (Ip & Jacobs, 2005) used in their study.

The relations between gender and gaming variables concerning the game story, social interaction, preferred game genres, violent content, challenge and competition were also examined. As was expected, we observed a number of differences between the male and female participants in both the casual and hardcore focus groups. Interestingly, the observed gender differences were not as straightforward as one would expect. Often there was an interaction, meaning that the gender differences were not the same for the participants categorized as casual gamers and those categorized as hardcore gamers. This interaction pleads the case for more attention concerning gender differences in the studies researching casual and hardcore gamers.

In summary, we have raised some issues that should be kept in mind when studying casual and hardcore gamers. The results from this study extend the knowledge on parameters used to categorize gamers as casual or hardcore. They also provide more insight in the relations between gender differences in gaming and the categorization of gamers in casual and hardcore gamers.
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THE IMPLEMENTATION OF EMOTIONS IN A SOCIAL STRATEGY GAME

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ABSTRACT
Existing research shows that emotions affect the decision making of the agent and make it appear more human-like. This paper presents the development of an Emotion Module in StateCraft, a software version of the social strategy board game Diplomacy, with aims to add emotion to agents in order to make the agent more believable and fun to play with. Based on the OCC-model we conducted interviews with players in order to identify what emotions are experienced in the game. These emotions are then mapped onto the OCC-model and implemented in the agent.

KEYWORDS
Emotion, agent, game design, strategy game, OCC-model.

1. INTRODUCTION
Emotions have been shown to be an important part of human intelligence which plays an important role in decision-making. According to Ortony et al. (1988, p. 13), emotions are valenced reactions to events, agents, or objects, with their particular nature being determined by the way in which the eliciting situation is construed. Most emotion theorists agree that some emotions are more basic than others, often called primary or fundamental emotions. However, they tend to disagree on which emotions are basic, why they are basic emotions or how many basic emotions there are (Ortony & Turner, 1990; Frijda, 1987). Despite of the lack of agreement, emotions are considered an important part of human intelligence. In fact, research has shown that emotions can be successfully implemented in agents. The results indicate that emotions can improve both the performance of an agent (Maria & Zitar, 2007), as well as the believability of the agent, where believability refers to the agent providing the illusion of life (Bates, 1994).

From an engineering perspective, emotions can help agents make better decisions, hence improve performance. Maria and Zitar (2007) showed that an agent with emotions performed better than a regular agent in a benchmark problem. Their research indicated that emotions can enhance performance if used correctly. In video games such as The Sims emotions are used to create a more human-like opponent, making it more fun to play with (Gilleade, Dix & Allanson, 2005; Hudlicka, E. 2009). The Ortony Clore Collins-model (OCC) is a widely accepted model to synthesise emotions in agents (Maria & Zitar, 2007; El-Nasr & Skubic, 1998; Bates, 1994). It focuses on what contribution cognition makes to emotion, and devotes less time to other important aspects such as facial expressions or behavioural components. Nor does it focus on how different emotions interact with each other. The OCC-model puts emotions into 22 categories. Depending on if they are appraisals to events, actions of agents or objects, it gives these emotions different emotion words. In the OCC-model, emotion was described as a valenced reaction to an event, agent or an object. Valenced means that the emotion has to get a positive or negative reaction, excluding neutral emotions such as surprise. The emotion's particular nature is being determined by the construal of the eliciting situation. Events are considered things that happen, and the agent's reaction depends on its goals. Actions of agents can be approved or disapproved depending on the agent's set of standards. If it is another agent who performs the action, it can give rise to the emotions admiration and reproach. If it is the agent itself that carries out the action, the emotion pride or shame might occur. Objects can be disliked or liked based on the agent's attitudes towards the object. An object can also be another agent. An important component in the OCC-model is that an emotion's intensity has to be above a certain threshold value. If the value is below the threshold value, the emotion will not be experienced by the person.
In this research we developed an Emotion Module in StateCraft, a software version of the strategy board game Diplomacy. We aim at adding emotion to agents in order to make the agent more believable and fun to play with. We have chosen to use the OCC-model because it is computation-oriented and used in different projects for synthesizing emotions in agents.

2. DIPLOMACY & STATECRAFT

Diplomacy is a strategy-based social board game. It simulates the First World War when seven nations fought for domination over Europe. The seven nations include England, France, Germany, Russia, Italy, Austria-Hungary, and Turkey. The board is a map of Europe (showing political boundaries as they existed in 1914) divided into 75 regions of which 34 contain supply centres. For each supply centre a player controls, she or he can build and maintain an army or a fleet on the board. If one of the players controls 18 supply centres, this player has won the game.

The game mechanics are relatively simple. Only one unit may occupy a region at any time. There is no chance involved. If the forces in operation are equal in strength, it results in standoff and the units remain in their original positions. Negotiation for forming alliances is a very important part of the game, because numerical superiority is crucial. Secret negotiations and secret agreements are explicitly encouraged, but no agreements of any kind are enforced.

Each game turn begins with a negotiation period, and after this period players secretly write orders for each unit they control. The orders are then revealed simultaneously, possible conflicts are resolved and the next turn can commence.

StateCraft is a software version of the Diplomacy, developed by Krzywinski, et al. (2008). It is an online multiplayer turn-based strategy game where each of the seven countries can be played by either a human player or an agent (Figure 1). A three-layered agent architecture is developed which includes an operational layer, a tactical layer and a strategic layer. These layers handle three main tasks when playing Diplomacy respectively, monitoring the game board, planning moves, and engaging in diplomatic negotiations. The operational and tactical layers are invoked once each turn, acting on the new game state that resulted from the previous round and the strategic layer is active throughout the whole game session. Thus the agent is driven by the periodical updates of the game state, while still maintaining continuous diplomatic interaction with the opponents.

![Figure 1. Game interface for players.](image)

The operational layer is a reactive layer and is triggered at the start of each round. It monitors the game board and discovers all possible and legal moves for each unit based on the game state. The tactical layer combines operations for each unit into a set of operations, a tactic. Each tactic contains thus one operation for each of the agent’s units. Each tactic has two values, potential value and factual value. While potential value represents the value of a tactic regardless of the other players’ moves, the factual value represents the tactics...
tactical value combined with its chance for success. If a tactic has a very high potential value, but is considered impossible to achieve, its factual value will be much lower, while a high certainty for success will give similar values for potential and factual value. The strategic layer is responsible for communicating with the other players, and based on this diplomatic activity and the weighted tactics from the previous two layers, selects the appropriate tactic for the current round. This layer is organized according to the Subsumption Architecture (Brooks, 1990) and in StateCraft it consists of four relatively simple modules – Choose Tactic, AnswerSupportRequest, SupportSuggester and Relationship (Figure 2). The result is a more flexible structure, as the modules impact each other in a non-linear manner and new modules can be added without breaking the former functionality.

3. THE EMOTIONS IN DIPLOMACY

To synthesise emotions in the agent, we considered two emotional models. They were the OCC-model (Ortony et al., 1988) and the three-layered architecture (Sloman, 1998). The OCC-model was selected because simplified versions of the OCC-model have been implemented into several projects, while the three-layered architecture lacks implementation-specific details and was not widely adopted.

3.1 Identifying Emotions in Diplomacy

In order to study what emotions are experienced and how the emotions influence the decision-making when playing Diplomacy, we invited seven players to play the game and conducted interview afterward. During the interview, the players were asked to describe their emotions and how the emotions affected their choices. The result from the interview was summarized in Table 1. The most frequently experienced emotions were joy, loyalty, guilt, fear, anger, shame, relief and disappointed. Relief and disappointment lead to the same outcome as joy and anger, shame overlaps with guilt. Therefore these three were not included in Table 1.

<table>
<thead>
<tr>
<th>Emotion</th>
<th>In which situations did you experience the emotion?</th>
<th>How did the emotion influence your decisions?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joy</td>
<td>Players tend to feel joy and happiness when things go their way (e.g. gaining a province or beating a peer). &quot;When things went my way, I felt happiness&quot;, said P1.</td>
<td>The players seemed to feel like they were on a roll, and maybe not think through their actions thoroughly enough.</td>
</tr>
<tr>
<td>Loyalty</td>
<td>P2 stated that he felt more loyalty towards P1, because P1 was the most experienced player, and therefore most likely the best player. P3 stated that he felt loyalty towards P5, since P5 helped him defeat P4 in Munich.</td>
<td>All of the players answered that loyalty made them keep their promises towards the player they were loyal to, except from P1 who thought it was a stupid thing to do from a cynical perspective.</td>
</tr>
<tr>
<td>Guilt</td>
<td>The players agreed that guilt occurred when one lies to another player about supporting him but attacks him instead. P1 also added that a player might feel guilt when he “exterminates” another player very early in the game.</td>
<td>&quot;The guilt might have made me be more nice to P4&quot;, P3 claimed, while P1 said that guilt had caused him to keep players with few units artificially alive. P2 and P4 did not think that the guilt affected them in any significant way.</td>
</tr>
<tr>
<td>Fear</td>
<td>Three of the players experienced some sort of fear and it occurred when they knew that an opponent could do damage to them if he wanted to.</td>
<td>According to the players, fear leads to a more defensive and cautious approach, thus taking fewer risks.</td>
</tr>
<tr>
<td>Anger</td>
<td>Two of the players experienced anger while playing Diplomacy. The emotion was caused by a negative event (e.g. losing a province) when they had an opponent to blame for the province loss.</td>
<td>P1 claimed that the anger drove him to seek for revenge. P4 had the same opinion and said that he threw all his resources into getting his province back.</td>
</tr>
</tbody>
</table>

Joy, fear, anger and admiration are categorized in the OCC-model. According to this model, joy is considered as the reaction to an event which was construed as desirable by the person. Fear is the prospect of
a situation which would be undesirable for that person. Anger is the combination of distress because of an undesirable event and the feeling of reproach towards a person who did something one does not approve of. Admiration is the reaction to another agent's action which one approves of.

Loyalty is not defined in the OCC-model as it is not a valenced reaction to events, agents or objects. However, the situations where the players reported that they experienced loyalty seem to be when they approved of another player's actions. In the OCC-model, admiration occurs when one approves another agent's actions. Therefore, we could assume that what the players actually meant was the emotion that is structured as admiration in the OCC-model, since an effect of admiration often will be loyalty to the admirer.

Guilt is not categorised by the OCC-model either. Based on the players’ statements, we could assume that guilt is a sub-category of the emotion shame. Guilt involves disapproving of one's own action towards another person, while also feeling sorry for that other person. This could be structured as a compound emotion in the OCC-model. For simplicity reason, we considered guilt a sub-category of shame.

Figure 2 shows the emotions experienced in Diplomacy based on the OCC-model.

![Figure 2. Emotion model for Diplomacy (adapted from OCC-model).](image)

### 3.2 Emotion Intensity

The intensity of an emotion is represented by a numeric value between 0 and 100, where all emotions start at a default value of 0. For an emotion to affect the agent's decisions it needs to exceed the threshold set for the particular emotion. All emotions have a different intensity directed towards each player, except from joy, which only has a general intensity. The emotions joy and admiration also have the possibility of negative values down to -100. A joy value of -100 represents the opposite of joy, which in the OCC-model is distress. A negative admiration value represents reproach. Alone, distress or reproach does not affect the decisions made by the agent, but together they form the emotion anger. The anger's intensity is calculated by calculating the square root of the absolute value of distress multiplied with reproach, provided that both of these emotions exceed the negative threshold. Pseudo code for anger is shown below.
To ensure that the agent has a clearly defined emotional state, the agent can only have one emotion towards each country at the same time. The strongest emotion will suppress the other emotions. For instance, when Germany feels very angry and a little afraid of Austria, since anger is the greatest in intensity, it will suppress the fear. The exception is joy, since joy is general and not directed towards a particular country. However, if fear or guilt is the strongest emotion towards a country, the intensity of joy will decrease. Furthermore, it is impossible to experience joy and anger at the same time, since anger depends on a negative joy value.

4. IMPLEMENTATION

In this section we present the implementation of the emotions in StateCraft. Figure 3 shows the events that cause the changes in emotion intensity and how these emotions affect the decisions and actions of the agent.

4.1 Joy and Distress

Joy is the positive reaction to events as specified by the OCC-model. The event that increases the intensity of joy is when the agent gains a province. The intensity depends on the desirability of gaining the province. Gaining a province containing a supply centre will be more desirable for the agent, and therefore increase the joy more than gaining a province without a supply centre.

In the emotion module, distress is modelled as the joy emotion with a negative intensity because joy and distress are mutually exclusive. The events that decrease joy are:

- The agent loses a province. The desirability of keeping the province influences the intensity.
- The agent asks for support, and the opponent agrees to perform the support, but for some reason avoids or neglects to perform the support.
- An opponent asks the agent for support and the agent performs the support order, but the opponent does not perform the move order of which they asked support.
- The agent is outnumbered by its opponents.

Joy will make the agent perform more risky moves.

4.2 Admiration and Reproach

Admiration is the approving reaction to actions by other agents, while reproach is the disapproving reaction. Actions made by other agents of whom the agent approves are:

- An opponent agrees to support the agent and keeps the deal by supporting the agent's move order.
- An opponent with adjacent units does not attack the agent.

The actions which increase reproach are:

- The agent asks an opponent for support and the opponent accepts. Despite this, the opponent does not perform the support move.
- The agent is attacked by an opponent. The intensity of the emotion depends on what the agent expects of the opponent. If the opponent and the agent has a friendly relationship, the admiration towards the opponent will decrease more than, for example, if they were at war.

Admiration towards opponents will decrease the chance of the agent attacking them. In addition, the agent will more likely perform the support moves it has promised towards the opponents it admire.
4.3 Anger

According to the OCC-model, anger is the combination of reproach and distress, meaning that when admiration and joy decreases, anger increases. The situations that decrease admiration and joy cause anger to increase (see 4.1 and 4.2).

Anger towards opponents will increase the chance of the agent attacking the opponents. It will also decrease the chance of the agent supporting them.

4.4 Fear

Fear is the negative expectation to an upcoming event. The negative events which the agents are likely to fear in StateCraft are to be attacked by an agent, and to be lied to by a player who agreed to support the agent. For the sake of simplicity, we have chosen to focus on the fear of being attacked by a mighty neighbour. The intensity is calculated based on two factors:

- **Probability.** The more adjacent provinces the opponent has to the agent's provinces, the more likely that the opponent will attack.
- **Damage.** A more powerful opponent can do more damage to the agent than a less powerful opponent.
Fear towards opponents will decrease the chance of the agent attacking them. It will make the agent more defensive.

4.5 Guilt

Guilt is the disapproving reaction to one's own action combined with feeling sorry for the agent(s) which the action affected in an undesirable way. The events which increase guilt are:

- The agent attacks an opponent to whom it has a friendly or neutral relationship.
- The agent agrees to support another player, but avoids performing the support operation. The intensity is also dependent on the relationship to the other player. If the agent performs a support towards a player towards whom it feels guilty, the guilt intensity will be reset to zero.

Guilt towards opponents will decrease the chance of the agent attacking them and make the agent less reluctant to support them.

5. EMOTIONSYNTHESIZER

Given that the Emotion module is an addition to the agent in StateCraft, the whole module has been implemented in the emotions package in the Strategic layer of the agent in StateCraft. Since the Strategic layer uses an architecture similar to the Subsumption system, using sensors to look for changes in the environment and actuators to act on the changes from the sensors, the Emotion module receives input through an input line from GameStateSensor, the sensor listening for new game states from the server, and MessageSensor, the sensor listening for new SupportRequestMessages and AnswerSupportRequestMessages. Then it performs its actions by suppressing the input to ChooseTactic, the module responsible for choosing tactics. Additionally, it inhibits the output from the AnswerSupport module. Figure 4 depicts the Emotion module as part of StateCraft's Strategic layer.

![Emotion module integrated in the strategic layer in StateCraft architecture.](image)

EmotionSynthesizer is the main class in the emotions package. It is implemented as a module in the Strategic layer of StateCraft, which means that it has a receive()-method, making it possible to couple the class with the output lines of different sensors in the StateCraft subsumption-like environment, in this case the GameStateSensor and MessageSensor. The receive() method receives the GameState and the diplomatic messages, through EmotionSynthesizer's input line that is added to the gameStateSensor in the Strategic class. This ensures that the EmotionSynthesizer receive the GameState object each action round, and thereby passes it to all of the emotions in the emotion list. Each emotion considers the last rounds orders and
outcomes and affects the emotion intensity based on it. Each SupportRequestMessage and AnswerSupportRequestMessage is also passed through the receive()-method of EmotionSynthesizer, and it keeps track of the deals made in the preceding round. The EmotionSynthesizer also implements the Suppressor interface, which gives it the suppress()-method used to suppress the TacticList from the ChooseTactic module and allows the module to remove tactics or change their values. It also implements the Inhibitor-interface, which gives it the ability to inhibit the outgoing AnswerSupportRequestMessage. The message is stored until next round, when the agent will check to see if it performed the support operations it promised.

Emotion is an interface. All classes implementation Emotion is required to implement the methods affectChoices(), affectEmotion() and getValueFor(). affectEmotion() is the method used to affect the emotion intensity based on rules described in each emotion. Each subclass of Emotion implements this corresponding with the rules defined in Section 4. affectChoices(TacticList) changes the TacticList based on the emotions’ intensities. This is where the emotions influence the agent's decisions according to the rules specified in Section 4. getValueFor(Country) gets the emotion's intensity towards the specified country.

6. CONCLUSION

In this paper we have presented the implementation of Emotion Module based on OCC-model and results from interviews with Diplomacy players. Currently we are planning a simulation and a user test to study the effects of the Emotion Module on the agent performance, believability and player enjoyment. We hope the results will give us more information on the advantage and limitations of our research.

Through informal conversation with players we have learned that it is difficult for the agents in StateCraft to express their inner emotional state through actions only. Therefore, we propose using emoticons (a graphical icon representing the agent's facial expression or mood) for expressing the agents' emotional state towards the player (e.g. when the agent controlling Russia is angry at the player, an icon of an angry face would appear next to the flag of Russia) and study how the emoticons affect the player's perception of the agents’ emotions and the enjoyment of the game.

REFERENCES

THE GAMES FLICKRITES PLAY: AN INVESTIGATION OF FLICKR-BASED GAMING ACTIVITY WITH SPECIAL FOCUS ON OPPORTUNITIES FOR EXPLORATORY INTERACTION

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ABSTRACT
What kind of games do people play with digital images? To probe this question, we examine image-based gaming activity as exercised in the Flickr photo sharing system. Noticeably, a surprising number of user-moderated games are being played within the structure of Flickr groups. We provide an assessment of this activity and a first categorization of the exact types of games played: Recurrent themes are observed and discussed. Furthermore, we examine gaming activity in the scope of collection exploration, looking for opportunities that may stimulate or engage the player to explore an image collection. Being interested in playful interactions with images and in games as a platform for exploration, we question if the games played can support collection exploration. Potentially promising ideas as derived from the current Flickr gaming landscape are grouped, reported and discussed.

KEYWORDS
Flickr, games, image collection, collection exploration, playful interaction

1. INTRODUCTION: FLICKR AS A PLAYGROUND
An invitation to play is an invitation to explore. In the context of data collections, where a potential for discovery and a need to explore are substantial, exploration can benefit from a more playful and open-minded attitude of the (re)searcher. Technically, exploration relates more to undirected, open-ended information activities such as browsing and is often exercised as movement across information space. Precision is not always the key: Getting an impression of the collection as a whole, following related or connected items, landing at unexpected but useful items, establishing serendipitous connections between items can all trigger a feeling of discovery. In order to design interfaces that will challenge and engage the user to explore, we believe that ideas from play and games are worth exploiting. We observe that gaming can support both the relevant tasks, i.e. navigation, and the relevant emotional state, i.e. positive affect, for exploration (Kallergi and Verbeek, 2010b). Our research aligns with the increasing interest of the HCI community towards more playful interfaces: Currently, much attention is given to the potentials of applying gaming elements in different contexts including application software. Consider as an illustration the classic work of Malone (1982) pollinating HCI with gaming elements, recent studies on funology (Blythe, 2004) and fun in the interface and the numerous examples of serious games (Alvarez and Michaud, 2004), games with a purpose (von Ahn, 2006) and other game-like applications. We are particularly interested in the “gamification” of interfaces to image collections and in “gamification” as the means to promote collection exploration. To date, we have been implementing suitable gameplay for collection exploration (Kallergi and Verbeek, 2010a). Nevertheless, we find it useful to examine what lessons can be learned from existing practices in popular image collections and from existing games involving digital images. We hope to be able to extrapolate our findings to further support playful interactions with image collections.

For the researcher interested in interactions with image collections, Flickr is one of the obvious choices to study. Its popularity and success are phenomenal. Flickr is one of the major photo hosting and sharing systems and one of the top visited websites worldwide, with a large community of users and a vast collection of images. Official statistics are not available but Flickr is rumored to consist of over 30 millions of
registered accounts (Flickr: The Help Forum, 2009); the 5-billionth photo was reported on September 2010 (Flickr blog, 2010). More importantly, Flickr has been a fruitful and influential platform for social web practices, such as tagging, social networking and social browsing. Daily, a substantial number of users are uploading, annotating, browsing and commenting photos in Flickr, while a great deal of social interaction is taking place via features such as favorites, comments and groups.

Play and playfulness have a noticeable role in the overall interaction with Flickr. According to Velasco-Martin (2009), “one of Flickr's main strengths, beyond being highly usable, is that it is fun, since they were somehow capable of conserving its playfulness, which is key for its user participation”. Similarly, in “Flickr is a MMORPG” (cited in Fake, 2004), the commentator enumerates the striking similarities between a typical game and Flickr: “Flickr is inherently, down-to-its-bones about play. If you look at a list of the elements of a successful game, they are all present in Flickr: a sense of space to explore, a range of challenges, a range of abilities which can succeed [sic], the need for preparation and skill, a variable feedback system”. Taking a slightly different approach, Mäyrä (2008) analyzes Flickr as a game of paidia, i.e. as an activity of less competitive but playful and game-like behaviors to support online photo sharing.

If the core of Flickr's interaction is infested by such implied play, the platform is also associated with a number of explicit play activities that use the Flickr collection and system. In one hand, the Flickr API has allowed a considerable amount of programming activity for external applications that use the Flickr collection. Many of these applications are simple, image related games. External games are hosted and maintained by their developers and reside outside of the Flickr system. On the other hand, the platform itself, and specifically the format of groups, is extensively utilized for playing simple image games. This study will exclusively discuss gaming activity exercised within Flickr groups. Our interest in group gaming activity is two-fold: Firstly, groups are noteworthy community spaces and are often associated with entertainment (Stvilia and Jörgensen, 2007). Secondly, group games are initialized and moderated by Flickr users themselves. This allows for freedom and flexibility in setting up or adjusting the games, which we hope to provide us with a better insight into the needs and preferences of the players. Nevertheless, it is exciting to observe how members in a self-organizing system provide playful means to interact with the system.

The rest of this paper is structured as follows: An examination of the types of gaming activity exercised across Flickr groups and a first look into the exact types of games played is given in section 2. Reoccurring themes and distinguishing game concepts are identified and discussed. In section 3, we examine one particular "genre", i.e. associative games, to contemplate on the potentials of gaming as exploration. Conclusions and points of discussion are given in section 4.

2. THE GAMES FLICKRITES PLAY

During the period September - November 2010, we reviewed a potentially relevant subset of Flickr groups and the gaming activity they employ. While manual and, consequently, only indicative, this examination verifies the extent of gaming activity taking place in the Flickr universe and provides us with a first yet informative look into the characteristics of this activity. The data examined in this section are available at http://bio-imaging.liacs.nl/galleries/iadis2011/.

2.1 Collecting and Examining Groups

Potentially relevant Flickr groups were retrieved by querying the Flickr interface for the terms 'flickr games', 'photo games' and 'games' with added restrictions. The ambiguity of the concept 'game' and the limitations of the Flickr search severely impaired the precision of our queries, the results of which required further manual filtering. Out of the overwhelming number of results, a maximum of 500 results per query were retrieved. Duplicate retrieved results, groups with insufficient number of members (\(<=1\)), non public groups and non English speaking groups were programmatically removed. Subsequently, groups with obviously irrelevant topics based on their title or description were manually removed. Examples of irrelevant topics encountered are sport events, toys, videogame screenshots, videogame conventions, game reserves and many more. After several manual filtering iterations, the original result set was reduced to 166 relevant groups for further analysis. Relevance of a group or activity was often assessed with respect to the intent of its initiator, i.e.
explicit reference to a game and its rules. All 166 groups make claims to some sort of gaming activity within their setting; however, their understanding of the concept of 'play' is varied.

The description texts of the examined groups in combination with their message boards suggest certain recurring themes. Specifically, it appears that most of the groups relate to any of the following themes:

1- Gaming as secondary activity: Groups of various topics may play games as threads in their message boards. These groups engage with unrelated to gaming topics (e.g. photos of boxer dogs or flowers) or communities (e.g. a group of Canberra based photographers) but provide or permit some entertaining diversion in the form of threaded games.

2- Gaming as core activity: A number of groups are specifically created for the purpose of playing “casual” games among their members. Several variations in the organization of these dedicated to gaming groups are possible. For example, dedicated groups can maintain collections of several known threaded games; such collection groups are often suggested as central hubs to play games otherwise scattered around Flickr. Other groups maintain multiple instances/threads of the same type of game in their message board. Finally, many dedicated groups are single instances of one game, played in the pool (image repository) of the group, rather than in the message board.

3- Gaming as contest: A number of groups are specifically created for the purpose of conducting image challenges and contests. Such activities are usually periodic, accompanied by strict posting rules and voting procedures and resolved with the announcement of a winning photo. A less formal variation of this theme is found in groups that require their members to award, rate, comment or favor images of other group members. While different in their organization, these groups also structure their play around rating the quality of one another's images.

4- External gaming activity: Groups may engage in games or playful activities that are photo-oriented but performed outside the Flickr system. Consider, for example, scavenger hunts that require players to shoot a list of given subjects in limited amount of time. In such cases, the group usually serves as a reference point for instruction and coordination and as a container for the submitted image entries.

Groups dedicated to “casual” games (theme 2), challenge/rate groups (theme 3) and container groups (theme 4) are all primarily engaged with playing images and could be all filed as dedicated to gaming. Yet, we find useful to distinguish these varied understandings of play. External gaming activity, although potentially creative, will not be further discussed; focus is on games that utilize the existing Flickr database. Challenges and contests are labeled distinctively from “casual” games due to their particular focus on judging and voting. Gaming as secondary activity (theme 1), however, is a discrete theme and can be easily intertwined. For instance, there exist challenge groups that also play “casual” threaded games. For the purposes of this study, an exclusive classification of the groups is less important than observing the various functions and forms of playing as suggested by the users.

2.2 Collecting and Analyzing Types of Games Played

We further look into the types of “casual” games, played as either core or secondary activity. To collect games, we used all 10 groups that maintain game collections and 2x10 random groups with secondary gaming activity. The message boards of the groups were queried via the Flickr interface for the term 'game'. Again, the notion of game in the retrieved threads is not clear cut. Similarly to the various forms of play in groups, we encountered various activities such as challenges/contests or themed showcases among the results. In consistence with our earlier distinction, pure contests and themed threads as well as overt requests for comments were not considered for further inspection. Moreover, we found numerous purely word-based games, which are worth mentioning but are irrelevant to our study as they incorporate no images in their gameplay. Word games were excluded but image variants of those exact word games were retrieved.

According to our retrieved set, a number of popular threaded games tend to reoccur across groups. Table 1 provides a list of the most frequently played threaded games, presented under their generic names. In most cases, the exact same game appears under different names, e.g. the ABC game was found as the 'Alphabet game', the 'I am going on a picnic and I am bringing...' game, etc. In some cases, slight variations in the rules occur (e.g. count to 10 or to an ever increasing number) but the core of the game remains the same. A frequent variation, particularly in groups with secondary gaming activity, is to play known games with a subset of images relevant to the interests of the group, e.g. the “NJ- New Jersey” group plays known games...
with New Jersey related images only. All these easily identifiable variants were filed under their generic names.

Table 1. Top-10 most frequent threaded games filed under their generic names. Given frequency reflects the occurrences of the same game concept across multiple groups, not the number of game instances within the same group (can be more than 1). Collections: Groups dedicated to gaming that maintain collections of threaded games. Secondary: Groups that play threaded games as secondary activity.

<table>
<thead>
<tr>
<th>Generic name</th>
<th>Rules</th>
<th>Collections</th>
<th>Secondary (1)</th>
<th>Secondary (2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABC</td>
<td>Post an image whose subject starts with letter L, L increases alphabetically</td>
<td>7</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>I spy</td>
<td>Post an image that depicts a subject spied in the previous image</td>
<td>6</td>
<td>6</td>
<td>5</td>
</tr>
<tr>
<td>Person-above-you</td>
<td>Post your favorite image from the previous person’s photostream</td>
<td>3</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Photo association</td>
<td>Post an image that relates to the previous image</td>
<td>5</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>I request a...</td>
<td>Post an image that depicts the requested subject</td>
<td>4</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Rainbow</td>
<td>Post an image with color C, C follows the rainbow</td>
<td>4</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Count</td>
<td>Post an image that shows X items, X increases</td>
<td>3</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Last letter</td>
<td>Post an image whose subject starts with letter L, L is the last letter of the previous subject</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Spell shot</td>
<td>Post an image whose subject starts with letter L, L moves along the letters of a given word</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Name my photo</td>
<td>Give a name/title to an image</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

A closer inspection of the collected threaded games reveals a rather limited range of game concepts. E.g. in both the ABC and the 'Last letter' game, the subject of the next image should start with a given letter. The two games differ in the way the next letter is produced, but, in both cases, the response is illustrative of a triggered subject. We attempt to capture such similarities in the core rules of the games by deriving a number of representative game concepts/genres. Our focus is on the function of images in the game: What is the player expected to do in respect to (an) image(s)? What is the contribution of a posted image in the progression of the game? Our proposed concepts are described in Table 2.

The proposed concepts were used to label all retrieved game threads (cf. Table 3). Also, we label the groups dedicated to one type of game (cf. section 2.1). Once again, our approach when applying genres is a deliberately image-centered one. For example, games labeled as associative require that the next move in the game is an image response to an image stimulus from the previous move. However, there exist word association games that ask the player to respond to a text stimulus with a text response accompanied by an image. Technically, the function of images in these games is illustrative. Still, it is difficult to assess the impact of the accompanying image on the response of the player: It is likely that, in the presence of an image, a player does not solely respond to a text even if supposed to.
Table 2. Proposed game genres/concepts, in alphabetical order. The verbs proposed are representative of the activity required by the player during the game and in respect to images

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>associate</td>
<td>Post an image response to the previous image post: Construct a chain of responses</td>
<td>Photo association, I Spy</td>
</tr>
<tr>
<td>create</td>
<td>Produce images, mosaics, etc</td>
<td>Flickr-Wikipedia game</td>
</tr>
<tr>
<td>guess</td>
<td>Guess the subject of a given picture</td>
<td>Guess what? Guess where?</td>
</tr>
<tr>
<td>illustrate</td>
<td>Illustrate a (requested) subject, subjects produced by current or previous player</td>
<td>Count, Alphabet, Last Letter, I request a..., Opposites</td>
</tr>
<tr>
<td>reflect</td>
<td>Reflect on a posted image or on a photo-stream (note: simple feedback threads were excluded)</td>
<td>Person above you, Name my picture</td>
</tr>
</tbody>
</table>

Table 3. Games identified per concept. Collections: Groups dedicated to gaming that maintain collections of threaded games. Secondary: Groups that play threaded games as secondary activity. Single games: Groups dedicated to gaming that play one type of game only

<table>
<thead>
<tr>
<th>Category</th>
<th>Collections</th>
<th>Secondary (1)</th>
<th>Secondary (2)</th>
<th>Single Games</th>
</tr>
</thead>
<tbody>
<tr>
<td>associate</td>
<td>14</td>
<td>7</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>create</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>guess</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>20</td>
</tr>
<tr>
<td>illustrate</td>
<td>29</td>
<td>12</td>
<td>13</td>
<td>8</td>
</tr>
<tr>
<td>reflect</td>
<td>8</td>
<td>8</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>not categorized</td>
<td>6</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>total</td>
<td>59 games</td>
<td>34 games</td>
<td>34 games</td>
<td>62 groups</td>
</tr>
</tbody>
</table>

3. POTENTIALS FOR EXPLORATORY BEHAVIOR IN FLICKR GROUP GAMES: ASSOCIATIVE GAMES

In this section, we focus on the games identified as associative. Note that the underlying mechanism of associative games can be highly relevant to collection exploration: Establishing associations is often related to discovery and knowledge production. Moreover, associative games produce chains of images that are comparable to paths in information space and may be worth exploiting for collection exploration. Towards a closer examination of associative games, we study the game rules and message boards of the groups dedicated to one type of game labeled as associative. Groups dedicated to one type of game often use the entire pool as a game in progress. During this investigation, we use collection exploration as a yardstick to organize our observations into three topics of interest, namely chain construction, chain navigation and chain interpretation. Note that this examination is mainly an effort to harvest potentially promising ideas rather than an exhaustive study.

To begin with, let us examine the practices involved in the construction of a chain of images. Images played in a chain are predominantly taken from the player's own photostream. This may be dictated by the use of the pool (but threaded associative games tend to be played similarly) and may be a reasonable choice against copyright infringement. However, the possibility to encourage players to search or browse for images for the purposes of the game seems to be a missed one. Along a chain, the nature or type of the connection varies according to the focus of the group: Some groups value visual associations (color, shape, composition) while others value links based on the depicted subjects, The mood or a picture, or the emotions it triggers to the player may also comprise acceptable links. Non visual elements such as date, place and camera settings may or may not be accepted and so are other conceptual or intellectual links such as word jokes. Overall, players seem to contemplate long chains of a very broad subject and a couple of groups explicitly aim for subtle or hard to identify links (cf. “Tenuous links” group”). Note that in the case of subtle links based on depicted content, minute subject details are captured and practically “zoomed” out in the next transition. Lively discussions on what comprises a successful link are frequent. Players also discuss their strategies for playing the game. Interestingly, players report having taken a picture particularly for the purposes of the game or for
future use in the game (cf. Table 4). Finally, it should be noted that the majority of image chains are linear: Links are established between two images only, i.e. between the new move and the last image in the pool. Yet, an intriguing exception was found in the “Matrix game” group which requires players to link their move to more than one images in the pool. Such experiments may allow for interesting topologies to emerge.

Table 4. Relevant quotes extracted from description texts and discussions held in the message boards of single game, associative groups (data accessed: 19-11-2010)

<table>
<thead>
<tr>
<th>Topic of interest</th>
<th>Quotation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deliberately shooting a move</td>
<td>“Crossed a line yesterday by taking a photo just for Snap!” (source: <a href="http://www.flickr.com/groups/snap_game/discuss/36652/">http://www.flickr.com/groups/snap_game/discuss/36652/</a>)</td>
</tr>
<tr>
<td></td>
<td>“I haven't taken a picture for a specific link, but I do take pictures of things that I wouldn't ordinarily photograph because it might make a good link someday”</td>
</tr>
<tr>
<td></td>
<td>“I haven't taken a picture for a specific link, but I have posted pictures to Flickr for a specific Tenuous Link.” (source: <a href="http://www.flickr.com/groups/association/discuss/72157603673979260/">http://www.flickr.com/groups/association/discuss/72157603673979260/</a>)</td>
</tr>
<tr>
<td>Threads vs. pools</td>
<td>“I definitely want to keep the links in the pool - I think it's easier to see the latest photos at a glance this way, rather than scrolling down a thread”, “I am against the putting photos in threads. Takes too much bandwidth” (source: <a href="http://www.flickr.com/groups/association/discuss/72157594512516387">http://www.flickr.com/groups/association/discuss/72157594512516387</a>)</td>
</tr>
<tr>
<td>Comments vs. permanent elements</td>
<td>“I agree that comments are a better form. There's more space to elucidate the association, and the comments can add to your tally for explore. Some people have hundreds of tags, so the comments would then be, at least, at the bottom and easy to find.”, “I'd prefer comments, too. I'm kind of picky about my tags” (source: <a href="http://www.flickr.com/groups/gameofphotoassociation/discuss/720575907646962">http://www.flickr.com/groups/gameofphotoassociation/discuss/720575907646962</a>)</td>
</tr>
<tr>
<td></td>
<td>“I always delete notes that are added to my photos, I find them distracting.” (source: <a href="http://www.flickr.com/groups/free_association/discuss/72157613635786863">http://www.flickr.com/groups/free_association/discuss/72157613635786863</a>)</td>
</tr>
<tr>
<td>Explanation vs. no explanation</td>
<td>“Sometimes people have questioned what someone else's association is, and the discussion revealed all kinds of possible associations: different ones to different eyes”. “I want to put my own interpretation on the association. I would rather not be told” (source: <a href="http://www.flickr.com/groups/free_association/discuss/72157613635786863">http://www.flickr.com/groups/free_association/discuss/72157613635786863</a>)</td>
</tr>
<tr>
<td></td>
<td>“I think if you had to explain the link there would be no fun in this game, either when you post a picture or when you ask yourself what link another poster had in mind” (source: <a href="http://www.flickr.com/groups/snap_game/discuss/72057594069503455">http://www.flickr.com/groups/snap_game/discuss/72057594069503455</a>)</td>
</tr>
</tbody>
</table>

Given an image chain, we look into the possible ways to browse or navigate the chain. As explained, dedicated associative games very often turn the complete pool into a chain in progress. This format may pose challenges for the players, who report difficulties in catching up with the last image, but provides more flexibility in accessing the chain. Members of pool-based games seem to be disapproving of long threads with thumbnails as used in threaded games. Pool-based chains are a noticeable example of using gaming as the mechanism to create accessible and interesting subsets of images. This mechanism is apparent in other types of gaming groups too, in particular contest groups that populate their pool with winning images only. However, in the case of associative games, the position of the image and, consequently, its context as
provided by its neighboring images are essential. As such, pool-based chains successfully demonstrate gaming as both a content and a context building mechanism. Moreover, using the pool for the needs of the game can lead to unexpected practical benefits such as the opportunity to use existing widgets for visualization and navigation: The default film strip navigation aid provided by Flickr is a representative example. Another, rather surprising, side effect is reported in (Tenuous Links, 2008): The default pagination and grid view of the pool resulted in serendipitous associations on the vertical dimension of the game.

Lastly, a frequent point of discussion among players is the use of explanations between moves. Several methods have been proposed to explain a connection between moves, such as adding a comment, tag, note or description text in the corresponding image. Generally speaking, players are reluctant to add permanent elements to their images and seem to prefer comments as explanations. More revealing, however, are the discussions whether an explanation should be provided at all. Opinions on this topic are divided and may depend of the focus of the group, e.g. visual, conceptual or subtle links. Explanations can be assisting in the case of difficult links and may provide a prevention mechanism against random posting (not connected images are deleted in most of the groups). Yet, in some cases, players seem to value the challenge of reconstructing an association and they perceive explanations as limiting to the imagination (cf. Table 4). Surprisingly, players report that they appreciate coming up with their own association, even if it is not the intended one. In our view, this may be a first step towards turning these chains into meaningful narratives.

4. CONCLUSIONS

This study attempts to crystallize aspects of gaming activity in Flickr groups. The work is intendend as an exploratory study along the lines of “gamification” for collection exploration; automation was, therefore, not a priority. While our study is certainly subject to human bias, we trust that it provides a useful scouting of the Flickr ecosystem: A good understanding of the types of gaming activity and games encountered as well as of the vocabulary involved can be beneficial towards more automated investigations. A more robust system for group or game classification should be visible but a better way to gather a representative sample of groups from the Flickr database remains an issue. The ambiguity of the term ‘game’ not only impairs the retrieval of relevant results but also hinders the filtering process. In our case, it is plausible that groups excluded as irrelevant upon their description text do play threaded games as secondary activity as well.

Stvilia and Jörgensen (2007) discuss Flickr groups as community spaces providing opportunities for learning, for feedback and for entertainment via games and tournaments. Furthermore, Stvilia and Jörgensen relate games to “active” viewing of images and note that games can be used for “building context and telling a story of a place or a person”. Such an observation is particularly relevant to our research on appropriating games for playful and exploratory interactions with images. During our study, we tried to better understand the processes and conditions for such an effect to occur. In other words, we questioned how or when image games may support building context and, particularly, how game rules and game mechanics may affect this process. A significant observation we made is that pool-based associative games provide the means to populate a pool while indeed deliberately creating a neighboring context for each image. In fact, the example accompanying Stvilia and Jörgensen's remark on context and storytelling turns out to be what we would call a pool-based associative game. In associative games, context building is facilitated by both the rules (associate images in a linear fashion) and the chosen format and available visualization (pool). Further research is required in order to better understand the storytelling aspects of Flickr games. In particular, the function of text as a gaming element should be more carefully examined.

If games are to support a more exploratory interaction with an image collection, associative games are a considerable genre to implement. Associative games provide a mechanism to construct potentially meaningful chains of images with meaning being captured in the connections across images instead of the content or metadata of a single image. Such “interrelations” are user-generated and may have a high degree of serendipity: Players respond to stimuli (i.e. previous image) in a creative way and reconsider their own collections in relation to the pending image. Eventually, these trails of player activity should be accessible to traverse by both players and future viewers. To that end, efficient visualizations and usable navigation aids are of particular importance. Finally, it is worth noticing that chains produced via associative games differ from thematically defined galleries as they require the viewer to decode the connection between two moves. This may call for a more active look into the images in question and can potentially result in even more
associations being made. A surprising observation we made is that players often value ambiguity and the challenge to reconstruct an association. This process is extremely relevant in the context of collection exploration, particularly while traversing interconnected information points. Moreover, we believe that taking advance of ambiguity as a source of creativity can be a useful strategy towards more exploratory and playful interfaces. Such a potential has been prominent in the concept of ludic interfaces as discussed by Gaver (2003, 2009). In a sense, ambiguity can be playful for it introduces opportunities for new usages and interpretations.

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REFERENCES

FRAME SELECTION FOR AUTOMATIC COMIC GENERATION FROM MUSEUM PLAYLOG IN METAVERSE

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ABSTRACT
The paper presents a system for generating comics from museum playlog in Metaverse. Metaverse is a 3D virtual world in which users can act freely, such as visiting museums or chatting with others, according to their own purposes. Compared with existing approaches for representing user experiences using snapshots or video clips, the comic approach can 1) allow users to grasp the whole story at a glance, 2) facilitate distinguishing of important frames, and 3) exploit varieties of comic writing techniques. In order to summarize user experience into comic’s frames, detection of important experience, interesting exhibits in case of the museums, is an important task. In this paper, we propose a visiting-time based method for frame extraction. After describing each module of our system, we discuss a system evaluation where the effectiveness of the proposed frame extraction method is confirmed.

KEYWORDS
Comic, metaverse, user experience, museum, playlog.

1. INTRODUCTION
Recently, virtual 3D space called metaverse has gained interests from educators and researchers as a promising educational and research platform. A representative of such is Second Life (SL) which is equipped with a function that enables users to build objects or architectures. Unlike online games, metaverse, in general, has no specific roles assigned to its users, and user experiences are arguably limitless including, for example, visiting to museums built by other users or chatting to other users. Other usages of metaverse include Machinima (Lowood 2006) that uses in-game avatars (user characters), objects, as well as architectures for filming and an experiment (Prendinger 2009) that aims at realization of an eco-friendly society.

A number of metaverse have functions that allow users to take snapshots of their experiences or record them into video clips. Such snapshots or video clips are used by the users to recall their memories or shown to other users via, for example, blogs or SNS sites. However, manually taking a snapshot each time imposes a burden to the user. And video clips require considerable time to grasp the story and distinguish between important and unimportant events therein. To circumvent these issues, we focus on the use of comics for representing user experiences.

In comic style, a given user experience can be summarized into a limited number of frames, provided that a proper summarization mechanism is used. Hence a whole story can be apprehended at one glance. In addition, a frame layout technique can be applied to emphasize important frames and underemphasize unimportant ones. In this paper, we focus on museum visiting, one of the major usages in metaverse, present a system for generating a comic based on the museum visiting experience of a user of interest, and propose a frame extraction method that uses the information on the user’s visiting time to each visited exhibit.
2. SYSTEM

The authors previously proposed a comic generating system and related methods (Shuda and Thawonmas 2008; Thawonmas and Shuda 2008; Thawonmas and Oda 2010) for on-line games. The objectives therein are to summarize players’ game experiences into comics so that the players can exchange their comics with others and recall their memories about the game. However, an online game, the research target in our previous system, is essentially different from metaverse, which is the research target of this paper.

In a typical online game, most of the players’ actions, such as “attack a monster” or “open a treasure”, are prepared and provided in advance by the game developer. Such actions are meaningful as important episodes and are thus worth memorizing. On the contrary, most of the actions in metaverse, such as “move” or “sit”, have not much meaning. It is therefore difficult to extract important episodes from playlog. As far as the museum visit application is concerned, one might come up with a method for extracting comic frames that cover important exhibits based on weights assigned to them in advance. However, this method needs to reassign such weights each time the exhibition layout changes. In addition, it does not take into account the preference of a user of interest.

In a study on a real-world museum (Sparacino 2003), the more interest a user has on a given exhibit, the higher probability is that he or she will spend longer time on it. In this paper, dividing the region of a target museum into \( m \times n \) grids, we hence consider that exhibits a user of interest finds interesting reside on grids where the user spends relatively longer time than the other grids. Based on this assumption, we propose a formula for deciding grids’ weights in (1) and show the system architecture in Fig. 1. In this figure, “playlog” indicates a file that contains information on the user traces, the user actions, and the object positions in the museum. An example of partial playlog about user positions is shown in Table 1, where “loop count” shows the number of samplings to acquire the user information. In this example, the user position when loop count = 112 was at the coordinate (163.7, 152.3, 23.1).

In the following, we describe each of the four modules shown in Fig. 1.

1. At the first module, the important level of each grid \((i, j)\), \(I_k(i, j)\) \((i = 1, 2, \ldots, m; j = 1, 2, \ldots, n)\), is calculated according to (1) based on user trace \(k\) residing in the playlog:

\[
I_k(i, j) = \frac{t_k(i, j)}{t_k(\cdot)},
\]

where \(t_k(i, j)\) is the visit time at grid \((i, j)\) of trace \(k\) and \(t_k(\cdot)\) is a normalization factor being the average visit time to each visited grid in trace \(k\).

2. At the frame extraction module, a frame \(Frame(f)\) is generated for each visited grid, where \(f\) indicates the current frame number. Based on our experience, we decide not to generate a new frame \(Frame(f)\) if its corresponding grid is the same as the grid of \(Frame(f - 1)\) or that of \(Frame(f - 2)\). This is done to prevent over-generating frames when the user moves along grid borders, causing a movement pattern that repeatedly goes back and forth between a pair of grids. The frame snapshot timing at a given grid could be decided by a complex method that detects changes in colors according to HSV histograms (Calic 2007). However, we use the formula in (2), which requires less computational resources, for this task:

\[
t(f) = a * t_{in}(f) + (1 - a) * t_{out}(f),
\]

where \(a\) is a parameter whose range is \([0, 1]\), and, in our system evaluation, it was assigned a value of 0.4. The term \(t_{in}(f)\) is the loop count at which the user entered the grid of \(Frame(f)\), and \(t_{out}(f)\) is the
loop count at which the user left this grid. Our reason to set the snapshot timing slightly nearer to $t_{end}(f)$ than to $t_{in}(f)$ is based on our observation that, after entering a new grid, most users spent time in the first half to locate an exhibit, and, therefore, the aforementioned shooting time could increase the chance in extracting a frame where the user is viewing the exhibit. Each frame $Frame(f)$ contains its important level $I_{i}(i, j)$, which is used for selecting frames, and the snapshot timing $t(f)$, which is used later for rendering the selected frames. In general, the number of generated frames exceeds the number of frames desired by the user. As a result, a mechanism for selecting frames is needed. We implement it by first selecting the first generated frame and the last one because we consider them important for storytelling and then sorting all of the remaining frames in decreasing order of important level and selecting the first $F-2$ frames, where $F$ is the number of desired frames.

3. At the frame layout module, each selected frame is assigned a page and the position therein. This decision is based on the information on the number of desired frames, the page margins, and the number of frames per row and column.

4. At the renderer module, the system scans the playlog from the beginning and renders the snapshot image of the user experience with the snapshot timing of each selected frame. Each rendered image is then placed on the specific position in the predetermined comic page according to the information stored in the corresponding frame. Finally, all comic pages are outputted as an image file.

3. EVALUATION

After implementing the proposed system, we conducted a system evaluation. The objective of this user evaluation is to examine if the proposed system can generate a comic that properly summarizes the user experience about the exhibits in which a user of interest was interested during his or her visit.

3.1 System Implementation

For the system evaluation, we targeted user experiences at a SL museum\(^1\) designed and operated by members of Global COE (Center of Excellence) Program “Digital Humanities Center for Japanese Arts and Culture” of Ritsumeikan University. This museum is aimed at a virtual exhibition of Kaga Okunizome Dyeing\(^2\), kimono and bedding from the Ishikawa region in Japan during the latter part of the Edo period until the beginning of the Showa period. However, we would like to point out that our system is also applicable to other museums in SL as well as other metaverse.

Figure 2 shows the museum building in which 19 exhibits and two posters are located. Our reasons for selecting this museum are that (1) the exhibition therein has a high cultural value because Kaga Okunizome dyeing is famous in Japan and (2) there is no copyright problem because the authors belong also to the aforementioned Global COE. For other representative museums in SL, please refer to the work by Urban et al. (Urban et al. 2007).

We implemented the system by adding the above four modules to the open-source SL client program (SL viewer program). For this work, we adopted a typical comic layout where the order to read is in the raster order, from top-left to bottom-right, and all frames have the same size. Figure 3 shows an example of a generated comic page of a user, say, user $k$. A partial trace information of this user is given in Table 2, where a row indicates the information on the visit grid at a given loop count, which is the timing that user $k$ entered the grid. In addition, Figs. 4 and 5 show the time series of the important levels over the grids in visiting order and over the loop counts, respectively.

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\(^1\) http://slurl.com/secondlife/rits%20gcoe%20jdh/167/189/22

\(^2\) http://shofu.pref.ishikawa.jp/shofu/okumi/english/index.html
3.2 Evaluation Outline

There were 15 participants, who were undergraduate and graduate students in computer science, in the evaluation. Each of them was asked to visit the aforementioned museum at least for two minutes, spend time on exhibits they find interesting, and compare two comics, generated by the proposed system and a baseline system, in each of the following pairs:

(1) **One-page case**

<table>
<thead>
<tr>
<th>Comic P_FEW consisting of 12 frames generated by the proposed system</th>
<th>Comic B_FEW consisting of 12 frames generated by the baseline system</th>
</tr>
</thead>
</table>

![Figure 3. Example of a resulting comic page](image3.png)

![Figure 4. Important levels over the grids](image4.png)

![Figure 5. Important levels over the loop counts](image5.png)
Two-page case

Comic P_MANY consisting of 24 frames generated by the proposed system vs Comic B_MANY consisting of 24 frames generated by the baseline system

The baseline system is the same as the proposed system except that a fixed-and-equal interval is used as the snapshot timing of each frame in a given comic, rather than the snapshot timing decided by (2). For each comic pair, one of the two questions that we asked the participants is “Which comic better represents your experience in terms of the time you spent to each of the visited exhibit?”. The other one is “What are your reasons behind your selection?”.

The layout of each page was empirically set to 4 frames × 3 rows, leading to 12 frames per page. In addition, we partitioned the museum space into 8×8 grids such that each grid can accommodate one or two exhibits. The camerawork for rendering comic frames was set to the default camerawork of the SL viewer. Figure 3 shown earlier is the first page of the resulting comic P_MANY from one of the participants. Figures 6 and 7, respectively, show the resulting comics P_FEW and B_FEW from the same participant.

3.3 Results and Discussions

Table 3 shows the evaluation result. It can be seen that, for the one-page case, the comics generated by the proposed system are better than those generated by the baseline system in representing the user experiences in the targeted museum. Compiling the participants’ reasons behind their comic selections, we summarize our analysis results as follows:

(1) Due to the use of the fixed-and-equal snapshot timing, the baseline system could not extract frames that cover exhibits to which participants spent relatively long time. On the contrary, the proposed system could. For example, the kimono in the fourth frame (the top-right one) of Fig. 6, having a relatively high important level $I(\text{Frame}(4)) = 1.26$, was not shown in Fig. 7. In addition, Fig. 6 does not display the pair of exhibits in the third frame of Fig. 7 because the participant spent relative short time on the corresponding grid. For the two-page case, however, the proposed system renders also this pair of exhibits as shown in the sixth frame ($I(\text{Frame}(6)) = 0.92$) of Fig. 3.

(2) As shown in Fig. 8, for the two-page case, there existed many resemble frames in comics generated by the baseline system when a participant spent relatively long time to a particular grid. Such phenomena occurred less frequently in the proposed system.

However, from Table 3, the two systems have similar results for the two-page case. This is because the proposed system must select most of the generated frames in order to meet the number of frames, i.e., 24. As a result, the proposed frame selection mechanism, based on the important level, contributes less in this case. However, as far as summarization of user experiences is concerned, the result in the one-page case is more important than that of the two-page case in evaluation of the proposed system.
Figure 6. Example of a resulting comic page (P_FEW) by the proposed system

Figure 7. Example of a resulting comic page (B_FEW) by the baseline system
4. RELATED WORK

In addition to the authors’ previous work (Shuda & Thawonmas 2008; Thawonmas & Shuda 2008; Thawonmas and Oda 2010) on comic generation for online games, other work includes comic generation for online games using a combination of screenshots (Chan et al. 2009), rather than using the targeted game’s engine for re-rendering frames as done in our approach, and for first person shooters (Shamir et al. 2006). Comics were also used for summarization of experiences in a conference (Sumi et al. 2002), daily experiences (Cho et al. 2007), and videos or movies (Calic et al. 2007; Hwang et al. 2006; Tobita 2010).

Collections of images were used for storytelling by generating slides from images taken at multiple locations on a given map (Fujita & Arikawa 2008). A scripting system (Zhang et al. 2007) was proposed for automating cinematics and cut-screens that facilitate video-game production processes such as the control of transitions between images, and the annotation of texts and sounds to image backgrounds. For segmentation of videos, a method (Xu et al. 2009) exists that uses histograms of human motions, but this method aims at fast movements such as sports or dances, not slow movements typically seen in SL avatars while they are visiting museums.

5. CONCLUSIONS AND FUTURE WORK

We proposed and implemented a system for generating comics from user experiences during their museum visits. The system enables extraction of frames that contain interesting exhibits, from the viewpoint of a user of interest. This was achieved by partitioning the museum space into multiple grids and determining their important levels based on the number of visits during each of them. The conducted system evaluation confirmed the effectiveness, in properly representing the aforementioned user experiences, of the proposed system, especially when the number of frames was limited.

As our future work, we plan to increase the expressivity of comics. One possible research theme is to strengthen the comic layout mechanism. This would increase the variety of comic frames, such as large frames, small frames, slanted frames, etc. Another theme is to improve the camerawork so that a more proper set of camera parameters, i.e., the camera angle, camera position, and zoom position, is applied to a given frame. The mechanisms proposed in our previous work for online games (Thawonmas and Shuda 2008; Thawonmas and Ko 2010) will be extended, respectively, for these two research themes.
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ABSTRACT
Game interface technologies have advanced rapidly; however, very few games provide support for gamers with disabilities. This lack of support prevents many disabled gamers from playing games. With the goals of hands-free, no expensive equipment, and relatively low implementation cost, this project studies the available technologies that can be applied to games to support players who cannot use their hands. The performances of the technologies in accuracy and computational cost, as well as adoption costs, are evaluated. We present the advantages and disadvantages of several technologies along with problems encountered and proposed solutions to these problems. Our results show that speech recognition and face detection are very promising technologies that have high potential for increasing game accessibility.

KEYWORDS
Low-cost, hands-free, speech recognition, visual tracking, multithreading.

1. INTRODUCTION
While games are growing in depth and complexity, there are few that have enough support for gamers with disabilities. Many people cannot play games properly due to a disability such as blindness, deafness, or mobility limitations. Compared to the mainstream electronic games, those that support accessibility for disabled gamers are very few. Thus, a large number of people are being excluded from gaming due to this lack of support. To make it worse, the difference between regular games and accessible games keeps increasing. For that reason, it is important to study and improve game accessibility.

Currently, there are several technologies that can be applied to games to provide accessibility. We studied those technologies, implemented them, analyzed them, and proposed solutions that can be applied to games to help gamers who cannot use their hands.

2. OVERVIEW
Disabilities are varied, including: visual disability, auditory disability, physical disability, and learning disability. Each type of disability has different characteristics, so it is very hard to have a “one-size-fits-all” solution for all of them. Thus, this project will only focus on people who have a physical disability (mainly the people who lost the control of their hands). From here, the term “disabled gamers” will apply to gamers that cannot use their hands sufficiently to play a game.

2.1 Target Audience
According to the Amputee Coalition of America, in the United States alone, there were approximately 1.7 million people with limb loss (excluding fingers and toes) in 2007 (ACA 2010). Also, according to Kulley (2003) there are 50,000 new amputations yearly in the USA. Moreover, disabled gamers seem to be more devoted to games than many non-disabled gamers. According to a survey conducted by Information
Solutions Group on behalf of PopCap, compared to the normal casual gamers, “those with disabilities play more frequently, for more hours per week, and for longer periods of time per gaming session” (PopCap 2008). Not only spending more time on games than normal casual gamers, disabled gamers also state that they feel significant benefits from playing and view playing games as an important factor in their life (PopCap 2008). Based on her study about disabled gamers, Kalning states “For disabled gamers, playing games can be more than just play. It’s a community. It’s a connection. It’s a life line” (Kalning 2003).

Since our target audience is unable to sufficiently direct game play with a mouse, keyboard or controller, we need other input devices and methods. Fortunately, there are viable current technologies such as speech recognition, head/eye-tracking, etc. that can be applied to allow for “hands-free games”.

2.2 Related Work

In the past few years, there are several projects developed to provide game accessibilities to physically disabled gamers. They can be categorized into two groups: special software or equipment that can assist with mainstream electronic games and games specially designed for accessibility.

These are equipment/software that provides support for mainstream games that have no built-in accessibility options. These included mouth-controller, head/eye-tracker, and voice control interactive software. The voice control interactive software currently on the market, unfortunately, are not totally hands-free. They are mostly made with the intention to be used in conjunction with other controllers. Special equipment tends to be expensive or require considerable training and customization by the user. The most viable solution on the current market is Microsoft’s Kinect. It has reasonable price (around $150), impressive performance and it also can do face and voice recognition. OpenCV and EmguCV (see Section 5) support Kinect and they can go very well together (Madhav 2011). We use a low-end webcam to reduce the cost, however, users can use Kinect or a high-end camera to increase performance.

Specially designed games have built-in accessibility to support disabled gamers without additional special equipment. Our project fits in this category, however, unlike other projects, our goal is not about making games with accessibility but how to add accessibility into existing games with ease and relatively low-cost.

2.3 Project Goals

Our primary goal is to find methods of increasing accessibility to games, specifically hands-free. In order to make a big impact the cost of accessibility must be low. We consider the cost of any additional hardware needed by the gamer, the cost to the developer to add accessibility to their game, and the computational cost of accessibility which could hamper game play. We also consider effectiveness; specifically, accuracy, precision and latency of the technology. We do not consider how effective it is in performing tasks within a specific game, as that is also affected by the game’s user interface design.

Many of the current specially designed equipment for accessibility are hand-made and most of them are still expensive so not many people can afford them. Thus, this project will focus on software-based solutions to avoid expensive equipment. Currently, a webcam with a microphone is $60 or less, or about the cost of a new title. Additionally, most standard laptops come with them. We therefore focus on solutions using them.

We also have to keep in mind that game developers make games mainly for profit. A solution that requires a high implementation cost would not be viable from the game developer’s point of view. That is why avoiding too much additional work for the game developers is also very important. This project will only study and introduce technologies that have the potential of being implemented with relatively low cost.

In summary, finding solutions to make hands-free games that do not require expensive equipment with relatively low cost is the main goal of this project. Potential technologies will be evaluated with 3 key factors: hands-free, inexpensive, and low implementation cost.

3. POTENTIAL TECHNOLOGIES

There are several current technologies that can be applied to make hands-free games. this section will briefly discuss the available technologies to find those most suitable. technologies that require expensive extra devices or have high implementation costs will be deemed unsuitable.
3.1 Sound

Sound can be used to control a game. The two main approaches are speech recognition, which uses a set of phases or words with each mapped to a command in the game, and using sounds with different magnitudes or frequencies (pitch detection). Here, we consider Speech recognition as the technology to recognize the words a user speaks, and not the actual speaker. With Microsoft Speech Application Programming Interface (SAPI), this technology is simple to implement with relatively low cost.

Instead of speaking specific commands, a player can use their pitch to control game play. In this technique, we analyze the sound made by a player to get its frequency, magnitude and the length. Then, these characteristics are used to compare and find the matched sound command to determine which command the player want to issue. Due to the complexity of handling sound this technology is left for future work.

3.2 Visual

This type of technology tracks user movements to control the game. We evaluate using the head/face as the main target of the tracking because cameras that are good enough to track eyes are rather expensive. The three technologies for tracking that will be discussed are face detection, Speeded Up Robust Features (SURF) detection, and motion detection. All three methods are viable.

3.3 Brain-Wave

Brain-wave technology is a very high level technique that allows the communication between the human brain and external devices. As a natural biologic occurrence, a human brain consistently cycles through several states which are called brainwave states. At any given time, a brain simultaneously pulses in all states, with one state being dominant (Immrama 2010). This technology will capture the waves produced by a brain when it pulses in the brainwave states, then analyze and use them as user input.

Because of its high level, implementing this technology is certainly not a simple task. That is why it would be very hard to find a way to implement this technology with low cost. Another down side of this technology is that it requires considerable training and customization from the user. At his point this technology cannot be considered as a low-cost software-based solution.

3.4 Nanotechnology

Nanotechnology uses very tiny objects implanted into the body for specific purposes such as diagnosis and treatment. Theoretically, with the diagnosis capability of the nano-devices, this technology can be a great way to provide game accessibility. However, this technology is very costly and certainly is not viable at this time. Moreover, while inserting nano-devices into the body for medical purpose is understandable, not many gamers would want to have them inserted into their bodies so they can play games.

4. SPEECH RECOGNITION

Recognizing speech is actually quite difficult. the main reason is that natural language is very complicated with many exceptions and irregularities and is highly context-sensitive. Fortunately, we only need to make the system recognize some, possibly very few, voice commands. Assuming that each controller button is mapped to a voice command, the total number of voice commands would be small. Making a system to recognize a command from a small dictionary of voice commands is not overly difficult. microsoft sapi is a good solution for this technology. Besides sapi, there are other speech recognition systems such as dragon naturallyspeaking and sphinx-4. The disadvantage of dragon naturallyspeaking is that it is not free (in fact, it is very expensive) and the advantage it has with non-predefined vocabulary is unnecessary for our purpose. We chose sapi over sphinx-4 because we are focusing on windows games so the advantage sphinx has with cross-platform was not taken into consideration. On windows, sapi is much easier to implement making it a

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better choice than sphinx. However, in the future, when we expand the project to support cross-platform, sphinx will be a very good candidate that cannot be overlooked.

The most notable advantages of speech recognition are the simplicity of implementation (using Microsoft SAPI) and its lower computational costs.

The disadvantages are its very susceptible to noise, difficult to distinguish speakers, long latency, and playing the game for a long period of time may be uncomfortable. Noise due to the environment or a bad microphone will drastically reduce accuracy. To reduce noise, complex filtering can be developed, however this greatly increases development costs. Another solution is to use a second microphone, which will increase user hardware costs and synchronization will increase development and computation costs. For now, the simplest and maybe the most viable solution is for the players to move the microphone as close to their mouth as possible. Commands spoken by someone other than the player should be ignored, however, in order to do this some form of speaker recognition must be employed, which is expensive computationally and to implement. There is a built-in latency since the system typically can’t recognize a command until the user has finished speaking the command plus some time for computation. This latency makes it almost useless for action games. There are some methods to do continuous recognition, but accuracy suffers. Also there is a trade-off between response time and accuracy and setting the threshold is difficult and user-specific.

4.1 Evaluation

Based on the advantages and disadvantages found with experimental results, we concluded that speech recognition has a high potential with its decent accuracy (which can be further improved by voice training), very little effect on game speed and also is very easy to implement. With further improvement to reduce the noise and when used in conjunction with other technologies, speech recognition can be a viable low-cost solution for making hands-free games.

5. VISUAL TRACKING

Head/eye-tracking technology is one of the current trends of research for accessibility. This technology uses camera(s) to capture pictures and then analyzes them to track the movements of the head or the eye gaze. Unlike speech-recognition, this technology has fewer problems with constant movement control. Thus, this technology is more suitable for controlling the constant movements of the characters in a game than the speech-recognition technology. To implement the tracking technology, we use OpenCV and its .NET wrapper EmguCV.

OpenCV (Open Source Computer Vision) was originally developed by Intel and now supported by Willowgarage and is a cross-platform library of programming functions for real-time computer vision. OpenCV is released under a BSD license and is free for both academic and commercial use. EmguCV is a .NET wrapper that allows OpenCV to be used with .NET compatible languages.

For evaluating technologies, we use XNA 3.1 and modify the platformer starterkit. The computers used for testing are a mid-low end Dell laptop (Intel Core 2 Duo 1.40 GHz, 2 GB DDR2, 256 MB GeForce 8400M GS, Windows XP Professional SP3) and a much more powerful desktop (2 Intel Xeon X5482, 16 GB DDR3, 2xNVIDIA Quadro FX5600, Windows 7 Enterprise). The camera used for testing is a Logitech Webcam 600 (2.0 megapixel, 720p, up to 30 frames per second) with microphone built-in.

5.1 Face Detection

For face detection, the system constantly detects the user’s face (demonstrated by Figure 1) and tracks the face movement to use as game input. We use a Haar Cascade Classifier and Canny Pruning for face detection. OpenCV provides several classifiers for the face, eyes, nose, mouth, body, etc. However, since this project only uses an inexpensive camera for image capture, small features such as the eyes, nose, and mouth cannot be tracked with high accuracy. Based on the results of several experiments, we chose the face as the most suitable object for detection. With many edges around the eyes, nose, mouth, etc. in a picture of human face, Canny pruning can be used to boost the performance of the detection (by eliminating the candidates that
do not have enough edges). Other edge detection techniques can be used, but only Canny is supported by EmguCV so we use it to keep development costs down.

![Figure 1. Face detection](image)

We found that face detection has several advantages including decent accuracy and simplicity of implementation. With the support of OpenCV and EmguCV, developers only have to write several lines of code in order to implement this feature. Note that more work is needed to be done on translating the captured movement to game input in order to have better accuracy. The accuracy of the face detection technique depends heavily on how good the chosen Haar Cascade Classifier is. From our experiments on the classifiers provided by OpenCV, face detection yields the best accuracy of the three visual tracking techniques and can be used to effectively play some games.

Disadvantages are a high computational cost that affects game speed, accuracy, and inability to distinguish individual faces. The accuracy is good for many games, but with low cost camera, the tracking cannot be as precise as mouse or keyboard control. Thus, games that require pinpoint accuracy are not supported well by this technique unless much better camera is used (which would be costly). The computational cost of a naïve implementation can be quite high and on low-cost systems gameplay will suffer, see Figure 3a. Additionally, all faces in view of the camera will be detected by the face detection system. To overcome tracking of all faces in camera view, we propose tracking the biggest face (it will most likely be the player’s face). Users can also train a classifier just for their face, but providing this ability is expensive to implement and difficult for users to perform.

5.2 Speeded Up Robust Features (SURF) Detection

The concept of this technique is to detect and extract some special features of an image (here the player’s face), and then use them to compare with another image to detect if the first image is part of the second image (to get the position of the player’s face in the captured image) as demonstrated by Figure 2. Currently, SURF is an excellent method for the interest point detection and description task; it outperforms the older scheme Scale-Invariant Feature Transform (SIFT). Thus, SURF would be the best method for detecting and extracting features from an image. Basically, this is another approach for face detection; but instead of using Haar Cascade Classifiers, we will use SURF. The most notable advantage of using SURF over Haar Cascade Classifiers is the ability to do face recognition.

![Figure 2. Examples of SURF detection.](image)

Based on experimental results, we found that SURF detection has several advantages such as the ability to handle transformation/rotation, less susceptible to noise, and the potential of doing face recognition. Because SURF will detect and use special features of a face, we only have to allow the player to register his face as the tracked object (which we have to do anyway). The last picture in Figure 2 is a demonstration for face recognition with SURF detection.

The disadvantages of SURF detection are the huge impact on game speed, inability to keep up with fast movements and low accuracy due to the low quality of captured images. Due to its high computational cost SURF can drastically affect game performance as show in Figure 3b. The solution we proposed to solve this problem is using multi-threading (details are explained in section 5.4). We found that SURF had trouble
following fast movements. The only method to improve this is to use more expensive cameras. SURF also suffers from low accuracy due to low quality of captured images. A more expensive camera can be used, but that is against our goals, so instead we propose using some markers to create more special/unique features, however game players may not want to mark up their faces, but they may enjoy it.

![Figure 3. Game speed while using naïve implementations of a) face detection and b) SURF detection.](image)

5.3 Motion Detection

Motion detection algorithms determine the movement vector of objects between two frames (shown in Figure 4). Since motion is really what we want, we can do this instead of detecting position in two frames and subtracting to get motion. OpenCV has robust motion detection that can be used.

![Figure 4. Motion detection](image)

The only advantages we found for motion detection was its computational cost which was the lowest of the visual methods. However, the disadvantages are that it was highly susceptible to noise, it is very sensitive, and it still impacted game speed as show in Figure 5. Since all motion is detected anything behind the player will affect results. This can be limited by tracking the largest blob, but shaking of the camera (which could be common for laptop users) will always cause problems. Motion detection is very sensitive and unintentional movements by the player will be detected. It is difficult for the user to stand still. Some thresholding can be used, but at the loss of fine control.

![Figure 5. Speed of motion detection in a naïve implementation](image)

5.4 Multithreading

Due to the need of constant tracking, the visual tracking must be put in a section that will be looped constantly. However, placing the tracking into a section such as the *update* method will drastically reduce the game’s speed as seen above. To solve this we use a separate thread to perform the tracking. However, multithreading is non-trivial, doing multithreading incorrectly may slow the game down or even lead to serious problems such as deadlocks. It is also much harder to debug the game with multithreading. To keep it
simple (as low cost implementation is a goal of this project), we use a dedicated thread for tracking and ignore synchronization (there will also be no blocking).

The only rule that we need to follow is: All variables needed for tracking will be modified by this thread exclusively; all other threads can only read those variables without modifying them. By doing this, the communication between the thread for tracking and other threads is one-way. This avoids conflicts between threads trying to modify the same data concurrently. However, because we ignore the synchronization, other threads may use outdated output of the tracking thread. This will result in a reduction of accuracy. Fortunately, based on our experiments, this change in accuracy is hardly noticeable while the gain in speed is significant (especially with slow computer).

Figure 6 (laptop) and Figure 7 (desktop) compare performance with and without multithreading for the visual detection techniques. As we can see, without multithreading, game speed can be significantly degraded by visual tracking (especially on a slow computer). However, multithreading improves performance greatly so that even on a less powerful machine we can get 30Hz, which is probably the minimal playable framerate.

![Figure 6. Speed achieved on the laptop without (left) and with (right) multithreading.](image1.png)

![Figure 7. Speed achieved on the desktop without (left) and with (right) multithreading.](image2.png)

6. CONCLUSION AND FUTURE WORK

We studied available technologies that can be applied to video games to provide accessibility for people who cannot use their hands and present the most viable here. We evaluate the technologies’ performance based on speed and accuracy. From the evaluation, we point out the advantages, disadvantages, problems that can be encountered when using the technologies and proposed solutions that can be used to solve those problems.

From the experimental results, even though the speech recognition and visual tracking technologies (with the face detection stands at the top currently) still have issues with the accuracy and can be a little uncomfortable to use at first, they are still very promising and have great potential for game accessibility. The most notable advantages that they have are the simplicity of implementation (low implementation cost) and the ability to perform decently with low cost equipment.

The biggest limitation of face detection is accuracy. Even though it can perform decently, the accuracy is still not good enough to support games that require fine control. For speech recognition, accuracy due to noise is the biggest problem for most games, and high-latency makes it unusable for action games. However, for turn-based strategy games it is very promising, not only for disabled games, but for all gamers. Continuing to improve upon these technologies will make them more likely to be used in future games. in order to make it into mainstream games, the accuracy must be high and the computational costs must be low.

There are some potential solutions that currently have higher implementation costs, but may still be viable, that we would like to evaluate. Using pitch instead of speech recognition is one such promising technique with high-accuracy and low-latency achievable. Another area we have yet to test is combining methods to take advantage of the strengths, and possibly overcome some of the weaknesses.
In this work, we primarily look at adding accessibility directly to a game via the developers, which not all developers are willing to do. Another solution is to write drivers that can translate the captured voice/head movement to game input. Instead of having to customize each game to add the accessibility, the drivers can be used for any pc game without the need of modifying the game itself. The advantage of this method is that users can customize their inputs. The disadvantage is that such a solution has very high implementation costs, but if done, will add accessibility to virtually any game.

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A PRACTICAL APPROACH TO INTRODUCE STORY DESIGNERS TO PLANNING

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ABSTRACT

This paper presents a design methodology that allows technical leads in the game industry to introduce story designers with low technical background to generative techniques for automatic plot creation, in particular to a specific method of AI-based planning. The approach provides support to convey necessary technical knowledge by paper prototyping. Further, it demonstrates that paper prototypes are not only useful to learn these concepts but also as tools of creation.

KEYWORDS

Game Design, Planning Algorithm, Design Method, Visualization, Paper Prototype

1. INTRODUCTION

Research in Interactive Digital Storytelling (IDS) aims at inventing techniques that provide possibilities for players to have meaningful influence on the story of a game. Traditional game design often makes use of branching story lines to achieve this influence, leading to an explosion of paths and content elements that is difficult to manage manually. IDS focuses on overcoming that issue with generative techniques. One reason why only few successful IDS solutions have been adopted by the games industry is that they are technically more demanding than traditional branching storylines. Technical leads often work with team members who are experts for story creation with little technical background in Artificial Intelligence (AI) or computer science. This hampers the uptake of more advanced generative technologies for storytelling in games.

We assume that a potential future IDS industry will work with a similar role distribution as in the actual game industry, however also including story engineers as designers for generative story engines that co-define the interactive story experience (see Figure 1).

Figure 1. Assumed roles in the creation of an interactive story artifact.

The current state of the art in IDS shows that right now, roles like in the above Figure are often combined and it is not uncommon that engineering and authoring tasks are performed by the same person in small projects (Spierling et al., 2010). When extending the scope to larger development teams, there is a need to introduce game designers and story authors to generative concepts. Even though authors may not need to
implement technical aspects, it is vital for their creative work to understand the nature and philosophy by which story engines generate new content.

While in traditional storytelling authors explicitly predefine all possible paths, directly controlling all decision points, in IDS the plot structure is in part defined only implicitly by the declaration of rules and abstract models (Spierling, 2009). Thus, we assume that current authors have to deal with two opposing ways of creating a plot. On the one hand, they create models for all parts that are to be generated automatically, and on the other hand, explicitly defined actions, events and states are still to be declared for the non-generative story parts.

In the following, we describe a case study in which we
• explore the transformation of a draft story into a story model and
• use the model as a strategy for educating story creators in technical concepts of IDS.

We decided to use AI-based planning, one prevalent generative method used for drama management in IDS (see below). The created model has then been converted into a physical card game (the paper prototype described below) and has been test-implemented with an authoring tool equipped with planning software1 (Pizzi and Cavazza, 2008).

2. FUNDAMENTALS AND RELATED WORK

Although AI-based planning – as described by Russell and Norvig (2003) – is one prevalent method used in IDS research, for example by (Charles et al., 2003), (Thomas and Young, 2006), (Thomas, 2006), (Pizzi and Cavazza, 2008), (Porteous and Cavazza, 2009), (Riedl, 2009), (Roberts et al., 2009), and (Skorupski, 2009), there is a lack of explanatory material that can be used as an introduction combined with creative story conception. For authors, AI-based planning at first may appear like an alien concept from the world of computer science. However, one important and interesting fact is that there are basic parallels between planning and storytelling. Therefore, technical fundamentals have to be explained with graspable metaphors before such an approach can be employed.

As pointed out by (Barros and Musse, 2007), there is a clear correspondence between planning algorithms and stories. Planning algorithms operate on the basis of causal relationships between actions. Stories are sequences of actions/events related through some form of causality. Because plans are composed of discrete operations and stories can be seen as sequences of events, they can be converted to computer-based models. The role of planning in IDS applications “is to define the actions or events that must occur during the story so that the world changes from its initial state to some goal state” (Barros and Musse, 2007). This point is shared by (Li and Riedl, 2010) who sum up that “plans closely resemble cognitive models of narrative” and that “cognitive science and neuroscience suggests that planning may be a very appropriate computational means for narratives”.

Planners can create an order of actions (or events) dynamically. The use of planning software may not directly reduce the amount of actions that have to be authored, but offers a greater degree of non-linearity and variation within a prepared set of actions/events. Once a story is decomposed into single actions (operators) of partial order, a high number of story paths within the same created repository of actions/events becomes possible. Another advantage of some planning algorithms is the ability to adapt to changes of the world state during runtime and to perform re-planning if the user or other agents interfere with the current plan, and the firstly authored course of actions is possibly changed.

Traditionally, the scope of software-based planning is to create optimal and efficient ways to transform the initial world state into the desired goal state(s). Planning with respect to IDS expands the scope from the efficiency of this transformation to interesting ways of the transformation itself. The resulting order of actions should lead to an interesting and suspenseful experience for the user. In successful storytelling, primarily ‘the journey is the reward’, and reaching the goal (or end of the story) most efficiently or quickly may be even undesirable.

The fundamentals of planning in Artificial Intelligence are described by some basic conceptual elements. Addressing the interests of story creators for games, these can be divided on the one hand into elements that

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have to be explicitly created during an authoring process, and on the other hand into only implicitly created elements that are finally generated by automatic planning during the runtime of the generative story engine.

Explicitly authored elements include:

- **Facts** (propositions): These are sentences that can be part of the story, describing possible elementary and changeable situations of people and objects, for example: ‘The cigarette is lit’. During authoring, a database of facts that are possible and relevant for the story needs to be collected.

- **Actions** (operators): These are events with the possibility to modify the validity of facts (propositions). For example: ‘To light a cigarette’.
  - **Preconditions** (propositions): For each action, necessary conditions have to be declared defining a situation in which that action is allowed to be performed. This is a proposition, for example ‘The cigarette is not lit’.
  - **Effects** (propositions): Also for each action, its transforming effect needs to be declared during authoring. This can be done by declaring which facts become true (are added to the world) or false (deleted from the world) after the action is performed. For example, the action ‘To light a cigarette’ adds the proposition ‘The cigarette is lit’ and deletes the proposition ‘The cigarette is not lit’.

- **Initial state** and **goal state(s)** (collections of propositions): Authors need to specify a selection of their defined facts (propositions) that are true at the beginning of the story, which describes the initial state of the world before the plot starts. Further, they define one or more possible goal state(s) as a selection of their facts (propositions) that describes the end of the story.

Implicitly created (generated) elements include:

- **States** (world states of the story, each of which is a set of actually valid facts (propositions) at each step of plan execution).
- **Chains** (sequences) of plausibly ordered actions changing world states.

The planning process can be divided in two parts, performed step-by-step creating a generated sequence of actions changing the world state:

1. Depending on the current world state, find possible actions (where preconditions are met), and
2. If multiple actions are possible, choose the ‘best’ action.

Each meaningfully authored action contains preconditions, describing under which circumstances the action is possible, and effects, which describe changes to the world after the action was performed. Both are defined by facts, the so-called propositions. The effects are divided into sets of propositions that are added and/or deleted from the current world state. The world state itself is defined by these propositions, describing the world with facts.

The choice of the ‘best’ next action is determined by a quality function. In planning-based IDS systems, designing these quality functions has the strongest impact on the final outcome and is central to the authoring process.

### 3. DESIGN PROCESS OF AN EXAMPLE STORY

This section describes a suggested process of design by a concrete example story ‘Harold in Trouble’. The process can be used by technical leads to collaborate on a non-linear story with a team of story designers. Parts of it can be performed as a collaborative workshop or seminar and can be scaled up or down depending on the size of the team and the intended results.

#### 3.1 Story Outline

The first step is to create a written story outline and to define scenes, characters and their goals within the story. This can be done in a brainstorming phase, in which possible scene descriptions are written down on cards. In our example, we created a kind of ‘James Bond’ story, with criminal super brain ‘Silvertoe’ wanting to blackmail the world.

The second step is to analyse the draft story and find a suitable genre. In our example we decided to choose parody to create a story with some humorous situations. So we developed a comic character, wannabe womanizer ‘Harold’ as the clumsy assistant to the agent who wants to stop Silvertoe. As a design principle, all effects of his actions have a contrary outcome to what would be proposed, creating havoc.
Every scene needs a goal to be reached. In our scene designed for the planner, the goal is reached when Silvertoe leaves the party with anger. While Harold tries to seduce the female guests, he creates chain reactions that let the event get out of control, like inflaming a poodle, poisoning the punch, drenching other guests and damaging the music equipment – thereby raising the anger level of Silvertoe. The goal of this scene is to make Silvertoe so angry that he cancels negotiations with other villains and leaves his own party.

3.2 Events and Actions

The next step is to extract possible meaningful actions and events from the story draft. In our story ‘Harold in Trouble’, two abstract actions at a high hierarchical level (subsuming other actions) were identified, which are crucial for the flow of the intended story experience: ‘creating havoc’ and ‘seducing’. The comical theme of the story can be well expressed by an involuntarily created chaos resulting from chain reactions making the happenings worse in each step. These chain reactions are also suited for planning in general because they allow for dynamic connections of different chains to each other. To initiate the chain reactions, the abstract action ‘seduce’ was chosen, fitting one main characteristic of Harold. Table 1 shows some concrete actions as variables that can be used to represent this abstract action.

3.3 States and Attributes

The next step is to extract story-relevant variable states and attributes, leading to the definition of propositions. The final goal of our scene is to make Silvertoe so angry that he leaves the party. So the most important changing states in the story are the various anger levels of Silvertoe, which have to be described as facts (propositions). The resulting exact order of events is not that important any more for the outcome of the scene, as long as actions increase that value. Further, we also need to describe all possible states of attributes in the world of the story, again as propositions in the form of sentences about possible facts, such as ‘Cigarette is lit’.

3.4 Groups and Alternatives

As implied above, we suggest the use of abstraction layers to group and structure collected ideas for actions and for variable attributes. Table 1 shows the example of the high-level action ‘seduce’, which gets increasingly specified at lower levels of abstraction in the sense of concrete actions that are to be finally used in the story. In practice for creation, such a table is also helpful for structuring the results of the brainstorming of alternatives for actions, because it is possible to fill in actions at different abstraction levels and to think later about higher or lower levels.

3.5 Chains

As stated above, the creation of plausibly ordered sequences of events or actions is actually meant to be generated automatically by planning software, processing on the authored structure of actions and their situational conditions. Still, we suggest that in order to help define these situations, the anticipation of potential chains of events is an important step in authoring. Actions collected previously are then examined.
for possible connections and are linked together if they seem to be believable and interesting as a chain. This can easily be visualized by a graph. Beginning to create chains with actions at a higher abstraction level reduces the complexity in the first steps. Actions of lower level can then be filled in later into the already existing graph to allow for alternatives and variable paths.

3.6 Action Sets including Situational Information

Each action needs to be equipped with information on how it changes the world of the story. This is accomplished by adding preconditions and effects. For each action, at first, circumstances have to be considered in which this action becomes possible. These are defined by variable cases of attribute states, described for each action by a list of propositions to be checked as true. For example, the action ‘Harold lights cigarette with a match’ can only happen if three facts are true, namely that a woman is bored, has a cigarette in her hand, and that the cigarette is not lit. Table 2 shows how this action is described with these preconditions. Likewise, the effects of the action on the resulting world state are noted. In our case, they are described by the removal of one fact ‘Cigarette is not lit’ and the addition of the new fact ‘Cigarette is lit’. (compare Table 2).

This representation of the story as a structured model can be directly transferred into a planning system. However, having only created the first draft, we want to experiment with the resulting dynamic sequencing before implementation, which would be also a barrier for non-programmers. The use of paper prototypes, for example with index cards, is very helpful in this design phase, because it is possible to write down only one part of the description and think about others later, for example leaving the preconditions open and focusing on the effects at first. We can immediately play with the incomplete cards such as in the card game described below, although the model is not yet technically consistent to be successfully run by software.

Table 2. Example of three full sets of actions and corresponding preconditions and effects.

<table>
<thead>
<tr>
<th>Preconditions</th>
<th>Actions</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bored woman is present</td>
<td>Harold lights cigarette</td>
<td>Cigarette is lit</td>
</tr>
<tr>
<td>Woman has cigarette in hand</td>
<td>with a match</td>
<td></td>
</tr>
<tr>
<td>Cigarette is not lit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cigarette is lit</td>
<td>Harold carelessly throws match away</td>
<td>Fire is spread</td>
</tr>
<tr>
<td>Fire is spread</td>
<td>Poodle burns</td>
<td>Someone burns</td>
</tr>
<tr>
<td>Poodle is present</td>
<td></td>
<td>Silvertoes anger raised by 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poodle is burning</td>
</tr>
</tbody>
</table>

4. IMPLEMENTATION

In our proposed paper-based design method, there are two types of cards: ‘action cards’ and ‘proposition cards’, which are dynamically arranged during playing of a card game to describe the ever-changing world state. The cards allow story designers to dynamically visualize and test the possible playout of their story, while gently introducing them to the structural requirements of planning systems. Figure 2 shows an action card of our card game prototype on the left and a suggested layout for the game on the right.
This paper prototype works as kind of a card game that simulates some working aspects of an AI planner through a team of players, who form a human representation of the planning algorithm. One additional player can take the role of an interacting user with that ‘human engine’. To play-test with the paper prototype, the initial state has to be created first by placing the corresponding proposition cards into the world state area on the table (see Figure 2). The participant in the role of the interacting user can add or remove facts to/from the state of the story world, forcing the ‘planner’ - the card game players - to react and to perform dynamic re-planning. They have to compare the propositions listed as preconditions on the cards in their hand with the current world state. If there is a matching card, it can be played and as such become an action in the evolving storyline. With each action, its effects have to be performed by adding and removing propositions as written on the played card. This is to be repeated in turns until a point is reached at which the world state corresponds to the goal state, ending the sequence.

The team of players – during story prototyping – can discuss different rules of the card game that allow some experimentation and exploration of planning strategies. For example, it is possible to decide whether or not an action card can be reused after it is played once. If it returns to the hand of a player, wanted or unwanted loops in the story become possible, because single cards and therefore whole chains can now be experienced again. If more than one action card become possible in any current world state, the question arises to decide which card is given priority. This problem needs to be solved by the definition of a so-called ‘quality function’, determining the ‘best’ next action of all possible. This is a creative decision and can depend on several things, for example on the potential to open up many possible following branches, or the potential to end the story in a way desired by the author, or the potential to create a desired world state (such as ‘havoc’), if that turns out as a design goal for the chosen story genre. The prototype allows story designers and technical leads to test, discuss and refine these quality functions in a visual and playful way.

After some refinements and for the support of increasing complexity, the paper-based model can also be implemented with an AI-based planning software, making it easier to modify and quickly test changes. We used the EmoEmma Authoring Tool (Pizzi, 2009) to evaluate the feasibility (Spierling et al., 2010).

5. DISCUSSION AND FUTURE WORK

Working with the prototype shows that in the first phases of story creation and with smaller projects, using planning in IDS and games does not reduce the authoring effort. Generative systems based on planning do not create new actions. Instead, authors/designers still have to predefine them together with their acting conditions. However, the result is a dynamic story world which offers end-users a non-linear experience concerning the order of events, which – if designed well enough – may influence each other and result in new directions within the story. Beyond small projects, planning becomes all the more useful the more actions are created and the more difficult it would be to design all story branches in a ‘hard-wired’ way.
The shown modeling process will be further explored with increasingly complex stories, which is necessary to enunciate understandable design principles for story creation making use of AI-planning. We expect a certain level of story complexity to be a threshold beyond which automatic prototyping methods outmatch manual solutions, such as our card game. This threshold needs to be explored by further creation experiments.

6. CONCLUSION

We presented a paper-based design method intended to introduce story designers to the field of AI-based planning. By playing with the cards, story designers gain a deeper insight into the underlying principles, opportunities and limitations of planning technology. We invite lead game designers who already have technical knowledge in the field of planning or are interested in it to use the presented card game to introduce their team to this field in a playful way. By the help of the proposed modeling process, they can design further paper prototypes similar to the card game, and can consider whether planning would be a promising approach for their project. The resulting card game and further material is available for public access\(^2\), provided by the IRIS Network of Excellence\(^3\).

ACKNOWLEDGMENTS

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Li, B., Riedl, M. O., 2010. Planning for Individualized Experiences with Quest-Centric Game Adaptation. Proceedings of the ICAPS’10 Workshop on Planning in Games, Toronto, Canada.


\(^2\) http://iris.interactive-storytelling.de

\(^3\) http://iris.scm.tees.ac.uk


ABSTRACT

Despite the dramatic growth of gender and games research, many challenges remain in designing a more gender-inclusive game. This paper addresses the problem of how to support gender-inclusivity in games by incorporating existing theories in games and gender. Existing research in games and gender tend to focus on finding out how each gender plays and their preferences in games. However, there is little evidence that researchers have approached the issue of gender inclusivity in games with the intent of building a cohesive understanding of gender inclusivity in games and the relationships that exist between the different dimensions and components. This research sought to identify emerging themes and components for supporting gender inclusivity in games based on findings from games and gender research. Consequently, the aim of this research is to develop an integrative framework that can support gender inclusivity in games. Analysis of existing research findings in games and gender produced 2 unique components lists with a total of 8 themes and 32 components relevant to gender inclusivity in games. Further classification and synthesis demonstrate that the proposed framework can be determined by 3 dimensions and 12 components. On-going research is being planned for experiments to validate the framework through expert evaluation, game experiment and game design projects.

KEYWORDS

Gender inclusivity, game design, game model, gender-neutral, game framework, design guidelines

1. INTRODUCTION

After more than a decade of girl game movement and in spite of efforts to accommodate female gamers with games by producers such as HerInteractive, Girl Games, GirlTech and Purple Moon, big production games are still being designed, developed, and marketed with the male player in mind. For example, the number one spot in the top 20 selling video games in 2009 goes to Call of Duty: Modern Warfare 2 on Xbox360 (ESA, 2010). The game is a first person shooter military campaign where a gamer takes on the role as a member of an elite multi-national counter terrorist unit. BBC News (2010) reported that an estimated $550 million sale was made in the first 5 days of its launch in November 2009 with a total of $1 billion in revenue. Recently, at the British Academy of Film and Television Arts (BAFTA) award ceremony, a shortlist of 10 games up for the most popular games award were dominated with games from the action or shooting genres i.e. Call of Duty: Black Ops, Halo Reach, Mass Effect 2, Red Dead Redemption while two from the platformer genre i.e. Limbo and Super Mario Galaxy 2, one game each from the sports genre i.e. FIFA11, interactive drama i.e. Heavy Rain, music genre i.e. Dance Central and racing genre i.e. Need for Peed: Hot Pursuit. The winner of the BAFTA Best Game Award 2010 goes to Mass Effect 2 and GAME Award 2010 goes to Call of Duty: Black Ops, both from the action-shooter genre. A similar pattern of commercial and popular games with violent-action-shooting content can be seen in Table 1, showing a list of award winning games for the last 10 years at the Academy of Interactive Arts & Sciences (AIAS) Game of the Year award ceremony. Almost all games that won the award are from either action, shooting or thriller (hack and slash) genre with only two exceptions i.e. The Sims a life simulation genre in 2000 and Little Big Planet a platformer genre in 2009. Seven of those award winning games i.e. Diablo 2, Halo: Combat Evolved, Half-Life 2, God of War, Gears of War, Call of Duty 4: Modern Warfare and Mass Effect 2, are categorized as containing mature content suitable for audiences ages 17 or older.

This situation with current games supports the hypothesis that large commercial and popular games are still being designed for the male audience. Hence, when Activision, developer of Call of Duty game series...
and other popular games such as Guitar Hero, World of Warcraft, Spider-Man and Crash Bandit, claimed that having a female protagonist would not increase the sales of a game title (Alexander 2010), it does not come as a surprise. Despite this rebuff, more importantly however, the girl game movement showed that there are female gamers, they have a discerning taste, they play a lot of games, their gameplay style and choice of games are different, and not only are they gamers but also game designers and game producers. For economic reasons presented in the earlier sections concerning the changing demographic of gamers and women purchasing power, interestingly, the situation in current games also highlights the fact that there is still room for a bite out of the gamers market and for design creativity - an opportunity for designers to challenge their designing skills and find out what female gamers actually wants in their games. Learning from the successes of games like Barbie Fashion Designer, Nancy Drew Adventure series, The Sims and Little Big Planet might uncover the design magic that made these games unique and popular.

Table 1. AIAS Overall Game of the Year Award winners from 2000 to 2011

<table>
<thead>
<tr>
<th>Year</th>
<th>Game</th>
<th>Genre</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>The Sims</td>
<td>Life Simulation</td>
<td>E</td>
</tr>
<tr>
<td>2001</td>
<td>Diablo II</td>
<td>Hack and slash</td>
<td>M</td>
</tr>
<tr>
<td>2002</td>
<td>Halo: Combat Evolved</td>
<td>First-person shooter</td>
<td>M</td>
</tr>
<tr>
<td>2003</td>
<td>Battlefield 1942</td>
<td>First-person shooter</td>
<td>T</td>
</tr>
<tr>
<td>2004</td>
<td>Call of Duty</td>
<td>First-person shooter</td>
<td>T</td>
</tr>
<tr>
<td>2005</td>
<td>Half-Life 2</td>
<td>First-person shooter</td>
<td>M</td>
</tr>
<tr>
<td>2006</td>
<td>God of War</td>
<td>Action-adventure game</td>
<td>M</td>
</tr>
<tr>
<td>2007</td>
<td>Gears of War</td>
<td>Third-person shooter</td>
<td>M</td>
</tr>
<tr>
<td>2008</td>
<td>Call of Duty 4: Modern Warfare</td>
<td>First-person shooter</td>
<td>M</td>
</tr>
<tr>
<td>2009</td>
<td>LittleBigPlanet</td>
<td>Platform game</td>
<td>E</td>
</tr>
<tr>
<td>2010</td>
<td>Uncharted 2: Among Thieves</td>
<td>Action-adventure game</td>
<td>T</td>
</tr>
<tr>
<td>2011</td>
<td>Mass Effect 2</td>
<td>Action RPG</td>
<td>M</td>
</tr>
</tbody>
</table>

Note: E – Everyone; T – Teen =>15 years old; M – Mature =>17 years old

Although there are a number of game models that can be used to guide game design, (Crawford 1982; Costikyan 1994; Hunnicke, LeBlanc et al. 2001; Konzack 2002; Kreimeier 2002; Bjork, Lundgren et al. 2003; Crawford 2003; Rollings and Adams 2003; Fullerton, Swain et al. 2004; Koster 2005; Salen and Zimmerman 2005; Barwood and Falstein 2006; Consalvo and Dutton 2006; Aarseth 2007; Jarvinen 2007) these models rarely take into account gender preferences during designing. When creating a game, designers add features to their design with the intention to enable certain gameplay experiences. However, there is a degree of separation between the desired gender-inclusive experience in games and the mapping of that experience. Currently, the determination of gender-inclusive features in games is not particularly documented and is largely based on a designer’s experience and intuition and was progressively developed based on prior designs. Consequently, how can we tell if the gender-inclusive gameplay experience is really compelling or even ‘right’? There is little reported experience in the issues that arise in determining what features should go into a gender-inclusive game and for determining the success or failure in the evaluation of those features. Although the design process for current games is more established but for gender-inclusive games it is yet to take shape. The key problem addressed by this paper is the lack of structure for analysing, designing and measuring gender-inclusivity in games.

Most previous research in gender and games only focuses on finding out how each gender plays, what their preferences are in games and highlighting their differences. Ibrahim et al (2010a) summarize current issues in games and gender research into the following six categories: (1) how different gender competes and their style of conflict resolution; (2) how each gender responds to stimulation; (3) how each gender views rewards in games; (4) which genre and game content each gender prefers; (5) what kind of play environment each gender prefers; and (6) what kind of design features each gender prefers.

The results of previous research were relevant and yet somewhat inconclusive. Most previous research in gender, games and design only focuses on finding out how each gender plays and what their preferences are in games. It is conducted on a specific content with specific player under specific conditions and thus a lack
of coherence – no integrative framework in which gender-inclusivity can be interpreted or applied. The questions that arise from this situation are: (1) what are the components of gender-inclusivity in games and, (2) how to define gender-inclusivity in games.

This paper is organized into 4 sections: (1) brief discussion of the domain research areas; (2) how findings from the domain research areas were aligned, reclassified and synthesized into dimensions and components relevant to gender inclusivity in games; and (3) describes the proposed conceptual framework; and (4) reflection and conclusions from this research.

2. IDENTIFY DOMAIN AREA AND LIST UNIQUE COMPONENTS

The first step is to identify the content area that relates to the concept of interest (Gable & Wolfe 1993; Waltz & Bausell 1981). Lynn (1986) recommends that a comprehensive literature review helps in identifying all the dimensions related to the content domain. Related work pertaining to games and gender was reviewed using the ACM Digital Library, ERIC, PsychARTICLES and Google Scholar. Keywords for the search included gender AND video or computer or digital AND games. The review was limited to English research articles, conference proceedings and frequently cited books. The following sections, present our review of related works and the resulting analysis which led to our proposed categorization of synthesized themes and components.

2.1 Game Models

A total of 14 game models were analysed and a synthesized list consisting of 4 themes were produced: (a) gameplay, (b) aesthetics, (c) narrative, and (d) interaction. In each theme, a set of components were identified and sorted into the theme that best describe it. The combination of these individual components in turn characterizes the theme as a whole. Table 2 shows the main themes and components used to categorize the related work in game models. The first theme gameplay consists of 8 components that can be used to create a play experience for game players. Next, 4 components were grouped under the aesthetics theme to describe visual and auditory stimuli in a game. Thirdly, a narrative theme with 3 components can be used to provide a story in a game. Finally, 4 components were grouped under interaction theme that generally allows a player to interact or play the game. As can be seen in Table 2, the majority of components belong to the gameplay theme with 8 items while aesthetics and interaction consists of 4 components each and finally narrative theme has 3 components. The degree of how each component is used during design depends on the type of game to be produced. For example games like Tetris or Pacman would not require realistic graphics or a wide range of avatars from which to select. On the other hand, games like the Prince of Persia, Assassins Creed and Ratatouille would require a rich game world with a variety of objects, NPC (non-playing characters) and scenes.

2.2 Games and Gender

Ibrahim et al (2010) identified 6 categories of issues concerning gender in games and further analysis produced a synthesized list with 4 themes: (a) gameplay experience, (b) games content, (c) play environment, and (d) design choices. In each theme, a set of components were identified and sorted into the theme that best describe it. The combination of these individual components in turn characterizes the theme as a whole. Table 3 summarizes the main themes and components used to categorize the related work in games and gender research. The first theme gameplay experience consists of 5 components that used to describe how a player experiences the game. Next, 3 components were grouped under the game content theme to describe the story, avatar and the game setting. Thirdly, play environment theme has 2 components to represent the different types of game environment such as competitive or collaborative. Finally, 3 components were grouped under design choices theme that describe how a game manage its reward and penalty system, the level of personalization it allows and the different types of activities available in a game. As can be seen in Table 3, the majority of components belong to the gameplay experience theme with 5 items while game content and design choices consist of 3 components each and finally play environment theme has 2 components.
Table 2. Shows a synthesized list of themes and core components derived from game models research. The list consists of 4 themes with a total of 19 components

<table>
<thead>
<tr>
<th>Themes</th>
<th>Components</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gameplay</strong></td>
<td>• Goals/Objectives</td>
<td>Crawford, 1982, 2003</td>
</tr>
<tr>
<td></td>
<td>• Conflict</td>
<td>Costikyan, 1994</td>
</tr>
<tr>
<td></td>
<td>• Challenge</td>
<td>Rollings &amp; Adams, 2003</td>
</tr>
<tr>
<td></td>
<td>• Fun/Play</td>
<td>Hunicke et al., 2001</td>
</tr>
<tr>
<td></td>
<td>• Rules/Patterns</td>
<td>Kreimeier, 2002</td>
</tr>
<tr>
<td></td>
<td>• Winning/Outcomes</td>
<td>Bjork, Lundgren &amp; Holopainen,</td>
</tr>
<tr>
<td></td>
<td>• Safety</td>
<td>2002</td>
</tr>
<tr>
<td></td>
<td>• Balance</td>
<td></td>
</tr>
<tr>
<td><strong>Aesthetics</strong></td>
<td>• Theme</td>
<td>Hunicke et al., 2001</td>
</tr>
<tr>
<td></td>
<td>• Game world</td>
<td>Fullerton et al., 2004</td>
</tr>
<tr>
<td></td>
<td>• Visual stimuli</td>
<td>Rollings &amp; Morris, 2004</td>
</tr>
<tr>
<td></td>
<td>• Auditory stimuli</td>
<td></td>
</tr>
<tr>
<td><strong>Narrative</strong></td>
<td>• Backstory</td>
<td>Hunicke et al., 2001</td>
</tr>
<tr>
<td></td>
<td>• Plot</td>
<td>Fullerton et al., 2004</td>
</tr>
<tr>
<td></td>
<td>• Storytelling</td>
<td>Rollings &amp; Adams, 2003</td>
</tr>
<tr>
<td><strong>Interaction</strong></td>
<td>• Functionality</td>
<td>Crawford, 1982, 2003</td>
</tr>
<tr>
<td></td>
<td>• Interface Style</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Navigation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Character Controls</td>
<td></td>
</tr>
<tr>
<td>4 themes</td>
<td>19 components</td>
<td></td>
</tr>
</tbody>
</table>

Table 3. showing a synthesized list of themes and components derived from gender and games research area. The list consists of 4 themes with a total of 14 components

<table>
<thead>
<tr>
<th>Themes</th>
<th>Components</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gameplay experience</strong></td>
<td>• Conflict resolution</td>
<td>Lewis, 1998</td>
</tr>
<tr>
<td></td>
<td>• Risk-taking</td>
<td>Good and Medina, 2000</td>
</tr>
<tr>
<td></td>
<td>• Stimulation</td>
<td>Miller et al., 1996</td>
</tr>
<tr>
<td></td>
<td>• Learning/Feedback</td>
<td>Carr, 2005</td>
</tr>
<tr>
<td></td>
<td>• Rewards</td>
<td></td>
</tr>
<tr>
<td><strong>Game content</strong></td>
<td>• Story/plot</td>
<td>Roberts et al., 1999</td>
</tr>
<tr>
<td></td>
<td>• Game world</td>
<td>Bonanno and Kammers, 2005</td>
</tr>
<tr>
<td></td>
<td>• Characters</td>
<td>Pratchett, 2005</td>
</tr>
<tr>
<td></td>
<td>• Subrahmanyam and Greenfield, 1998</td>
<td></td>
</tr>
<tr>
<td><strong>Play environment</strong></td>
<td>• Collaborative or competitive</td>
<td>Bryce and Rutter, 2005</td>
</tr>
<tr>
<td></td>
<td>• Contemplative or action</td>
<td>Jenkins, 1998</td>
</tr>
<tr>
<td></td>
<td>• Type of activity</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Flexibility</td>
<td></td>
</tr>
<tr>
<td><strong>Design choices</strong></td>
<td>• Failure management</td>
<td>Kafai, 1998</td>
</tr>
<tr>
<td></td>
<td>• Type of activity</td>
<td>Miller et al., 1996</td>
</tr>
<tr>
<td></td>
<td>• Flexibility</td>
<td>Flanagan, 2005</td>
</tr>
<tr>
<td>4 themes</td>
<td>14 components</td>
<td></td>
</tr>
</tbody>
</table>

3. GROUP COMPONENTS WITH SIMILAR THEMES

Next, the two component lists produced in the previous section were merged and an initial alignment was conducted to discover any patterns between the 8 themes. It was discovered that some similarities in the meanings of the word even though the terms used were different. In this instance, the term gameplay experience and gameplay represent gameplay. Similarly the term aesthetics and game content represent content objects or artefacts. These two themes were reclassified as gameplay dimension and content dimension respectively for simplicity. Genre was placed into a dimension of its own as it will be used as a
categorization of games. Next, the remaining 4 themes and its’ components will be analysed based on its relevance towards gender inclusivity in games.

An initial analysis identified some components have a direct mapping between the two domain research areas, more importantly however; the inclusion or exclusion of a component depends on its relevance to gender-inclusivity. As an example, the components goals/objectives and challenge (from Gameplay theme in Table 2). Defining a goal/objective in any game is the first task to achieve before any development can be done. It is a neutral element which all games must have. However, the element of challenge has a gendered inclination which is informed by findings from research in gender and games. Male players prefer a challenge that comes from its avatar’s increased physical abilities such as an increase in power to kick or punch to fight bigger and stronger opponents. On the other hand, female players prefer a challenge that comes from solving puzzles such as reassembling an object to reveal a hidden message. Hence, the inclusion or exclusion of a potential component depends on a component’s relevancy to gender-inclusivity in games. Following the application of this criterion 8 components were excluded as follows: goals/objectives; fun/play; rules/patterns; balance; functionality; interface style; navigation; and character controls. Not only these 8 components show no supporting evidence towards gender inclusivity in games, they were also identified as more of a technical/programming and/or neutral factor which all games must have.

The remaining 25 components were examined and synthesized by determining whether each of the component falls into any of these three categories:

i. **Unique component**, a component that can only be found either in game models list components or game and gender list components.

ii. **Direct mapping component**, a component that can be found in both game models and game and gender list components.

iii. **Combination component**, two or more components were combined to best represent the meaning of the component.

Following the 3 criteria listed above, 7 components were found to be unique components while 17 components were combined to form a new component depending on whether individual components have similar meaning and/or more suitable as a part of a bigger component. Lastly, all 14 synthesized components were sorted into one of the 3 dimensions that represent them best. Gameplay dimension consists of 9 components while content dimension has 5 components. At this stage, the alignment process has now produced a synthesized list with 3 dimensions and 14 components as potential dimensions and components for inclusion in the proposed framework. Next, the synthesized dimensions and components were reclassified in light of gender inclusivity in games. From the previous section the alignment process produced 3 dimensions and 14 components. On further analysis, two components i.e. competition and conflict resolution were combined as both represent some form of action in a game. Similarly, gameworld and visual stimulation were combined as both of these components describe a game’s graphics. Eleven components were renamed and given new labels to better represent the components of gender inclusivity in games.

### 4. CONS TRUCT THE GENDER-INCLUSIVITY FRAMEWORK GIF)

A framework such as the Gender Inclusivity Framework (GIF) allows the conceptualization, development and assessment of more gender inclusive games. Drawing upon established theories and prior research findings, the proposed framework suggests that gender inclusivity in games can be determined by 3 dimensions and 12 components. Each dimension in the framework is divided into individual components that can be modified or further investigated in future studies. The components describe the dimension in terms that can be measured and evaluated in empirical studies. Hence, the combination of dimensions and components used to construct the framework provide the description of gender-inclusivity in games, which in turn is expected to predict the actual degree of gender-inclusiveness in games. A diagrammatic representation (see Figure 1) and description of the aforementioned dimensions and components are as follows.

The **Gameplay** dimension investigates a player’s perception on the level of gender inclusive gameplay of a game and has 8 components. **Nonviolent Action (NVA)** component investigates the level of non-violent competitive and conflict resolution actions in a game including collaboration with an enemy by invading, exchanging gift or doing a favour. **Game support (GS)** component represents the extent of in-game
supporting features e.g. backstory, tutorial or demo in a game. **Forgiving gameplay (FG)** component represents the extent of game continuity allowed after a wrong choice during gameplay in a game such as saving multiple game scenarios or showing hints. **Non-violent challenge (NVC)** component examines the level of the non-violent challenges during gameplay such as solving puzzles or resource management. **Variety of activities (ACT)** component represents the extent of different types of activities within a game including solving a problem with a variety of solution or a combination of activities work together towards solving a bigger goal. **Feedback system (FEED)** component addresses the extent of assertion non-violent feedback in a game including using sounds and giving feedback in a positive tone. **Personalization (PER)** component investigates game personalization in terms of game speed, play pace and difficulty level in a game. **Collaboration (COLL)** component addresses the level of support available for collaborative play with other players including connection to chat room, social networking websites and/or an email.

The **Content** dimension investigates a player’s perception on the level of gender inclusive content of a game and has 4 components. The **Avatar portrayal (AVP)** component deals with an avatar’s portrayal in terms of appearance, behaviour, avatar modification and gender selection in a game. **Gameworld graphics (GW)** component addresses the level of graphics realism, colours shades and variability of scenes in a game. **Sound/music (SM)** component deals with the level of customization available in terms of music styles and volume control during gameplay. **Storyline (STOR)** component examines the extent a story is interwoven into a game through compelling plot and characterization.

Finally, the **Genre** dimension represents game categories and a total of 12 genres were identified i.e. racing, simulation classic/board, strategy, sport, shooting, role playing game (RPG), platform, children, puzzle/quiz, action and adventure.

<table>
<thead>
<tr>
<th>GENRE</th>
<th>Children</th>
<th>RPG</th>
<th>Sports</th>
<th>Simulation</th>
<th>Strategy</th>
<th>Adventure</th>
<th>Classic/board</th>
<th>Educational</th>
<th>Racing</th>
<th>Shooting</th>
<th>Puzzles/quizzes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Action</td>
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<tr>
<td>Simulation</td>
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<tr>
<td>Educational</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>GAMEPLAY</th>
<th>CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-violent action (NVA)</td>
<td>Avatar portrayal (AVP)</td>
</tr>
<tr>
<td>Game support (GS)</td>
<td>Gameworld graphics (GW)</td>
</tr>
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<td>Non-violent challenge (NVC)</td>
<td>Storyline (STOR)</td>
</tr>
<tr>
<td>Feedback system (FEED)</td>
<td></td>
</tr>
<tr>
<td>Variety of activities (ACT)</td>
<td></td>
</tr>
<tr>
<td>Personalization (PER)</td>
<td></td>
</tr>
<tr>
<td>Collaboration (COLL)</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1. The diagram represents the structure of the framework. Each dimension is shown at the top of each box. Components related to each dimension are listed in the box.

5. DISCUSSIONS AND CONCLUSIONS

This paper identified the relationships between the themes, dimensions and components that affect the degree of gender inclusiveness in games. It also demonstrates the development process an integrative conceptual framework, **Gender-Inclusivity Framework (GIF)**, which is synthesized from the results of related research in games and gender. The first section identified the two major domain areas for this research: (a) games models, and (b) games and gender. Eleven game models were analysed, categorized and synthesized into a list consisting of 4 themes and 19 core components. Findings from this area can help towards a better understanding of how games are made, what goes into the process and what considerations were made during design and development. The next section looked into how gender is related to games research. The findings from this research area were analysed, categorized and synthesized into a list of 4 themes with 13 core components. There were 6 categories of issues concerning gender and games. These findings were focused on investigating each gender differences and preferences in a gameplay and content. Findings from these two domain areas: (a) game models, and (b) games and gender, were synthesized into two lists of unique themes.
and components corresponding to the two domain areas. These lists were used as the theoretical foundation in the construction of the proposed Gender Inclusivity Framework (GIF). The proposed framework serves as an integrative conceptual framework that aims to help understand, define and measure gender-inclusivity in games by providing a generic structure to support gender-inclusivity in games, which in turn is expected to predict the level of gender inclusiveness in games.

The contribution of this paper is that it integrates the relevant games and gender research in order to enhance the knowledge of gender-inclusivity in games and consequently provides clear directions for future research. It evaluates various issues relating to gender-inclusivity in current games. Secondly, it assimilates previous research findings in order to develop a coherent picture of the games and gender research. Next, this paper introduces a conceptual framework that integrates components from different research areas to study gender-inclusivity in games. Finally, it serves as a guideline for future research to test and validate the conceptual framework for gender-inclusivity in games. In order to test the underlying assumptions that can verify the conceptual framework’s future work includes: (1) to develop suitable items associated with each component; (2) to select and develop and reliable data collection tools and conduct pilot research; (3) to select appropriate sampling frame for the target population; (4) to determine the sample size and generate random numbers; and finally (5) to collect and analyze empirical data collected from the respondents. Completion of the aforementioned future work will lead to refinement and validation of the proposed framework of gender-inclusivity in games.

REFERENCES


AM I THE FASTEST CHARACTER TO POINT (X, Y)?
GETTING A QUICK AND PRECISE ANSWER

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ABSTRACT
In order to bring more realism in computer games, physics based movement of the game characters is the desirable option. Thus we propose an improved algorithm for moving a human-like character as the laws of mechanics permit. In order to reduce the computational complexity, we use somewhat simplified physics still keeping the main peculiarities intact. By optimizing the character dash force, we minimize time to reach the destination point. This allows reaching the point significantly faster than by using the widely used direct pursuit. The new method is equally applicable to for guiding the character on the trajectory and assessing the situation with the purpose of optimized decision making. Compared to the direct pursuit, the new method demonstrates noticeably higher performance in the area close to the character. Thus it could be especially useful for the calculations in the pursuit-and-evasion video games.

KEYWORDS
Video game, RoboCup, pursuit-and-evasion, direct pursuit, optimization, tri-linear interpolation.

1. INTRODUCTION

Many video games create a virtual environment populated by so-called non-player characters (NPCs) driven by artificial intelligence. They are agents acting on their own while interacting with game characters controlled by human players. We focus mainly on sports and pursuit/evasion video games where reaching given destination by a NPC is a frequent action. As game industry evolves, it is safe to assume that the demand for more realism in video games is growing. Realism entails that game developers need to know how to make a NPC moving realistically, by following the laws of mechanics rather than just creating the illusion of true motion. Moreover, making rational decisions about reaching given destination in the shortest time also appears to be important consideration.

The objective of this paper is to develop a near-optimal algorithm for reaching point (x, y) on the plane by a human-like NPC in the fastest possible way. This problem becomes non-trivial when the NPC’s dynamics are taken into the consideration. The especially difficult case is when the character is running with rather high speed $V_P$ and a need emerges to approach some point $A$ that is lying far apart from the character’s path but is still rather close to this NPC as shown in Figure 1.

Calculation the (near-)optimal character trajectory in video games is done with two different purposes: (1) guiding the character to the destination point and (2) estimating time to reach multiple points by (possibly many) characters. In the soccer game, the second task may be performed in order to make optimal higher-level decision such as intercepting ball (Stone, McAllester, 2001) or rendering oneself for receiving a pass (Kyrylov, Razykov, 2008). The two tasks have different requirements of the algorithms. In particular, for task 1 optimality is more important while for task 2 keeping the computational complexity at bay is critical.

This has been investigated in regards the ball interception problem in the robotic soccer (RoboCup). The problem boils down to calculating time to reach a set of trial interception points located on the ball trajectory and determining the point where the ball and the player arrive simultaneously. In other words, the problem to reach a fixed point $A$ in Figure 1 that we investigate here is the key part of higher-level behaviors such ball interception or player positioning on the field.

By exploring the publications of the RoboCup research symposia and robotic soccer team descriptions (Stone, McAllester, 2001; Stolzenburg et al. 2004; Gabel, Riedmiller, 2006; Kyrylov, Razykov, 2008), one can conclude that by far most robotic soccer teams were relying on the naive ball interception method known
in the literature on the optimal control of guided missiles as the direct pursuit (Ben-Asher, 2010; Palumbo et al., 2010). This method requires the player dashing towards the current location of the moving ball at any given time on the interception path. Attempted improvements to this method made in the RoboCup community are heavily relying on the specifics of robotic soccer simulation, such as rather long simulation step (100 ms) when the discrete nature of the simulation is apparent. On the other hand, little could be said about similar research in the video game developer community; by far, we could not find any academic publications on this subject.

The advantage of the direct pursuit method is the simplicity because time complexity is $O(N)$ where $N$ is the number of simulation steps to reach a fixed target. However, this guidance law, if applied to human-like character, has apparent performance flaws. In what follows, we demonstrate that this method could be substantially improved.

![Figure 1. Time-to-reach geometry](image1)

![Figure 2. The generic algorithm for calculating time to reach point A](image2)

**Figure 1.** Time-to-reach geometry

**Figure 2.** The generic algorithm for calculating time to reach point $A$

### 2. CHARACTER MECHANICS MODEL

Figure 1 illustrates the time-to-reach geometry in 2D. We assume that a human-like non-player character is located in the origin. His initial velocity vector is aligned with x-axis and has absolute value $V_P$. Character reaches point $A$ if the distance becomes less than the radius $r$.

Thus we are interested in determining the following function:

$$t_r = \text{Time}(x_A, y_A, V_P),$$

where $t_r$ is time to reach point $A$ in the (near-) optimal way. We want to derive a fast algorithm for calculating this function. We also want to know the character (near-) optimal guidance law on his trajectory.

To make this problem tractable, we make a set of assumptions about the character physics:

1. the model is two-dimensional; character can only move on xy-plane
2. at any time, the character can apply a dashing force in any direction
3. the linear dynamics are governed by a second-order model (described below)
4. character always aligns his body with his velocity vector (this entails some body rotation on turns)
5. character does not make turns other than as the result of applying dashing force to his body
6. the angular momentum is modeled by setting the maximal limit $\Omega_{max}$ on the angular velocity when the character is turning
7. the rotation friction damps the angular velocity to zero in one simulation step if no turn is being made.

Thus we do not consider turning the character body as a standalone action. At each time instant, character can only choose his dash force vector, i.e. its direction and magnitude. Because the body direction shadows the velocity vector, this parameter is unnecessary.
In what follows, we use the discrete-time representation with time increment $\Delta t$. Character linear motion is determined by his inertia, friction, and dash force. For the acceleration $\ddot{a}_{it}$, velocity $\dot{V}_{it}$, and position $\vec{P}_{it}$, we have the following second-order system:

$$\ddot{a}_{it} = k_1 \dot{F}_i - k_2 \dot{V}_i,$$  \hspace{1cm} (2)

$$\dot{V}_{it} = \dot{V}_i + \ddot{a}_{it} \Delta t,$$  \hspace{1cm} (3)

$$\vec{P}_{it} = \vec{P}_i + \dot{V}_{it} \Delta t.$$

where $\dot{F}_i$ is the dash force vector and $k_1, k_2$ are the coefficients explained below.

Coefficient $k_1$ determines the ability of character to accelerate given his maximal attainable speed $V_{\text{max}}$, time $T_{\text{max}}$ to reach the benchmark speed $(1-e^{-1})V_{\text{max}}$, and the maximal dash force $F_{\text{max}}$:

$$k_1 = \frac{V_{\text{max}} \Delta t^2}{(T_{\text{max}} F_{\text{max}})}.$$  \hspace{1cm} (5)

Coefficient $k_2$ determines the character linear deceleration due to friction:

$$k_2 = k_1 F_{\text{max}} / (V_{\text{max}} \Delta t).$$  \hspace{1cm} (6)

Character body angular movement could be also described by similar model. However, humans can start and stop turning almost instantly and there is the apparent upper limit for the body angular speed; it takes one second or so for a human to turn around. So we did not find much advantage in using a second-order model and hence made assumptions 4-7. Thus we eliminated from our model the character facing direction and angular momentum. Instead we set the maximal limit $\Omega_{\text{max}}$ that subtly restricts the character angular speed in equation (3) whenever the acceleration is not collinear to the velocity. In a nutshell, we treat the character as a material point. Yet this ‘point’ has a surrogate momentum of inertia that only kicks in at rather low linear speed preventing character from making too quick turns.

3. REACHING POINT $(X, Y)$ AS AN OPTIMAL CONTROL PROBLEM

The straightforward algorithm for integrating the discrete equations (2)-(6) is shown in Figure 2. This algorithm returns the time to reach point $A$ measured in the number of simulation steps $n$.

The character guidance law is the sequence of the dash force vector $\{ \dot{F}_i \}$, $i=0,1,...,n$ such that

$$|\vec{P}_{it} - \vec{P}_A| < r.$$  \hspace{1cm} (7)

The optimal interception occurs when the number of steps $n$ is minimal. The simplest, yet suboptimal, solution is persistently applying the maximal dash force in the direction of point $A$. This method is referred to as direct pursuit; we are going to use it as a benchmark to measure the improvement of our method and compare the computational complexity. The direct pursuit could be implemented by integrating the discrete equations (2)-(6) with the dash force recalculated at each step on Line 06 in Figure 2 using the algorithm whose time complexity is $O(1)$. Line 01 in this case does nothing. Thus the complexity of the direct pursuit method is $O(n)$.

The moving target interception problem has been addressed in the optimal control theory with the application to guided missiles. Closed-form solutions have been found, yet for substantially simplified problem formulations (Spitz, 1946). More general cases of this problem have been also solved (Ben-Asher, 2010; Palumbo et al, 2010). Still the optimality criterion used in these cases was the missile-target distance at the interception point rather than the interception time that we want to minimize. Moreover, missile dynamics in these studies were not considered; some assumptions are made that are hardly applicable in our case. Typically it is assumed that at the initial small part of its trajectory the missile first makes a standard maneuver to attain favorite position for the interception. Then the derived optimal guidance law could be applied to keep the missile on the collision kinematic trajectory.

Unfortunately, these results do not fully apply to controlling human-like character. The major difficulty is that we are interested in cases when character has no time for making the initial standard maneuver like the
missile; character frequently has to run along the whole interception trajectory in the transient mode. In soccer, straight-line trajectory mainly takes place at distances more than 10 meters; still we want to optimize character motion at closer distances which is especially important in pursuit-and-evasion situations. Thus we need to develop a new method for finding the optimal control sequence \( \{ \vec{F}_i \} \) that kicks in from the first step on the character trajectory skipping the preliminary maneuver.

Using the complete search is the trivial option. Let on each step \( i \), there are \( p \) possible discrete values of the dash force magnitude \( F_i \) and \( q \) values of its direction \( \gamma_i \). With \( n \) steps, there are \( N=(pq)^n \) combinations of \( 2n \) parameters to choose from. To find the best sequence of the dash force vectors, with brute force approach, we have to compare all these \( N \) possibilities. In Figure 2, it is meant that these calculations should be done on Line 01. This is impractical, as the computational complexity is \( O(e^n) \). Without further simplifications, determining the optimal guidance law for human-like character remains a computationally hard problem. Some improvement to our grim complexity estimate is possible by using, for example, the dynamic programming method. Still we would speculate that this would likely result in the complexity that is anyway unacceptable for real-time calculations.

We consider two heuristic varieties of the generic method for guiding the character towards a fixed point on xy-plane:
1. Direct pursuit when character steadily applies maximal dash force towards the fixed target point.
2. A turn followed by a nearly straight run towards given point. Line 01 is used for pre-calculating the optimal turn parameters.

We are going to use the first method as the benchmark solution to measure the improvement in the second method.

4. THE NEAR-OPTIMAL GUIDANCE LAW FOR REACHING A FIXED POINT

For the purpose of illustration, we are using a software program with reasonably small simulation step \( \Delta t \). This allows in most cases neglecting the discrete nature of the simulation and treat processes as continuous. Character parameters are shown in Table 1. With these settings, character can run 100 meters in 12 seconds which is noticeably worse than for the world’s best sprinters (~9.6 s) but is still very good even for physically fit men. While standing still, character can turn around by 180 degrees in half second by applying just a near-zero dashing force in the desired direction. The dash force magnitude does not matter in this case; only the maximal angular speed \( \Omega_{\text{max}} \) is the constraining factor. At a speed greater than ~2 m/s, the turning rate is constrained by the linear momentum; the faster character is running, the slower he can change his direction. At the maximal speed, the rate of change is ~5 degrees per simulation step, i.e. 100 degrees per second.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>( \Delta t )</th>
<th>( V_{\text{max}} )</th>
<th>( T_{\text{max}} )</th>
<th>( F_{\text{max}} )</th>
<th>( \Omega_{\text{max}} )</th>
<th>( r )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>0.05 s</td>
<td>9.0 m/s</td>
<td>1.0 s</td>
<td>100</td>
<td>360°/s</td>
<td>0.75 m</td>
</tr>
</tbody>
</table>

We have found that the direct pursuit may result in the anomalies like shown in Figure 3. Note that the final parts of trajectories 2, 3, and 4 leave substantial room for improvement.

The improved method has only two parameters: the threshold angle \( \alpha \) and the relative to character body dash force direction \( \gamma \) both optimized for each target point (Line 01 in Figure 2). The character trajectory has two phases. First the maximal dash force having fixed direction \( \gamma \) relative to the character velocity vector turns character towards the target and moves closer to it. The second phase kicks in once the mismatch of the velocity vector and the direction to target becomes less than \( \alpha \). Then character switches to the direct pursuit.

This appears to be similar to what guided missiles do; the major difference, however, is in that the first maneuver made by character is not standard; rather, it is optimized for given initial state. One more difference is that the initial maneuver of a missile typically takes a small fraction of its trajectory while in our case this maneuver can last along the substantial part of the character path to the destination point.

The relative dash force direction \( \gamma \) has the critical impact on the interception time. This direction is a nonlinear function of the character initial speed and the target xy-coordinates. To find this optimum, we first
used straightforward search of the best $\gamma$ for given target point which requires $O(n^2)$ steps. This is done on Line 01 in Figure 2.

In order to measure the degree of optimality of the proposed method, we attempted to use several independent optimized values of the dash force angles on different trajectory segments. This substantially slowed down the calculations but did not result in significant time to reach gain though. In other words, the single optimization parameter $\gamma$ is responsible for the lion’s share of the time gain as compared to direct pursuit. Adding more parameters does not add much. Therefore, we refer to the proposed method as near-optimal.

Optimized character trajectories for the same target points as in Figure 3 are shown in Figure 4. Each trajectory is using its own fixed relative dash force angle $\gamma$ and same threshold $\alpha$. The trajectories near the target point are almost straight; this resulted in the substantial reduction of the time to reach. We have found that the threshold $\alpha$ is not critical and should be kept in the range between 10 and 25 degrees. Still the direct pursuit works a little better for the trajectories like 5, 6, and 7. This could be mitigated by increasing $\alpha$ up to 60 degrees for the initial target-velocity direction angles exceeding ~100 degrees.

![Figure 3. Direct pursuit trajectories for character having maximal initial speed](image1)

![Figure 4. Optimized trajectories for character having maximal initial speed](image2)

Obviously using the exhaustive search for determining the optimal dash force direction $\gamma$ having the complexity $O(n^2)$ is impractical. After some experiments, we found reasonably good and simple approximation for this parameter. The optimal relative angle $\gamma$ proved to be practically independent of the character initial speed:

$$\gamma = a \ln(b \beta / d),$$

where $a$ and $b$ are the adjustable coefficients, and $\beta$ and $d$ are the polar coordinates of the target point $A$ (Figure 1).

### 5. APPROXIMATING THE TIME-TO-REACH FUNCTION

Still even with good and simple approximation of the dash force parameter $\gamma$ trajectory calculations are time consuming and cannot be used in video games if they are massive. Thus we want to find good approximation for the time to reach as a function of the three parameters $\{x_A, y_A, V_P\}$ (Figure 1). In doing so, we use a grid of the pre-calculated time-to-reach values and the tri-linear interpolation between the grid points.

To simplify calculations when we need to retrieve the pre-calculated data, we used the regular grid. The approximation errors are maximal near the places where the time-to-reach function is discontinuous; these places can be seen in Figures 5, 6.

Thus the grid density is determined by what is observed in the vicinity of the character where this discontinuity is present. To reduce the total number of points, we use three equidistant rectangular grids of the increasing size on $xy$-plane. The grid ranges measured in meters are $[-2 < x < 5.25, 0 < y < 4.75]$, $[-15 < x < 15, 0 < y < 15]$, and $[-45 < x < 45, 0 < y < 45]$. (What is shown in Fig. 6, is contained in the first grid.). For the third parameter, player initial speed $V_P$, it is sufficient to have only four discrete values in the range $0 < V_P < 9$. 

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The first grid contains 1800 points, the second and the third have 480 points each. With less than 3000 pre-calculated points in the look-up tables, using the tri-linear interpolation resulted in the mean square error less than 40 ms in the first grid and less than 20 ms in the rest two.

Figure 5. The near-optimal time to reach by character having maximal initial speed

Figure 6. The near-optimal time to reach in the vicinity of the character

Figures 7 and 8 show the apparent difference between the direct pursuit and the proposed near-optimal method. While in direct pursuit the dash force is persistently directed to the destination point, in the proposed method the dash force maintains a constant angle $\gamma$ with the velocity vector until the character turns towards the destination point. This angle is different for different destinations; while for the top trajectory in Figure 8 it is about 105 degrees, for the bottom trajectory the near-optimal angle is about 125 degrees.

Figure 7. Direct pursuit trajectories with the velocity and dash force vector displayed

Figure 8. Optimized trajectories with the velocity and dash force vector displayed

Because calculation of the optimal turn angle $\gamma$ using (8) has only $O(1)$ complexity, we have moved this calculation inside the loop (Lines 03-09 in Fig 2) without significantly slowing down calculations. This resulted in reducing time to reach by some 5 per cent. We explain this effect by the accumulation of errors
due to the discrete time; by recalculating the turn angle on each step, this error is eliminated. The computational overhead could be mitigated by allowing these recalculations not on each step.

Figure 9 displays the area where the proposed method is better than the direct pursuit by at least one simulation step (50 ms) when the character has the maximal speed.

Table 2 shows the performance indicators estimated on 10000 points uniformly distributed in 15 m radius when the character had the maximal initial speed 9 m/s.

Table 2. Algorithms comparison in 15 m radius for the character speed 9 m/s

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Average time in steps</th>
<th>Proportion when better</th>
<th>Average lost time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct pursuit</td>
<td>53</td>
<td>42.3%</td>
<td>22.5%</td>
</tr>
<tr>
<td>Near-optimal</td>
<td>44</td>
<td>57.7%</td>
<td>2.7%</td>
</tr>
</tbody>
</table>

On the average, the proposed method is faster by 11 steps (550 ms). Still in 42.3 per cent cases the proposed method takes same or greater time to reach the destination than the direct pursuit; this results in 2.7 per cent average lost time, or about 1.2 simulation steps. We explain this loss by the imperfect approximation used in expression (8). Still in 57.7 per cent of cases the proposed method in terms of time is better by 22.5 per cent than the direct pursuit. In game situation, this may make a difference between winning and losing the game. If in the initial position the character is standing still, the difference between these algorithms is nonexistent. As the initial speed increases, the advantage of the proposed methods becomes apparent. The maximal gain is achieved at the maximal speed.

Figure 9. The two methods compared in 10000 points placed in 30 m radius about the character position. The purple area is where the near-optimal method is better than the direct pursuit.

Thus we see that with the same computational complexity of both algorithms, the proposed optimized version exhibits substantial better time to reach a fixed destination point.

6. CONCLUSION

By using several simplifications to the apparently unsolvable character trajectory optimization problem, we have proposed an engineering solution. This solution is noticeably superior over the widely used direct pursuit method in terms of the time to reach a fixed point. This is especially apparent when the human-like character has high initial speed. With the maximal speed, the proposed method is better than the direct pursuit in 57.7 per cent cases in the 10 meter radius yielding average time gain 550 ms. The advantage of the direct pursuit in the rest 42.3 per cent cases is still negligible and can be explained by the imperfect approximation.

The essence of the new method is using by a human-like character the constant (relative to the body aligned with the velocity vector) optimal turning dash force until it is possible to switch to the direct run towards the destination point. By using simple approximation, we achieved the complexity of calculating the
near-optimal dash force $O(1)$. This method can be used for guiding the character towards the destination point substantially faster than by using the direct pursuit method. Recalculation of the dashing force as the character is running towards the destination may slightly improve time to reach without deteriorating the computation time.

Because adding more optimization parameters to the proposed algorithm did not result in noticeable improvement, we refer to the proposed method as near-optimal.

Estimating time to reach multiple destinations is necessary for solving higher-level problem such as optimal decision making by the intelligent non-player characters in evasion-and-pursuit games. Whenever these massive calculations are needed, we propose using a lookup table with the pre-calculated set of time-to-reach values for a regular grid in the three-dimensional space ($x$, $y$, $V_p$). We apply tri-linear interpolation to calculate time to reach in between the grid points. In the video games, this lookup table can be calculated in the pre-game mode or retrieved from the permanent storage. The storage memory size must be about 10KB which is negligible.

We see the significance of our work in that our method allows characters in video games exhibiting more realistic movement governed by the laws of physics rather than creating the illusion of such movement based on heuristics which is commonly done by game developers. Our results are general enough for being applicable in different video games populated by characters having human like physical characteristics. Compared to the direct pursuit, the new method demonstrates higher performance, especially in the area close to the character when he is running with rather high speed. Therefore, the proposed method could be especially useful for the calculations in the pursuit-and-evasion games.

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AVOL – AUDIOVISUAL ONLINE:
PLAYING WITH INTERACTIVE SOUND VISUALIZATION

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ABSTRACT

AVOL (AudioVisual OnLine) is an interactive audiovisual project for the Web, installation and performance by Video Jack (a collective composed of the author and André Carrilho). AVOL was one of the four winners of a competition by the Portuguese Ministry of Culture to develop artworks for their net art portal. Further to the launch of this portal, AVOL has been presented as installation and as performance. In AVOL, users manipulate seven “objects” composed of different elements: a sound loop; an animated visualization of that sound; and graphical user interface elements that facilitate the integrated manipulation of sound and image. Each of the objects has four main variations, allowing for multiple audiovisual combinations. The objects may interact with each other, creating additional diversity. The main research question that the project addresses is: how to develop a project that allows for an integrated musical and visual expression, in a way that is playful to use and engaging to experience. The methodology used for the evaluation of the project is practice-based research. In this paper, the project and its motivations are presented, as well as prior work from the same authors in the field of interactive audiovisual art. A short discussion of the state of the art follows. The development of the project and the different modes of presentation (Web, installation and performance) are discussed, as well as feedback gathered. Conclusions are then reached, and possible future developments are outlined.

KEYWORDS

Sound visualization, audiovisual, animation, net art, graphical user interface, interaction design.

1. INTRODUCTION

AVOL (AudioVisual OnLine) is an interactive audiovisual project for the Web (http://www.videojackstudios.com/avol/, referenced 11/1/2011), installation and performance by Portuguese new media artists Video Jack. Video Jack are a duo composed of the author, a programmer and musician, and André Carrilho, an illustrator and animator. AVOL was released in December 2007, and further developed until 2010. It is the outcome of a competition organized by Direcção Geral das Artes (DGA, a department of the Portuguese Ministry of Culture) in order to create their Net.Art portal. AVOL was released in December 2007 (http://netarte.dgartes.pt/, referenced 11/1/2011), integrating AVOL (Figure 1.).

2. BACKGROUND, MOTIVATION AND AIMS

In January 2007, Video Jack were among the 12 Portuguese artists invited by Direcção Geral das Artes (DGA, then Instituto das Artes, a department of the Portuguese Ministry of Culture) “to submit a proposal to develop an art work conceived specifically for the Internet, for the purpose of integrating the future Net.Art Gallery of the Instituto das Artes” (translated from the original invitation letter). Video Jack submitted AVOL, which was one of the four proposals accepted for the Gallery. The DGA Net.Art Gallery was released in December 2007 (http://netarte.dgartes.pt/, referenced 11/1/2011), integrating AVOL (Figure 1.).
In 2006, Video Jack had finished their first major project, entitled *Heat Seeker* (http://www.videojackstudios.com/projects/heat-seeker/, referenced 11/1/2011). The main objective of *Heat Seeker* was "to combine animated visuals with sound in an electronic music performance (restoring a visual element that is lacking in laptop-based music performances) creating an engaging hypermediated experience for the audience" (Correia 2010, p. 244). An additional aim of *Heat Seeker* was "to make the act of manipulating the visuals apparent to the audience, similarly to how the audience views a musical instrument being played live in a performance" (Correia 2010, p. 245).

In *Heat Seeker* performances, the sound element was manipulated separately from the visual element – the software built by Video Jack allowed for visual manipulation, whereas the audio element was manipulated using commercial software (*Ableton Live*). Another distinctive aspect of *Heat Seeker* was its use of narrative animation, combined with non-narrative elements. Among the latter were “animated icons”, flexible small animations that could be manipulated by drag-and-drop, key presses or random behaviors.

Another previous work by Video Jack, *Idiot Prince* (http://www.videojackstudios.com/projects/idiot-prince/, referenced 11/1/2011), also from 2006, was influential for *AVOL*. In *Idiot Prince*, programmatic behaviors such as random movement can be added to abstract animation modules, creating overlapping patterns. The starting point for *Idiot Prince* were the “animated icons” developed for *Heat Seeker*, although in *Idiot Prince* their behavior lost the interactive aspect, depending exclusively on random behaviors. *AVOL* combines elements from both.

For the audio side of *AVOL*, the author drew inspiration from *Role-Playing Egas* (http://www.videojackstudios.com/collab/egas/, referenced 11/1/2011), a project about Egas Moniz, Portuguese winner of the Nobel Prize in Medicine. *Role-Playing Egas* (2005) was developed by the author and Portuguese artist and researcher Patrícia Gouveia. The project includes a “music box” section, with eight audio loops of equal length. There are start and stop buttons for each loop. Having the same length, they are interchangeable, allowing for the creation of multiple combinations of sounds.

For their next project, Video Jack aimed to integrate the two elements that were separate in *Heat Seeker* – audio and image – under the same application and the same interface. The call for proposals from DGA provided the trigger to develop a follow-up to *Heat Seeker*, which would be showcased on the Web instead of in performances. This provided an additional challenge – to develop an application that would be used not by Video Jack, but potentially by anyone with Internet access. With their *AVOL* proposal, Video Jack aimed to pursue their objective to integrate image and sound in the same software environment. Their main concern was to develop a project that would allow for an integrated musical and visual expression, in a way that would be playful to use and engaging to experience.

For *AVOL*, the author planned to develop the “animated icons” in *Heat Seeker* into animated elements that not only would be audio-reactive, but also would control sound. As in the “animated icons”, they would have drag-and-drop functionalities and randomization possibilities. The author entitled these elements “Interactive AudioVisual Objects” (“IAVOs”), because they would combine an interactive element - a GUI (graphical user interface) to control sound - with sound visualization, by means of audio-reactive animations.

Using *AVOL*, the user should be able to combine different sound loops, and consequentially different animation loops, creating an audiovisual composition.
The name of the project was inspired by Sergi Jordà’s work FMOL (Faust Music OnLine), “an Internet project for real-time collective composition” (Jordà 1999, p. 1).

3. STATE OF THE ART

The relation between music and image has been explored throughout the centuries. Ancient Greek philosophers, such as Aristotle and Pythagoras, considered that there was a correlation between the musical scale and the rainbow spectrum of hues (Moritz, 1997). The color to music correlation was further explored in the Renaissance by several artists, including Leonardo da Vinci, and later by Isaac Newton (Van Campen 2008, pp. 45-46).

3.1 Early-mid 20th Century

Artistic movements of the early 20th century, such as Bauhaus and the Futurists, further explored combinations of music and image. Italian Futurists Arnaldo Ginna and Bruno Corra, experimented with “color organ” projection in 1909 and painted “some nine abstract films directly on film-stock in 1911” (Moritz 1997). In the 1920s, Oskar Fischinger and Walther Ruttman created visual music films in Germany – a combination of tinted animation with live music (Moritz 1997).

When Oskar Fischinger moved to Hollywood in 1936, he became an inspiration to a younger generation of visual music artists, such as brothers John and James Whitney, who “decided to take up abstract animation after seeing a screening of Oskar’s film at the Stendhal art gallery in 1939” (Moritz 1995).

John Whitney is “widely considered ‘the father of computer graphics’” for his explorations of computer-generated manipulation of visuals through mathematical functions (Paul 2003, p. 15). He was among the first generation to use computers for the creation of artworks in the 1960s. He and his brother James were also inspired by Fischinger, and decided to take up abstract animation after seeing one of his screenings (Moritz 1995). Whitney’s work is influenced by music – “I am moved to draw parallels with music. The very next term I wish to use is ‘counterpoint’” (Youngblood 1970, p. 215). However, Whitney dismisses those who attempted to correlate color with music: “they were so hung up with parallels with music that they missed the essence of their medium”. He prefers to approach his own musical parallels more loosely: “the essential problem with my kind of graphics must resemble the creative problem of melody writing” (Youngblood 1970, p. 220).

3.2 Audiovisual Art the late 20th and Early 21st Centuries

Progress in personal computing hardware played an important role for the dissemination of digital art in the 1990s, when “affordable personal computers were powerful enough to manipulate images, render 3D models, design Web pages, edit video and mix audio with equal ease” (Tribe and Jana 2007, p. 10).

Artistic digital sound and music is a vast territory, that includes: “pure sound art (without any visual component), audiovisual installation environment and software, Internet-based projects that allow for real-time, multi-user compositions and remixes, as well as networked projects that involve public places or nomadic devices” (Paul 2003, p. 133).

These digital sound and music projects are frequently interactive, and some of them incorporate visuals: “(they) also commonly take the form of interactive installations or ‘sculptures’ that respond to different kinds of user input or translate data into sounds and visuals” (Paul 2003, p. 136).

Many of these projects that combine music and visuals digitally “stand in the tradition of kinetic light performance or the visual music of the German abstractor and painter Oskar Fischinger” (Paul 2003, p. 134).

Golan Levin is one of the artists that have explored interconnected audiovisual creative expression, in works such as Audiovisual Environment Suite (1998-2000), “an interactive software that allows for the creation and manipulation of simultaneous visuals and sound in real time” (Paul 2003, p. 133).

In 1994, Netscape released the first commercial Web browser, “signaling the Internet’s transformation (…) into a popular medium for personal communication, publishing and commerce” (Tribe and Jana 2007, p. 6). For many artists, the advent of the Internet represented the emergence of “a medium in its own right”, of a “new kind of space in which to intervene artistically” (Tribe and Jana 2007 p. 11).
Some of the projects exploring interactive music and graphical interfaces use the Web as a medium. In 1999, John Klima created Glasbead, an “online art work that enables up to 20 simultaneous participants to make music collaboratively via a colorful three-dimensional interface” (Tribe and Jana 2007, p. 54).

In 1998, Sergi Jordà created the first version of FMOL, “an Internet-based music composition system that could allow cybercomposers to participate in the creation of the music for La Fura’s next show, F@ust 3.0 (…) freely inspired by Goethe’s work” (Jordà 2005, p. 326). Like Glasbead, it allowed for online collaborative music composition.

In 2005, Sergi Jordà and his team at Universitat Pompeu Fabra created Reactable, a multi-user electro-acoustic music instrument with a tabletop tangible user interface. Reactable has dynamic visual-feedback capabilities: “a projector (...) draws dynamic animations on its surface, providing a visual feedback of the state, the activity and the main characteristics of the sounds produced by the audio synthesizer” (Kaltenbrunner et al 2006, p. 1).

In 2006, Nintendo released Electroplankton, developed by artist Toshio Iwai. Electroplankton is a collection of 10 “musical toys”, where “a playful visual style is employed to give the impression that each takes place in some sort of bizarre petri dish – or perhaps a very musical aquarium – filled with different species of plankton that can produce sound and light when you interact with them” (Davis 2006). The “plankton” entities have a simulated biological behavior, “serving as a visual and functional metaphor enabling the simultaneous generation of visuals and music” (Stockburger 2009, p. 122). Electroplankton can also be seen as a summary of Iwai’s previous work, such as Composition on the Table. According to Axel Stockburger, Electroplankton is a good example of the fusion of different roles – composer, performer and audience “converge in the playing subject” (2009, p. 122).

After Electroplankton, Iwai developed Tenori-On for Yamaha, a new kind of music instrument consisting of “a hand-held silver tablet framing a square grid of 16x16 flashing LED buttons” (Walker 2008). Tenori-On is therefore an audiovisual device, suited for performances due to its two sides: “both faces look identical, but one is played by the performer, while the other provides a miniature light show for the audience – providing a visual rendering of every sound” (Walker 2008).

4. PROJECT DEVELOPMENT

The project development was divided into four main areas: music, sound visualization, interaction design and software development.

4.1 Music

The author decided to re-use for AVOL music he had recently composed, which had a modular structure adequate to the project. These four music tracks were similar and coherent in terms of sound palette, which made them suitable for the interchangeable logic of AVOL. André Carrilho used these tracks as inspiration for the AVOL animations. The music had to be adapted in order to fit within the operational logic of AVOL. All loops were converted to the same tempo (120 beats per minute). The duration of the music loops had to be changed, since in AVOL all loops should have the same duration (16 seconds) to insure synchronization.

AVOL was developed using Adobe Flash software. One of the limitations of Flash (at the time) was that only a maximum of eight sounds could be played back simultaneously. Therefore, the author decided to divide the four music tracks into seven loops, leaving one possible extra sound to be played (a sound for object collisions was planned). As the original tracks were composed of a different number of loops, these loops had also to be regrouped.

The author aimed to group the different sound loops into coherent entities as much as possible, similarly to band members on a stage. He decided that four of the loops should be rhythmic (bass drum, snare drum, hats and clicks) and the remaining three loops should be melodic (keyboard, guitar, strings). With a few exceptions, this division was maintained across tracks. André Carrilho developed the animations taking this distribution into account.

Therefore, AVOL contains 28 sound loops – four loop permutations (corresponding to the four original songs) for each of the seven IAVOs.
4.2 Designing Sound Visualization and Reactivity

The audio reactivity in AVOL animations is based on scale. The size of the animation of each IAVO is increased when the sound amplitude of the correspondent loop becomes higher, and decreases when the sound amplitude is lower. The total variation of size is determined by the sound playback volume – a higher playback volume will result in a larger animation. Since many sound loops in AVOL contain silence, Video Jack initially faced a difficulty with this behavior – the animation would often almost disappear (whenever silence was reached), and the current playback volume was not apparent then. The solution they conceived was to separate each animation into two – one of them being audio-reactive animation, and another one not. This second animation (complemented with a circular boundary) would only scale proportionately to the sound playback volume. Therefore, it was insured that the animation as a whole would be visible even when its correspondent sound loop was silent, and that the current playback volume was always apparent.

The sounds in AVOL are stereo. Most of the animations are scaled taking into account an average of the amplitudes of the left and right channels. Animations reacting to “string” type of sounds, however, react differently to the left and right signals. Since these “string” sounds evolve slowly, and with more stereo complexity than other sounds, Video Jack found it interesting to map left and right sound channel information to the horizontal and vertical scaling of the correspondent animations.

Using the same formula, with the same parameters, for the sound reactivity behavior of all the animations would result in some animations changing much more in size than others. Some of the sounds in AVOL are softer, and have less dramatic changes in amplitude than others, resulting in an overly subtle (sometimes barely noticeable) sound reactivity behavior. To level this discrepancy, the author introduced a “sensitivity multiplier” – a number allocated to each sound loop, which would be multiplied by the number resulting from the sound analysis mechanism, when scaling an animation. This resulted in a more even sound reactivity behavior of the different animations.

4.3 Interaction Design

When users access AVOL, they are presented with a black screen containing a circular pre-loader, which resembles one of the IAVOs to be found upon entering the project. Therefore, the pre-loader is also an introduction to the aesthetics of AVOL. The pre-loader is composed of two concentric arcs, their growth representing, respectively, the loading process of one individual sound, and the number of sounds loaded.

After the pre-loader is concluded, seven small white circles appear, distributed on the black screen. Each of the circles represents an IAVO. The circles appear randomly, but distributed on a horizontal sequence. The first four correspond to the rhythmic sounds, and the last three to the melodic sounds. AVOL’s screen is resizable – when users adjust the size of the browser, AVOL’s “stage” is scaled.

The visually minimal starting point for AVOL is intentional. It is meant to be mysterious, to stimulate curiosity and to motivate the discovery process by users. As Donald Norman states, “one important method of making systems easier to learn and to use is to make them explorable, to encourage users to experiment” (2002, p. 183).

When users roll over one circle, four white petal-shaped buttons appear. These trigger each of the four loops associated with the IAVO. The first time a user activates one of the loops, it starts playing immediately, and AVOL’s internal clock is started. New elements also appear on the IAVO’s interface: three “traffic light” buttons (red, yellow and green) (also petal-shaped), and a “ring” encompassing the “petal” buttons, incorporating a minus and a plus button. The petal corresponding to the loop currently playing disappears, applying Donald Norman’s notion that “a good designer makes sure that appropriate actions are perceptible and inappropriate ones invisible” (2002, p xii).

The “traffic light” user interface elements in the IAVOs are meant to control the playback of each object: the red button stops its playback while the green button “solos” it, stopping all the remaining ones. By using a traffic light metaphor, Video Jack hope to make these functionalities more intuitive. As Jakob Nielsen states, “metaphor can facilitate learning by allowing users to draw upon knowledge they already have about the reference system” (2000, p. 180). When the yellow button is pressed, the IAVO starts moving in a random direction. Clicking on the outer ring stops the object (if it is moving), or allows the user to drag the object on the screen. The graphic design of the ring, with its rough edges, is meant to convey this “drag” affordance. According to Donald Norman, affordances refer to “the perceived and actual properties of the
thing, particularly those fundamental properties that determine just how the thing could possibly be used” (2002, p. 9). The plus and minus buttons embedded in the ring control the sound playback volume, and consequently the size of the animation (Figure 2.).

![IAVO user interface detail](image)

Figure 2. IAVO user interface detail

André Carrilho conceived the “petal” aesthetics of IAVO buttons in order to be harmonious with the animations, which also resemble flowers. Each song has its color palette and type of animation (for example, animations triggered by every third petal are blue), but they where designed to integrate with each other. The attractiveness of the interface is meant to enhance the experience of the user, and to emphasize the act of manipulation: “the mouse and the pen-based interface allow the user the immediacy of touching, dragging, and manipulating visually attractive interfaces” (Bolter and Gruisin 2000, p. 23).

One of the difficulties the author faced when programming AVOL was the issue of sound synchronization (Adobe Flash is not very efficient in synchronizing sound). In order to solve this problem, he conceived a synchronization solution based on cycles of equal length. After the first sound has been selected, AVOL’s internal clock starts, counting cycles of 16 seconds (the duration of all sound loops). To insure synchronization, all playing sounds are restarted every 16 seconds. Therefore, when a user chooses another sound, it does not play immediately, but only after the cycle restarts. An animated circular graphic is shown within the respective IAVO highlighting the remaining time until the next cycle.

Since objects can move on the screen, either by automatic random motion (by pressing the yellow button) or by drag-and-drop, they can also collide with each other. Video Jack saw object collisions as an opportunity to add an element of sonic spontaneity to AVOL. Each audio loop has a collision sound counterpart. Whenever two IAVOs collide, the static IAVO releases a collision sound. To avoid cacophony, only one IAVO can be moving automatically at a given time. Users can create compositions using collision sounds (and often do, as observed by the author in AVOL installations), by positioning objects so that they intersect with the moving IAVO.

A Video Jack logo in the lower right corner links to the Video Jack website. On rollover, it reveals the credits of the project.

The animations in AVOL resemble John Whitney’s floral compositions. Quoting Gene Youngblood’s description of one of his animations (which could well apply to AVOL): “all colors move into the ring simultaneously from all sides, forming circles within circles all scintillating smoothly in a floral configuration” (Youngblood 1970, p. 220). There is also some resemblance between AVOL’s flower-like objects and the plankton in Electroplankton, even more apparent when collisions occur. The objects in AVOL, due to their “draggable” nature and fluid movement in space, besides their audio-reactivity, also resemble the animated modules in Reactable. Like Electroplankton and Reactable, AVOL fuses performer and audience into one entity (the user). AVOL, together with many of the related examples quoted, are indebted to Oskar Fischinger’s music-inspired abstract animations.
4.4 Software

Video Jack decided to use Adobe Flash to develop AVOL, taking advantage of recent developments in that platform – namely the release of Flash CS3 in 2007, including the ActionScript 3 programming language, with sound analysis capabilities.

5. PRESENTATIONS

AVOL was presented as installation at several new media art and design festivals in 2008: Cartes Flux, Espoo, Finland; Re-New, Copenhagen; Create 2008, London; and Live Herring, Jyväskylä, Finland (Figure 3). These installations were composed of a projection on a wall (with one exception, Cartes Flux, where a flat-screen monitor was used) and speakers. Users could manipulate AVOL with a mouse (the keyboard and computer were hidden, except in Create 2008).

Figure 3. AVOL installation at Live Herring, Jyväskylä Art Museum

Video Jack presented AVOL as performance in the same year: at Abertura Festival, Lisbon (August); and at Electro-Mechanica Festival, St. Petersburg, Russia (November). At Abertura Festival, the author and André Carrilho performed AVOL using their two computers simultaneously, splitting the IAVOs between them – the author using the four rhythmic objects, and André Carrilho using the three melodic ones. The audience could see two contiguous projections, one for each computer. At Electro-Mechanica Festival, the author performed AVOL by himself, using a single projection (André Carrilho added some extra visual elements and effects using a video mixer). Documentation relative to these presentations can be found in Video Jack’s website (http://www.videojackstudios.com/c/blog/, referenced 11/1/2011).

The author considers that the most successful installations were those using large projections on a wall (instead of a smaller LCD screen). A large projection allows for a more immersive experience, hiding the frame of the image. Since the background of the project is black, it blends with the wall, and the objects seem to be floating on the projected space.

The author believes that AVOL is better suited for being presented as interactive installation than as performance. The project has a “hands-on” character, and some features are missing that could be more captivating to a passive audience – for example, a way to introduce more dramatic changes in multiple objects.
6. **RECENT DEVELOPMENTS**

The release of Video Jack’s new website in September 2009 (http://www.videojackstudios.com/, referenced 11/1/2011) motivated the author to make some adaptations and additions to AVOL. The first decision was to create a “mirror” of the project in Video Jack’s own server, instead of relying exclusively in DGA’s server. That also allowed the author to make some changes to the sound loops – he was displeased with three of the 28 loops, as he felt they did not fit well with the remaining ones. They were slightly adapted. That change occurred in January 2010.

The author felt that the project was not sufficiently documented in terms of videos and music. In March 2010, he uploaded video captures of AVOL, and music using AVOL loops, to the Video Jack website (and related websites, such as YouTube and Vimeo). These additional media elements (particularly the videos) are meant to provide alternative and complementary ways for users to experience the project, and also to quickly understand the possibilities of AVOL (http://www.videojackstudios.com/projects/avol/, referenced 11/1/2011).

7. **CONCLUSIONS AND FUTURE DEVELOPMENTS**

The project represents a turning point for Video Jack, as it was responsible for a change in focus in their work. Before, their focus was in performances, and in creating tools that they would use for themselves. With AVOL, they started designing for other users, and having the Web as a main platform. This new focus would be important in redefining their previous Heat Seeker project (an online version was later released), and for their next project, Master and Margarita.

7.1 **Conclusions**

The author considers that AVOL was successful in introducing the concept of Interactive AudioVisual Objects – entities composed of UI elements controlling sound and animation, and also audio-reactive animations visualizing sound. As user and performer, he considers that the project is playful, engaging, and allows for integrated audiovisual manipulation and expression.

However, the author detects several limitations in AVOL.

One of the limitations of AVOL is its closed nature. There is a fixed amount of sounds and animations to interact with. Being an Internet-based project, it would be desirable to implement functionalities to load external sounds and/or animations.

Another limitation of AVOL is its inability to record the interactions of users. It would be interesting to have some recording ability (as video, for example), which would allow users to share the results of their interactions on the Web.

Online collaboration features would be an important addition to AVOL. Currently it only allows for the interaction of one user in each individual session of the project.

Audio manipulation is limited to start, stop, solo and volume control of loops. Additional audio manipulation would be desirable, in order to make AVOL more playful and versatile.

The author considers that each IAVO should have an identification that distinguishes it visually from others, such as a color code. That would make it easier for users to trigger specific sounds and animations, particularly after the objects have moved from their initial locations.

The automatic movement functionality of each IAVO could be improved. The author believes that the user should have more control over the direction and speed of the movement, which is currently random. One option would be to implement a “throw” type of behavior to the objects.

One additional limitation is the difficulty of doing fast dramatic changes, besides “soloing” one object. It is difficult to change multiple parameters quickly in AVOL, which hampers its expressiveness. In the author’s opinion, this particularly limits the functionality of AVOL as a performance project.

Based on the presentations so far, the author believes that AVOL is a project which is more “fun” to play with than to watch. Therefore, AVOL should be presented preferentially as installation, and not as performance.
7.2 Future Developments

A user survey should be conducted to assess and enrich the conclusions reached so far.

Future developments of AVOL should address the limitations that have been detected. In *Master and Margarita*, the project following AVOL, Video Jack attempted to combine its IAVO approach to a more narrative-based project in the line of *Heat Seeker*. Video Jack are currently working on a follow-up project to AVOL, which will allow for loading sounds from an Internet database (greatly opening up the sonic palette) and for matching them with a built-in library of animations. Additional sound manipulation capabilities will also be explored. Sounds and animations will be grouped into “families” for a higher coherence, identifiable with color.

There is still a vast territory to explore regarding and integrated audiovisual expression – particularly one where, quoting Stockburger (2009, p. 122) “composer, performer and audience converge in the playing subject”. This territory is the playground of a new type of artist, as Dähl states – one who is both musician and visual artist, or a collective of sound and motion graphics artists. With these new creative forces, “a unique audiovisual language can be developed, just as each musician or band develops its sound” (Dähl 2009, p. 153).

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Short Papers
ADAPTIVITY IN STORY-DRIVEN SERIOUS GAMES

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ABSTRACT
Learning is an important part of our society and the search for good learning tools and environments is an ongoing debate. Serious Games are often suggested as they are able to promote active and reflective learning (Conle 2003, Eisner 1997). However efficiently creating effective serious games is hard. On one hand they should be tailored to the learner’s needs in every possible way, on the other hand they should tell a story that goes hand in hand with the content taught. Therefore changing the content directly results in a need for changing the story. Doing this without breaking the narrative can be very hard. In this paper a model for representing stories is suggested that allows for selecting the best learning path based on inferences made about the learner with the Knowledge Space Theory.

KEYWORDS
Serious Game, Learning, Knowledge Space Theory, Story, Adaptivity

1. INTRODUCTION

…to a particular person, the meaning of an object, event, or sentence is what that person can do with the object, event, or sentence. (Barsalou 1999, p.77)

Supporters of the serious game movement argue that serious games are able to promote active and reflective learning (Conle 2003, Eisner 1997) while at the same time providing motivation. The narrative of serious games strongly influences the efficiency of the learning experience. A story that is integral to the learning content of the game and does not only serve as some kind of sugarcoating carries the learner’s motivation and aids in comprehension (Dickey 2006, Rieber 1996, Laurillard), as meaning can only be developed “bottom up via embodied experiences” (Gee2007, p. 105). A well developed story can provide a context for the content and thereby provide the learner with an opportunity to collect embodies experiences, which allow him in the long run to gain a more abstract knowledge about the topic. Such a story is however neither easy to design nor to implement, especially for serious games.

When utilizing the computer as a learning tool only making use of its multimedia support does not exploit its full potential, instead its potential to adapt to a learner should also be integrated. However adapting the content in a learning game with a story that is interweaved with the content poses the problem that one cannot simply exchange the content anymore. Instead the whole story needs to change without breaking the narrative.

In this paper we address this problem by combining the Competence-Based Extension of Knowledge Space Theory (KST) in combination with a flexible data structure for presenting storylines.

2. COMPETENCE-BASED EXTENSION OF KNOWLEDGE SPACE THEORY

The Knowledge Space Theory (KST) was first suggested by Doignon and Falmagne in 1985 with the original objective to assess knowledge efficiently and adaptively on a purely behavioristic basis (Falmagne & Doignon 1985, Falmagne et al 1990). It was later extended (Albert) to allow the prediction whether a learner can solve a given problem correctly by separating observable performance, i.e. test item solving behavior, from the underlying competencies (Hockemeyer 1997, Albert & Kaluscha 1997) whose dependencies are
represented through prerequisite relationships. A function defines the relation between problems and performance. This made it a viable tool for determining the best learning path for a learner.

Extended Knowledge Space Theory deals with a set $Q$ of assessment problems, a set $L$ of learning objects (LO) and a set $S$ of skills relevant for solving the problems and taught by the LOs. The relationship between assessment problems and skills can be formalized by the skill function (Hockemeyer 2003), which associates each problem with a collection of subsets of skills, which are sufficient for solving the problem. Learning objects are additionally assigned a set of skills they teach, allowing for suggestions of learning paths.

Consider the set of skills $S = \{w, x, y, z\}$

- w) Resolving brackets
- x) Addition of natural numbers
- y) Multiplication of natural numbers
- z) Application of the precedence rule

and the set of problems $Q = \{a, b, c, d\}$ and

- a) $7 + 2$
- b) $4 \cdot 2$
- c) $7 + (2 \cdot 3)$
- d) $\frac{4}{2} + \frac{6}{2}$

Which lead to the skill function $s$, where

- $s(a) = \{x\}$
- $s(b) = \{y\}$
- $s(c) = \{\{x, y, z\}, \{w, x, y\}\}$
- $s(d) = \{b\}$

Looking at the example we can observe two aspects of the competence-based extension of KST: First, some tasks can be solved through different skill sets, for example the calculation $7 + 2 \cdot 3$ can either be solved by a student who can resolve brackets correctly or by a student who knows the precedence rule. Addition and multiplication are required for both solutions. Second, not all combinations of skill sets are possible, as there is no problem that only requires the knowledge of $x$. Instead, every problem where $x$ needs to be used, also requires knowledge about $y$ and $z$, which are hence called prerequisites of $x$. Those dependencies cannot only be induced indirectly from the assessment of skills to problems, but also explicitly. When talking to teachers or other domain experts for example one might realize that addition is a prerequisite for learning multiplication. This ordering on skills is called competence structure.

Formally this competence structure can be represented through a surmise system where each skill is assigned collection of subsets of skills, called clauses. Learning a skill then requires knowledge about all skills in at least one of its clauses. Based on a surmise system, adaptivity can be realized by deriving the current competence state from patterns in answers to assessment problems. The fringe of the competence state is the set of all skills which distinguish the knowledge state from its direct neighbors in the competence structure (Hockemeyer 1997). The next learning object is then chosen to deal with a skill from the fringe.

3. MODELING A FLEXIBLE STORY

KST is a useful presentation for knowledge that can drive adaptive systems. But in order to guarantee that tailoring the selected problems does not break the narrative, an additional structure is required, which defines dependencies and mutual exclusions between the quests that make up the story. This structure should also support different ways of storytelling:

- Linear stories where only one quest is available at a time and the next quest follows as soon as its predecessor has been solved.
- Non-linear stories where the player can pursue more than one quest at a time, which gives more freedom of choice to the player but disallows repeated playing of a quest.
- Exploratory stories where more than one quest can be pursued at a time and quests that were available once stay available.

We present this data structure as a directed graph consisting of quests and various types of “play conditions” used to connect quests:
• SEQ for linear progression through a number of quests
• AND for requiring all predecessors of a quest
• OR for requiring at least one predecessor but still allowing other predecessors to be solved
• XOR for requiring exactly one predecessor, mutually excluding other predecessors
• NOOP for optional side quests

These directed graphs can easily be displayed as an UML Activity Diagram, as seen in Figure 1.

![Activity Diagram](image)

Figure 1. Filled diamonds represent “OR”, filled rectangles “AND” connectors in this extract of a story where the player needs to gather tools to repair a bridge.

4. INTERPLAY BETWEEN KST AND STORY STRUCTURE

During the game the story structure is used to guarantee a consistent narrative. Every time a player solves a quest it is used to determine which quests should be available next. Whenever some quests are mutually exclusive the system uses the fringe of KST to determine which of them should be taken next based on the problems required to solve it (Figure 2). For example two quests are available, one that requires subtraction and another that requires multiplication. If student A has already proven that he knows addition and subtraction, the game would provide him with a quest that trains multiplication, which the system assumes to be in his zone of proximal development. For student B who hasn’t mastered subtraction yet, the quest where subtraction is practiced will be selected. The fringe also contains competencies, that have been learned recently. Therefore if a third quest featuring addition would be available the system could also decide to repeat this content for student A.

In non-linear or exploratory games the quests are activated, which can for example be seen by highlighting them on the map, making available new dialogs or simply adding them to a quest journal. The player can then decide on his own, which quest he wants to pursue next. In linear games this decision is taken over by the system, again applying KST.
5. CONCLUSION

In this paper we presented a model which allows for macro-adaptivity where not only the difficulty of the task, but also the type of task presented are selected according to the learner’s skills, while at the same time keeping the story aligned with the content to be taught. The model is applicable to multiple types of games including adventures, role-playing games, and also simulations.

While the data structure allows for the creation of quests that can be solved with two different sets of skills it is not possible to determine which of the skills the learner actually used to actually solve it. This makes it very hard to determine his competence state. These findings call for further research to analyze the current competence state despite ambiguities.

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OPENNESS AS A METHOD FOR GAME EVOLUTION

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ABSTRACT

The social impact of games to players and developers, software quality and game labour are cornerstones of a software game production model. Openness is, naturally, a significant factor for games evolution, overall acceptance and success. The paper authors focus on exploring these issues within the proprietary (closed) and non-proprietary (free/open) source types of software development. The authors identify developmental strengths and weaknesses for the (i) game evolution; (ii) game developers and (iii) game players. The main focus of the paper is on development that is done after the first release of a game with the help of add-ons. Concluding, there are suggestions for a more open and collaborative thinking and acting process model of game evolution that could benefit both types of development and all stakeholders involved. This process can integrate quality features from open and traditional development suitable for game construction.

KEYWORDS

Free/Open Source Software (FOSS); Closed Source Software (CSS); Software Games Specification and Implementation

1. INTRODUCTION

Playing has always occupied a significant part in humans’ lives. Virtual gaming communities offer an intriguing and participatory environment through the activities of designing, constructing, initiating, learning and playing games. Edutainment with online games is one of the latest trends of the learning industry. In the field of software-based games, there seemed to be three fields of ongoing research interest in the recent past regarding: (i) formal models (Nummenmaa et al. 2009, Siitonen, 2003; 2007); (ii) informal practices, that is the culture of playing and the culture around it, and (iii) the interaction between the game and the gamer (e.g. Järvinen, 2003). There is a fourth, rather under-researched area, that of the game development process (Scacchi, 2004) and the game developers as well as the progressive evolution of games’ features.

The phases of game evolution are distinct, rich and diverse, also dependent on game developers and game players, who are key holders of the game’s success and acceptance. Hence, openness is required in software game evolution. A participative and open process (Koskinen, 2005; Ahlgren, 2006) can eliminate fears of game acceptance and could increase game availability to more developers and players for improvement feedback. This, in turn, could increase the game’s quality, which can, eventually, increase game sales. This dimension of openness that increases quality is important to be understood in the context of software development, since the progress of a software-based global economy creates a strong resistance. The latter is based on experiences and fears of the local trends’ loss and identities change (Castells and Himanen, 2004; Jäkälä and Berki, 2004). Game developers and players well-being, culture, values (Georgiadou et al. 2005; Siakas et al., 2005; Himanen, 2001) productivity and unpaid labour are also worrying issues.

This study mainly concentrates on identifying ways-of-working and interaction patterns in game evolution and playing. We maintain that (i) best development practices can bring about significant reforms in games’ progressive evolution, and (ii) integration of different knowledge, skills and expertise can provide a more formalized, flexible, development approach that is time efficient and increases developers productivity. These two can only be achieved with more open and shorter delivery cycles. Openness can guarantee the sharing of different viewpoints and the provision of quality feedback (see e.g. Berki, 2006; Berki et al. 2007). Our focus is on (i) people and community and (ii) games and changes through continuous modifications. In the development cycle of games, changes can happen in the implementation and design level. These changes might take place either before the game is released or after the release, according to future needs. These changes can be called game evolution. Game modifications are implementation level changes and in
this study a special case of modification for a specific game is exposed. The additional components (in-game add-ons) are analyzed for a game, World of Warcraft by Blizzard Entertainment. The authors focus on the use of FOSS development principles in add-on construction and the benefits this approach offers for the whole gaming community, regardless of whether the games are proprietary or non-proprietary software. In fact, there are many game parts where FOSS principles are apparent. These parts/products can be additional components to the already complete and released game, some adjustments for a more enjoyable gameplay, or a complete rewrite of the game if the source code is available. The development of these parts is, however, different depending on how the original game development. First, the authors revisit the FOSS and CSS game development features and then expose the observations at the game implementation level, after the first release. The central theme of the paper is the game evolution through openness, and this is illustrated through the analysis of the open approach and the game updates through the developers’ add-ons contributions.

2. GAME EVOLUTION IN CLOSED AND OPEN DEVELOPMENT

Figure 1, adapted from Nummenmaa et al. (2009), depicts a software game production model that favours CSS development. The developer provides the sponsors, who are often the game publishers, with an idea, which the sponsors can decide to fund, market and sell. If the idea is ‘good’ and according to the publishers’ plan, the developers will be funded. With secure funding, the developers can make a more accurate specification and, finally, a product, which is then sold by the publisher. The developer may then receive feedback from the players, and that feedback may be utilized for updating the game or for a possible sequel.

In some cases, the players continue the development of the game themselves, after it has been released. For a closed source game, the changes to the game cannot be directly implemented into the main version of the game, as would be the case if the game were open source itself.

The FOSS development cycle is different. Common steps, according to Raymond (1999), for a FOSS project, are: (i) Someone announces the intent to develop a public project and may receive help with a group proceeding to code. (ii) A limited but working code can publicly be released. Developers continue improving it. (iii) The source code of a mature project is released. (iv) A well-established FOSS project can be forked by an interested party. Developers can then start a new project, whose source code diverges from the original.

In FOSS game add-on development, often the developers are also the players with a good knowledge of gaming mechanics and programming skills. The add-ons can be personally or by a FOSS community constructed. The game is frequently evolved through patches that provide new contents for the players. While the content is evolved, the need for updating the game modifications also arises in order to maintain their functionality and software quality. Within these game patches, the functionality of the add-ons might be embedded into the real game. However, the play styles and elements of add-ons change more frequently than patch releases, so the features, in many cases, cannot be embedded.

3. WORLD OF WARCRAFT ADDON CASE STUDY

World of Warcraft, or often WoW, is a massively multiplayer online role-playing game (MMORPG) by Blizzard Entertainment, a subsidiary of Activision Blizzard. It is the fourth released game set in the fantasy Warcraft universe, which was first introduced by Warcraft: Orcs & Humans in 1994. In addition to the monthly usage fee for keeping the game account active and playable, the players need to pay for the main
game and the consecutive expansion packs in order to play them. As of November 2010, there are more than 12 million subscribers around the world; that makes WoW the most-subscribed MMORPG.

3.1 World of Warcraft and Add-ons

The add-ons for WoW are enhancements, meant to tweak the game’s resources for users’ needs. Several add-on categories exist, i.e. user interface enhancements, game mechanic trackers, data exporting, artwork modifications, guides and audio/text communications [1]. Common properties of almost all add-ons are: i) users do not need to pay extra fees for using them, ii) they are mostly developed following FOSS practices. The largest online WoW add-on database Curse.com maintains that there exist around 10,000 add-ons [2]. Add-ons may change from a couple of lines to thousands of lines of code depending on the functionality they provide. The basic scripting programming language that WoW supports for add-ons is LUA (LUA, 2011). Blizzard developers also provide their API for public functions in order to be used in add-ons.

Almost all add-ons are created to satisfy the users’ needs. There are several similar add-ons and modification policies (see e.g. Järvinen and Sotamaa, 2002; Sotamaa, 2010) that provide similar functionality but because of the nature of FOSS development, each developer or community follows their own ways, implementing features they are interested in. They initiate an add-on project or modify an already abandoned add-on to adapt it to the current implementation of the game. Since WoW itself is an evolving game, the game mechanics, UI elements, used libraries, function calls and user interaction may constantly be changed for better gameplay. This brings the need for add-on updates, bug fixes and in-game testing.

3.2 The Importance of Professional Open Spirit in Quality Tracking

For keeping the add-ons up-to-date, the players need to be often in contact. Some of the version control mechanisms, i.e. the Curse’s curseforge [3], keep the developers community within the FOSS principles: they release notes, keep version history, change request and documentation. It is not enough to reach every person using the add-on and wanting to contribute. When this need emerges from a big number of users, the project follows the FOSS concept and creates a discussion forum, in addition to the classical mailing lists observed in FOSS projects. One of the most popular add-ons, the DeadlyBossMods forum [4], currently holds more than 2000 topics including code discussions, suggestions and bug reports.

One common principle that the FOSS community accepts is that the rate of bug reports and change requests can indicate the success and reliability of a project. Change requests and related releases show that the project under development becomes more decent and compatible with the real game. Further, the forum keeps the users informed on fixes and faults and prevents reporting same issues several times by different people. Thus, the availability to review the source code of different releases helps the people understand what to report and what not. The rate of bug reports and change requests show the typical pattern of a FOSS project. It is on peak level after the initiation of the project or major releases and declines throughout the lifetime of add-on usage. Surprisingly, this might show both the success and failure of the FOSS add-on.

One general impression is that a FOSS project can be considered to have failed when another project uses its code and advances the development of the software. If the project has a very active community, further developments based on the current code will be expected and the initial project will fail. Notwithstanding, the initial project is then considered a successful one that attracted many developers [5]. In the add-ons case the incoming bug report rate might indicate that the final version works perfectly satisfying the user needs. It might also mean that it is not used by players anymore, though very popular once. For a better understanding of this other criteria such as number of downloads or initiation of similar add-on projects should be analyzed.

3.3 Public lícensing and Freeware Security Guarantee Openness

Most of the WoW add-ons are relatively small in size to usual FOSS. The continuous change of the game itself forces sometimes the developers to release very simple add-ons or abandon them completely. As a result, not many add-on developers deal with licensing. Most of them release the add-ons under the Gnu Public License (GPL) and some mark their license as Freeware while submitting to repositories. The complex and relatively large in code freeware add-ons follow this licensing in order to accommodate the original game developers’ decision to implement the functionality internally. On top of the freeware add-ons,
there are also some paid add-ons, but their code is still open after purchasing. There is no agreed licensing for
the paid ones; purchasers can distribute them freely, without legal concerns. Paid add-ons usually provide
players with successful gameplay, which serves as a guide making an abstract and organized set of
information available. Although this exists in game specification, it requires efforts to understand and master.

Until recently, developers were not worried for the side effects of this tendency. Since though in game
currencies and equipment this approach became a source of real income for many, developers had to act.
Thousands make their living out of online activities, i.e. hired just to acquire fast in game currencies, where
these currencies are sold online. It sometimes seems that the paid add-ons culture and people’s hard working
conditions in game currency and online transactions threaten the spirit of the open online gaming.

The add-ons developers and users community encourages information sharing as well as complete pieces
of code. So, those paid add-ons become the target of FOSS developers. Further, the paid add-ons even are the
start for creating more complex brainstorming activities for the interested parties. While Blizzard
Entertainment do not take any legal action for paid add-on distributors, they encourage people not to use
them. They also encourage and prefer the use of FOSS add-ons to proprietary ones for security reasons.
There is always the risk of data mining and hacking incidents if the proprietary one is programmed to steal
usernames, passwords and identity related information, whereas the users cannot detect at all. [Add On].

A combination of the closed and open game development could potentially bring fruitful results.
Proprietary game developers can enjoy the benefit of being able to make one simple version of the game,
while FOSS communities can create specialized versions for more demanding players. Also, features from
the open source add-ons can be incorporated later in the closed source evolving version of the game. The
latter is more appealing to players as they prefer using the add-ons to the initial game version. Players, who
are also developers, have a chance to be directly involved in the game evolution through add-ons, thus
satisfying the need to participate in developing a game they enjoy. This is also the case in World of Warcraft
add-on development. Add-ons are important for keeping subscribers active with a better gameplay experience
and also attracting more possible players, hence increasing their profits.

4. CONCLUDING REMARKS AND FUTURE RESEARCH

The traditional game development approaches were adopted and customized for the design structures and
interaction features of game cultures of the past, for different players, and in the interests of less people
within a few software industries. Current industrialism adopts a production-line mentality that aims at
standardizing products. Accordingly, software development schools of thought trained CSS developers to
think in convergent ways – towards building one final product, possibly with a few future variations. Sadly,
openness and wide collaboration are not encouraged by the current closed source stream. In most game
development closeness is an obstacle that hinders effective game development since less feedback cycles,
less design knowledge, actual code and game features’ contributions are available.

On the contrary, the open culture for contribution and feedback in FOSS communities results in activating
the innate programming capacity of all contributors while manifold (Valtanen et al., 2008) and divergent
thinking are active and utilized to give ideas and feedback for improvement. Manifold thinking comprises
creative, critical, reflective and caring thinking. Divergent or lateral thinking (De Bono, 1990) is the ability
to interpret questions in different ways and to see many possible alternatives and answers. The paper showed
how this is achieved in open game development environments, and suggests that this strategic choice of
development should be adopted by the CSD game industry. Multiplayers and multi-users game communities
go on increasing along with the growing of different software trends and collaborative work approaches.
Various stakeholders and change agents are creatively involved in a game’s evolutionary cycle, raising their
different interests in the evolving features of the game. The aim of this study was to offer an analysis and
improved understanding of the group dynamics and interaction in game development and multiplayer online
communities.

Although there is a huge gap regarding values, polices and quality assurance between the traditionally
established CSD industry and the emerging FOSS paradigm, when it comes to game evolution, someone
observes notable needs for achieving process and product quality. The authors suggest that collaborative
integration of the life-cycle’s sub-processes through a new, flexible, open process with continuous quality
feedback can be beneficial for game development. This could result in enhanced game quality, which, in turn,
can increase (i) players’ satisfaction because of evolving game features and (ii) developers’ satisfaction
because of better knowledge and skills fit throughout the game evolution stages. Games and software development are communicative processes by nature; closeness would not be a natural fit to their evolution.

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SEMI AUTONOMOUS CAMERA CONTROL IN DYNAMIC VIRTUAL ENVIRONMENTS

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ABSTRACT
We present a system for controlling the camera movement in an interactive dynamic virtual world. The camera control is scripted in a specialized scripting language. A portable script interpreter has been implemented, allowing to run the scripts both on standard PCs and XBOX 360 systems.

KEYWORDS
Camera control, script interpreter, PC and XBOX

1. INTRODUCTION

Interacting with semi autonomous agents in dynamic virtual environments has been a central research topic over the last decades. Agent control has become more reactive and intelligent, making the agents' actions more realistic and user friendly. Camera control, on the other hand, has not been in focus of research so much. In most virtual environments the camera is realized as a simple follow up camera or it takes on the first person perspective of the currently active agent. This simple approach has a strong negative impact on the way interactive stories are constructed in virtual environments. Therefore, in order to make the human computer interaction believable, an adaptive and intelligent camera control is essential.

As a test bed we developed an XNA-based game engine for the XBOX 360 and standard PCs (see 2). The game engine allows us to display complex 3D virtual environments. Animated agents populate the world, assets can be placed, the agents are able to manipulate the assets and can interact and communicate with other agents (see 5).

The central part of the game engine is a portable script language interpreter targeting the intelligent and adaptive camera control. Scripts can be attached to any kind of agents within the virtual environment. This also includes cameras as a specific kind of agent. As such, the script language, could also be used to control the agents, which is a nice side effect of the development. It should also be noted that up till now, no functional script interpreter existed for the XBOX 360.

The camera control language abstracts away from the underlying mathematical concepts. Instead the commands mimic the language used in film making. The script language includes control statements making it possible to react to dynamic state changes in the virtual environment.

All parameters of the camera can be controlled over simple to use commands. The camera control parameters include position, focus, zoom, angle, field of view, animated movement, follow up behavior, path following and even visual special effects, using pixel shaders for image post processing.

The following script defines two positions in the virtual environment. The camera is focusing an agent and then continuously moves from position p1 to position p2 without losing focus on the agent:
Even as the agents moves through the world, the camera will not lose focus on him. The camera’s movement is controlled independently of the agent's actions. It will continue in parallel as long as the director is not giving new commands, aka attaching a new script to the camera.

2. GAME ENGINE ARCHITECTURE

It must be noted, that it is not possible to develop a whole game engine during a student's project in one year (lack of time and students do not meet the necessary requirements). Nevertheless the students had been able to develop playable games, having their focus of development on the visual parts of the game (rendering and animation). Using the Microsoft XNA Framework, the games were developed in C# and runnable on PC and Microsoft XBox 360.

Based on the results of the course, a new game engine was developed. The goals of the game engine are: previsualization, simple definition of virtual worlds, realistic lighting and rendering, simple development of 3D games with mixed environments.

The developed script language, as a central part of the game engine, aims for a simple camera control. Conceptual, the camera control orientates itself by the vocabulary of film creation, which means it abstracts from the underlying linear algebra and does not require knowledge of it.

The goal of the game engine architecture is to provide simple to use components and base classes the students can use to achieve fast results (see 3).

Figure 1. Components of the game engine architecture
3. SCRIPT LANGUAGE

Currently, there is no functional script language supporting the XNA Framework and especially not a script language supporting XBox 360. Therefore a script interpreter was developed, supporting game development on PC and XBox 360.

The ANTLR (see 1 & 5) class library for C# was used to generate the parser classes from a formal grammar. The main part of the development was the integration of the script interpreter into the game loop. This way, scripts can synchronize with the game loop by using an event-based mechanism to start events that take several frames to complete, wait for their completion by the game loop and resume afterwards.

The interpreter itself works as a one-pass system, which means that function and struct definitions are recognized in the execution pass. This restricts those definitions to appear in the source code before they are used the first time.

Script execution time is only a few milliseconds, which is required by a real-time application like a game engine. However, on the first script execution, the Just-in-Time-Compiler needs to compile the required sources first, so that script execution takes a lot longer then. But this has no negative impact on practical applications.

A big advantage of this script interpreter is the support for Microsoft XBox 360. It's fully compatibel with both systems, PC and XBox 360, while other interpreters (e.g. LuaInterface, see 4) are limited to PCs. But performance differences caused by the different hardware of the XBox 360 must be taken into account, too.

The current application of the script interpreter is the camera control. Using abstract commands that orientate by camera directions for a camera man (panning, zooming and movement), a simple camera control arises that doesn't require knowledge of linear algebra or 3D programming. Therefore, the commands only interact with the event mechanism by creating events and waiting for their completion.

The following is a sample script that moves a camera along a specified path and also keeps focus on a point in space:

```csharp
#auto included from "vector.sfx"
Vector3 target = Vector3{100.0, 50.0, 100.0}; Focus(target);
int pathID = NewPath(); AddKey(pathID, 0.0, Vector3{-5.0, 50.0, 165.0}); AddKey(pathID, 5.0, Vector3{50.0, 70.0, 100.0}); AddKey(pathID, 10.0, Vector3{150.0, 90.0, -200.0});
// Tell the camera to move along the previously defined path
int waitID = Move(waitID); Wait(waitID);
```

Listing 2. Camera movement with fixed eye point.

It takes just a few lines of code to let the camera move along a long path. The synchronization with the game loop is done by the call of the function "wait", which waits for the completion of the specified event.

4. CONCLUSIONS

The system runs stable on both platforms, PC and XBox 360. The script language can be used to implement flexible camera controls. The system is also extensible, which makes it suitable for many other applications within game engines or in ordinary applications.
REFERENCES

GENDER INCLUSIVITY FRAMEWORK (GIF):
INTER-RATER AGREEMENT ON THE COMPONENTS OF GENDER INCLUSIVITY IN GAMES

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ABSTRACT
Gender inclusivity in games studies are just beginning to emerge and exploratory in nature. This study proposes an integrative framework, named Gender Inclusivity Framework (GIF) that will provide a common platform for understanding gender inclusivity in games. The aim of this paper is to investigate agreement patterns on components of the framework. To evaluate the GIF, an expert evaluation was conducted to obtain feedback on the components of gender inclusivity in games. Five experts from the games industry and academic researchers were invited to participate in this study. A novel measuring instrument was developed based on the Gender Inclusivity Framework (GIF) with a total of 32 items. For each component a number of items were generated and a brief description with an example to illustrate the meaning of each item was also provided. Experts were asked to rate how important each item is towards gender inclusive gameplay and content. Results suggest that there is a statistical significance between the experts’ agreement towards the components of gender inclusivity in games and revealed two distinct clusters of experts’ agreement towards the components of gender inclusivity in games.

KEYWORDS
Game framework, gender inclusivity, gender neutral, game design, video games

1. INTRODUCTION

Gender inclusivity is the new catchphrase in the game industry. Many long held assumptions about games and gamers, understandably, associate game playing activities and buying consumer electronics with the male gender and masculine activities. However, a recent market report showed that women have a large share of the games market. The Entertainment Software Association (ESA) (2010) reported that the average gamer is 34 years old and has been playing games for 12 years. More importantly, 40% of the market consists of female gamers over the age of 18 and they represent a significantly greater portion of the gamer’s population (33%) than boys age 17 or younger which is 20% of the gamer’s population. These trends reflect how games industry landscape is facing a major shift in its consumer’s demography and economic powerhouse. Today, women are a major contributor to the household income, have the purchasing power, is internet savvy and, have large networks both offline and online. Specifically for a gamer demography, this is a far change from the common assumption that a gamer has to be male between the ages of 18 to 34 and must be technically savvy. One of the implications of these trends is that it is not enough just knowing what women want but to fully understand the intricacies of that wants. Consequently, it is a misguided assumption that all female likes things in pink, fluffy and sparkles.

Most previous research in gender and games only focuses on finding out how each gender plays, what their preferences are in games and highlighting their differences. Ibrahim et al (2010b) summarizes current issues in games and gender research into the following six categories:

- how different gender competes and their style of conflict resolution;
- how each gender responds to stimulation;
- how each gender views rewards in games;
- which genre and game content each gender prefers;
- what kind of play environment each gender prefers; and
what kind of design features each gender prefers

The results of previous research were relevant and yet somewhat inconclusive. Most previous research in gender, games and design only focuses on finding out how each gender plays and what their preferences are in games. It is conducted on a specific content with specific player under specific conditions and thus a lack of coherence – no integrative framework in which gender-inclusivity can be interpreted or applied. The questions that arise from this situation are: (1) what are the components of gender-inclusivity in games?, and (2) how to define gender-inclusivity in games?.

Ibrahim et al (2010a) and Ibrahim et al (2010a) proposed a conceptual framework aimed to help understand the components of gender-inclusivity in games, measure the level of gender-inclusiveness in games, and guide the gender-inclusive game design process. Table 1 shows the Gender-Inclusivity Framework (GIF) consisting of 3 dimensions and 12 components. These dimensions and components provide the description of gender inclusivity in games, which in turn is expected to predict the actual degree of gender-inclusiveness in games. The Gameplay dimension consists of eight (8) components describing the game behaviour and how a player experiences the game. It include non-violent action (NVA), game support (GS), forgiving gameplay (FG), non-violent challenge (NVC), feedback system (FS), variety of activities (ACT), personalization (PER) and collaboration (COLL). Next, content dimension consists of four sub-components describing the aesthetics elements of a game. It consists of character/avatar portrayal (AVP), game world graphics (GW), sound/music (SM) and storyline (STOR). Finally, genre categorizes games into twelve broad genres: racing, simulation, classic/board, strategy, sports, shooting, role-playing game, platform, children, puzzle/quiz, action and adventure.

<table>
<thead>
<tr>
<th>GENRE</th>
<th>GAMEPLAY</th>
<th>CONTENT</th>
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<tr>
<td>Action</td>
<td>Non-violent action (NVA)</td>
<td>Character/avatar portrayal (AVP)</td>
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<td>Simulation</td>
<td>Game support (GS)</td>
<td>Gameworld Graphics (GW)</td>
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<tr>
<td>Educational</td>
<td>Forgiving gameplay (FG)</td>
<td>Sound/music (SM)</td>
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<td>Non-violent challenge (NVC)</td>
<td>Storyline (STOR)</td>
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<td></td>
<td>Collaboration (COLL)</td>
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2. INTER-RATER AGREEMENT

Validity looks at how well the items of an instrument represent a concept or domain of content (Gable & Wolfe 1993, Saw & Ng 2001, Beck & Gable 2001, Rubio et al 2003). Validation becomes an important step especially when a new measure is being developed for a concept where no existing measure exists that operationalizes the concept as the researcher conceptualized it (Rubio et al 2003). For example, there are instruments measuring fun, violence, presence and usability in games however a framework that defines gender inclusivity in games or an instrument that measure gender inclusivity in games is new and need to be validated. Using a panel of experts during a validation will provide useful feedback about the quality of a newly developed measure. Without conducting a validation study, a researcher is using an untested measure to conduct their study. Data from an untested measure may indicate that the instrument needs revisions and the process would need to be redone with another pilot study for the revised instrument. Hence, more resources and effort will be spent in evaluating and recreating the instrument. For example, if the components of the gender inclusivity framework are used without validation, an instrument developed based on the framework would need to be revised and another round of pilot study must be conducted. On the other hand, if the components were validated early on, an instrument developed based on the framework would require less revision and need not be evaluated repeatedly. Therefore, the aim of this study is to explore patterns of
agreement between experts towards the components of gender inclusivity in games. Without a gold standard or an integrative framework describing how gender-inclusivity in games looks like i.e. dimension, components and description, it is difficult to support gender inclusivity in games. This study adopts the quantitative method of a survey instrument to obtain self-reported information from the experts.

2.1 Participants

There were five experts; three from academic game researchers and two are professional game designers recruited for the study. These experts were recruited based on their experience and publications in game design and game development. Two female and three male experts ranging from 20 to 45 of age were invited to participate through the Learning Societies Lab, University of Southampton, UK research group; social networking group i.e. Facebook, LinkedIn; and games associations i.e. Women in Games International (WIGI) and IGDA Women in Games SIG.

2.2 Materials

The expert evaluation instrument was developed with 2 sections, corresponding to the GIF framework in Table 1, and has a total of 32 items. The first section was has 17 questions items used to collect data for gameplay dimension that might appeal to both male and female players including non-violent action (NVA), game support (GS), forgiving gameplay (FG), non-violent challenge (NVC), feedback system (FS), variety of activities (ACT), personalization (PER) and collaboration (COLL). The second section has 15 question items used to collect data about the content dimension that might appeal to both male and female players including character/avatar portrayal (AVP), game world graphics (GW), sound/music (SM) and storyline (STOR). For each item a short description is given to explain its meaning in relation to gender inclusivity in games. Experts were asked to rate how important each item is to gender inclusive gameplay and content. The response option uses a four-point scale format to rate each of the items. If an item is deemed as a “1 = Not Important” then the exclusion of that item does not affect gender inclusivity in games. On the contrary, if an item was rated as a “4 = Very Important” then the exclusion of that item would be detrimental to gender inclusivity in games. While an item with a rating of “2 = Somewhat Important” and “3 = Quite Important” may need a revision in terms of wording or reorganization to make it more relevant to gender inclusivity in games.

2.3 Procedure

Two weeks prior to the study, an email was sent to each expert inviting them to participate in the study. After they agree to participate, a second email containing a link to the questionnaire and ethics information were sent. The experts were also advised that their participation was voluntary; no monetary compensation will be given and all data gathered remains confidential and that the study lasts about 2 weeks.

3. FINDINGS

The aim of this study is to discover inter-rater pattern of agreement towards the components of gender-inclusivity in games. The inter-rater differences were examined using one-way repeated measure ANOVA and the inter-rater associations were assessed using principle component analysis. All analysis was done using SPSS version 17. Two items were reversed coded and no missing data was found.

A one-way repeated measure ANOVA was run to test the effects of interaction of the experts and results showed there was a statistical significant difference between five experts’ responses to gender inclusivity in games, F(2.43, 75.37) = 4.95, p < .05. Principle component analysis results in combination explained 68.16% of the variance. All experts were retained because their primary loading were above .4 and none has a cross loading above .3. The factor loading matrix for this final solution showed the two factors solution was preferred because of its support to the clustering of experts on the component plot diagram in Figure 1.
4. DISCUSSION AND CONCLUSION

The results of this study suggest that both inter-rater differences and associations are statistically significant between the five experts. The results are in line with initial expectations that an expert’s gender do contribute to their agreement patterns towards the components of gender inclusivity in games. This finding concurs with previous findings that each gender has their own preferences even with game designers. Expert 4 and 5 are female expert game designers whose background and experience in the design of games that appeal to female gamers might explain their pattern of agreement towards the components of gender inclusivity. While the second cluster of agreement is made of Expert 2 & 3 whom are male game designers and researchers and this may explain their responses towards the gender inclusivity in games. And unanticipated result was from Expert 1 whom is a male game researcher but his background and age may contribute to his pattern of agreement towards the components of gender inclusivity in games.

A majority of previous gender and games studies only make use of game players themselves while this study used experts who are game designers as subjects. The combination of findings provides support for the conceptual premise that the components support the foundation of gender inclusivity in games. However, this study was focused on finding out experts’ agreement and may lack comparisons due to the lack of similar previous studies of gender-inclusivity in games. Further research are being planned to investigate the application of the Gender Inclusivity Framework (GIF). In order to test the underlying assumptions that can verify the conceptual framework’s future work includes: (1) to develop suitable items associated with each component; (2) to select and develop and reliable data collection tools and conduct pilot research; (3) to select appropriate sampling frame for the target population; (4) to determine the sample size and generate random numbers; and finally (5) to collect and analyze empirical data collected from the respondents. Completion of the aforementioned future work will lead to refinement and validation of the proposed framework of gender-inclusivity in games.
REFERENCES


IMPROVEMENT AND EVALUATION OF VEGETATION INTERACTION GAME

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ABSTRACT

In this study, we have improved the Vegetation Interaction Game (Deguchi et al., 2009). Improvements have been made to the expression of competitive interaction between plants and the simulated display of vegetation succession phases on the interface. The evaluation experiment was a within-subject comparison of the existing version and improved version of the game. Surveys on the motivation to learn, understanding of knowledge, and ease of understanding of the interface in the subjects indicate that the improved version of the game (1) improves the subjects’ motivation for learn, (2) gives the same level of assistance to the understanding of knowledge as the existing version, and (3) has a more effective interface that expresses the interaction between plants in an easier-to-understand way than does the existing version.

KEYWORDS

Digital interaction game, Vegetation succession, Science learning

1. INTRODUCTION

One learning assistance tool that attracts people’s attention in the field of science education in recent years is the digital game. The learner can acquire scientific ideas and rules built into the game while playing the game. Digital games that use techniques such as simulation allow players to learn through a simulated experience of natural phenomena that are hard to learn in ordinary classes (e.g., Clark et al., 2009; Dede, 2009).

Deguchi et al. (2009) developed the Vegetation Interaction Game. This game was recognized as an effective tool for learning vegetation succession in forests. In this study, we have improved the Vegetation Interaction Game and evaluated the improvements.

The purpose of this study was to improve the Vegetation Interaction Game developed by Deguchi et al. (2009), and to evaluate the validity of the improvements. Improvements have been made to the expression of competitive interaction between plants and the simulated display of vegetation succession phases on the interface. The research question of this study was whether the improved version is better than the existing version in the following four points:

(1) Does the improved version of the Vegetation Interaction Game stimulate the player’s motivation to learn?
(2) Does the improved version of the Vegetation Interaction Game support the player’s understanding of vegetation succession?
(3) Does the interface of the improved version of the Vegetation Interaction Game clearly express the competitive interaction between plants?
(4) Does the interface of the improved version of the Vegetation Interaction Game provide an easy-to-understand simulated display of vegetation succession phases?

2. VEGETATION INTERACTION GAME

2.1 Game Interface

The Vegetation Interaction Game is a digital sugoroku board game that works with Adobe AIR (Adobe Integrated Runtime). Figure 1 is the existing version of the digital game. Six pieces represent six characteristic plants that grow in the Mt. Rokko region. The size of the sugoroku board was set at 1024*768 pixels. The surrounding part is the grid area of the sugoroku board, and there are a total of 48 grids. The central part houses the following components of the game: there is event cards (figure 1-a), a direction window to move pieces (fig 1-b), and a visualization window to show vegetation succession according to the progress of the game (fig 1-c). We set the event cards to correspond to some kinds of disturbances that could possibly occur in the Mt. Rokko region.

2.2 How to Play

Six players can participate in one game. Each player handles one piece. Players draw event cards, one at a time, by clicking in turn. When a plant piece advances ahead on the board grids, it implies that the plant is dominant in that particular environment. Each piece is to be moved by the number of grids that the current event card indicates. These directions are shown in the central part of the main window. If more than one piece takes the same position on the grid, they will be moved along the grids as indicated by the rules governing the interaction between plants. A game finishes when all event cards are drawn.

2.3 Improvement of the Game

Figure 2 shows the main window of the improved version. Although the basic structure of the window is the same as that of the existing version, the expression of competitive interaction between plants and the simulated display of vegetation succession phases have been improved on the interface of the improved version. First, the competitive interaction between plants was formerly expressed by text alone, and the improved version expresses the interaction between pieces graphically and symbolizes the current dynamics between the plants clearly (fig 2-a). Second, the simulated display of vegetation succession phases has been improved from a random display of woods to a stereoscopic picture configured with grids (fig2-b), with the addition of six buttons for displaying the status of each plant (fig 2-c).
The subjects were 47 university students, and the evaluation experiment was a within-subject comparison. The 47 students were divided into two groups and played the existing version and improved version of the game.

Figure 1. Existing version

Figure 2. Improved version

3. EVALUATION OF THE GAME: RESEARCH DESIGN AND METHODOLOGY

The subjects were 47 university students, and the evaluation experiment was a within-subject comparison. The 47 students were divided into two groups and played the existing version and improved version of the game.
game in different orders in the groups, so that they would be counterbalanced. To get the answer to the research question, we conducted a survey on the following four points:

(1) The motivation to learn was surveyed by using a written questionnaire after the subjects played the game. They were asked whether they enjoyed playing the game and whether they wanted to play the game again, and then asked to give ratings on a scale of 1 to 5.

(2) In a survey on the understanding of knowledge, the subjects divided into two groups took the same test before they played the game for the first time and again after they played the game. The test included 13 questions asking whether they understood the effect of disturbance and the interaction between plants in vegetation succession.

(3) The ease of understanding the expression of competitive interaction between plants was surveyed by using a written questionnaire after the subjects played the game. They were asked seven questions, and then were asked to give ratings on a scale of 1 to 5.

(4) The ease of understanding the simulated display of vegetation succession phases was surveyed by using a written questionnaire after the subjects played the game. They were asked seven questions, and then were asked to give ratings on a scale of 1 to 5.

4. DATA ANALYSIS AND RESEARCH FINDINGS

(1) Questionnaire survey on the motivation to learn: Table 1 shows the results of the survey on the motivation to learn. The results of the Wilcoxon signed-rank test indicate that there are many positive answers to the two questions about the improved version.

(2) Test survey on the understanding of knowledge: The results of the Mann-Whitney U test indicate that the marks obtained by the pre-test and post-test on the existing version and the improved version are not different ($Z = 0.614$, n.s.; $Z = 0.890$, n.s.).

(3) Questionnaire survey on the expression of interaction: Table 2 shows the results of the survey on the expression of interaction. With significant values for five of the seven questions and a somewhat significant value for one question, the results of the Wilcoxon signed-rank test indicate that the improved version is more effective than the existing version.

(4) Questionnaire survey on the simulated display of vegetation succession: Table 3 shows the results of the survey on the simulated display of vegetation succession. With significant values for three of the seven questions, the results of the Wilcoxon signed-rank test indicate that the improved version is more effective than the existing version.

**Table 1. Results of the survey on the motivation to learn**

<table>
<thead>
<tr>
<th></th>
<th>TS</th>
<th>STS</th>
<th>NA</th>
<th>DQTS</th>
<th>DTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you enjoy playing the game? *</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>existing</td>
<td>14</td>
<td>24</td>
<td>2</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td>improved</td>
<td>20</td>
<td>20</td>
<td>3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Do you want to play the game again? **</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>existing</td>
<td>6</td>
<td>19</td>
<td>14</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>improved</td>
<td>14</td>
<td>21</td>
<td>5</td>
<td>5</td>
<td>2</td>
</tr>
</tbody>
</table>

N=47. TS: Think so, STS: Somewhat think so, NA: Neither Actually, DQTS: Don’t quite think so, DTS: Don’t think so **: p<.01, *: p<.05

**Table 2. Results of the survey on the expression of interaction**

<table>
<thead>
<tr>
<th></th>
<th>TS</th>
<th>STS</th>
<th>NA</th>
<th>DQTS</th>
<th>DTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you take a look at the dynamics of the plants displayed in the window when an interaction occurred? **</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>existing</td>
<td>9</td>
<td>18</td>
<td>6</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>improved</td>
<td>25</td>
<td>17</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Did you understand the dynamics of the plants shown in the window immediately when an interaction occurred? **</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>existing</td>
<td>3</td>
<td>12</td>
<td>8</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>improved</td>
<td>27</td>
<td>11</td>
<td>5</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Did you consider the increase and decrease in the number of plants carefully when an interaction occurred? +</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>existing</td>
<td>4</td>
<td>22</td>
<td>8</td>
<td>10</td>
<td>3</td>
</tr>
<tr>
<td>improved</td>
<td>8</td>
<td>21</td>
<td>9</td>
<td>7</td>
<td>2</td>
</tr>
<tr>
<td>Were you absorbed in the game when you looked at the window showing an interaction? **</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>existing</td>
<td>5</td>
<td>16</td>
<td>16</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>improved</td>
<td>15</td>
<td>16</td>
<td>8</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>Were you excited when you looked at the window showing an interaction? **</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>existing</td>
<td>5</td>
<td>16</td>
<td>16</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>improved</td>
<td>15</td>
<td>16</td>
<td>8</td>
<td>7</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 3. Results of the survey on the simulated display of vegetation succession

<table>
<thead>
<tr>
<th>Question</th>
<th>Existing</th>
<th>Improved</th>
<th>TS</th>
<th>STS</th>
<th>NA</th>
<th>DQTS</th>
<th>DTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Did you observe your plant in the visualization window? **</td>
<td>10</td>
<td>25</td>
<td>10</td>
<td>18</td>
<td>5</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Did you see the increase or decrease in the number of plants immediately when you looked at the visualization window? **</td>
<td>5</td>
<td>22</td>
<td>12</td>
<td>10</td>
<td>14</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Did you think of actual vegetation succession seriously through the visualization window? *</td>
<td>6</td>
<td>9</td>
<td>7</td>
<td>1</td>
<td>11</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Were you absorbed in the game when you looked at the visualization window?</td>
<td>5</td>
<td>7</td>
<td>23</td>
<td>9</td>
<td>9</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Did you feel like playing the role of a plant when you looked at the visualization window? +</td>
<td>0</td>
<td>10</td>
<td>10</td>
<td>9</td>
<td>16</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Did you feel like being in a forest when you looked at the visualization window?</td>
<td>2</td>
<td>3</td>
<td>12</td>
<td>15</td>
<td>8</td>
<td>4</td>
<td>0</td>
</tr>
</tbody>
</table>

N=47. TS: Think so, STS: Somewhat think so, NA: Neither Actually, DQTS: Don’t quite think so, DTS: Don’t think so
**: p<.01, *: p<.05, +: .05<p<.10

5. CONCLUSIONS

In this study, we evaluated the improved version of the Vegetation Interaction Game. The results of the evaluation experiment conducted by using university students as subjects indicate that the improved version of the Vegetation Interaction Game having an improved interface is better than the existing version in stimulating the motivation to learn and in ease of understanding the expression of competitive interaction between plants. It is inferred from the results that the improved version of the Vegetation Interaction Game can further help promote science education on vegetation succession. One problem that can be pointed out now is the inadequate improvement of simulated display of succession phases, and this needs further improvement.

ACKNOWLEDGEMENT

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ABSTRACT
This paper introduces an ethnographic case study of InsomniaGame, pervasive game production that took place in Insomnia LAN-party event in Pori, Finland in October 2010. The InsomniaGame was conducted by the research group from the Department of Digital Culture, University of Turku, Finland. The game production was a part of a research Project called CoEx, funded by Tekes, the Finnish Funding Agency for Technology and Innovation. In addition to being a prototype of a pervasive game which is tested and developed further during the two-year research project, InsomniaGame is also a tool for teaching. By participating in research data collection the digital culture students were able to learn about ethnographic fieldwork and had a chance to experiment with research methods such as interviewing and participatory observation.

In this paper we introduce self-reflective analysis of the research process of InsomniaGame. By reviewing the participatory observation work done by the students we discuss about the effects of prior knowledge and pre-assumptions on emergence of the research data.

KEYWORDS
Gameplay experience, ethnographic approach, participatory observation, reflectivity

1. INTRODUCTION: THE GAME AND THE RESEARCH PROJECT
InsomniaGame is a pervasive game (on pervasive game genre, see Montola – Stenros – Waern 2009) production, which took place in Insomnia LAN-Party event (http://www.insomnia.fi) in Pori, Finland in October 2010. The implemented game production was a part of the research project called CoEx funded by Tekes, the Finnish Funding Agency for Technology and Innovation. The aim of the ongoing two-year project is to create new values and contents for the Insomnia game event and to study collective gameplay experiences in LAN-party environment.

InsomniaGame 2010 consisted of four sub-games and it was played during a four-day event weekend. The game was designed and created by Aliisa and Tuomas Sinkkonen and developed in cooperation with the rest of the research group of CoEx and Insomnia Association, organizer of annual Insomnia LAN-party event.

In this paper we review the research process of InsomniaGame and discuss about participatory observation work done by the students during the Insomnia LAN-party event.

2. DESCRIPTION OF THE RESEARCH PROCESS AND METHODS
The aim of the InsomniaGame research was to study the process of player-game interaction during the game sessions and to develop the InsomniaGame-concept. The research material was collected to answer these questions: How did players experience InsomniaGame and its elements? Do the developed game features support an entertaining and collective player experience? The research group was interested in discovering which features of InsomniaGame relate to a positive or negative gameplay experience.

The fourteen participants of the digital culture course of ethnographic fieldwork took part in sub-games of
InsomniaGame and reported their experiences in research field notes. Digital culture students’ involvement in research data collection made it possible to gain autoethnographic (on autoethnography, see Ellis – Bochner 2000) descriptions of gameplay experiences of these students.

Along with the autoetnographic field notes InsomniaGame research data was collected during the Insomnia LAN-party event by observing InsomniaGame players, audiences and the Lan environment. The research group and the student’s paid attention to players’ behaviour, reactions, facial expressions and gestures during the InsomniaGame sessions. Players of InsomniaGame were also interviewed after the Auditorium Pac-Man, which was one of the four sub-games of InsomniaGame. (See Suominen 2011, forthcoming).

Because the social context is central in gameplay experiences the research group and the students participated in the event during the whole weekend and also collected context knowledge about the LAN-party event. (See e.g. Ermi & Mäyrä, 2005. On context knowledge see Multisilta – Mienenää – Suominen 2010) In addition to taking part in the research data collection we also did observations among game-playing LAN-party participants as well as supervised the students and took notes about the participatory observation work done by them. (InsomniaGame Research Field Notes, 2010) By doing so we also documented the research process to be presented and reported in later phases of this ethnographic study. (See Williams, 2005).

3. ETHNOGRAPHIC APPROACH IN GAME PROTOTYPE RESEARCH – SOME LESSONS LEARNT

While reviewing the collected research data we started to contemplate especially on the role of students in this research process and how each individual participating in observation work had influence on emergence of the research data. Although the advices and instructions given before the field work period were the same for all the people taking part in participatory observation, every observer’s field notes were eventually written from a different perspective. (On collective ethnography, see Gordon – Hynninen – Lahelma – Metso – Palmu – Tolonen 2006)

Students were advised to direct their observations primarily to interaction between the player and the game and to social interaction between players of InsomniaGame. We also instructed them to write down only what they saw, felt and heard during the InsomniaGame sessions and periods they worked in the event. If students were to interpret the situation they observed, We advised them to write this down also, but clearly separate their own interpretation from the actual observation. We also encouraged students to identify their potential presumptions towards social context of the event and reflect them during the research process. Although our instructions were quite well understood, judging by the students field notes, observation reports and learning journals pointed out that the students’ previous gaming experience and their prior knowledge (or lack of it) in the social context of LAN-party event affected the outcome of the research data collected with participatory observation. (InsomniaGame Research Field Notes, Reports and Learning Journals 2010). We also noticed that the lack of prior experience in the participatory observation method had a strong effect on the ability to make observations and articulate them in the field notes. The students’ ability to use rich and descriptive language in the field notes had potentially more significance because they wrote their notes for the benefit of the research in question and not merely for their own purposes. Accuracy and meticulousness in taking notes were also important regarding how beneficial the students’ notes appeared to be as research data. (InsomniaGame Research Field Notes and Reports 2010).

3.1 Far but Close Enough

The preliminary analysis of the observation data indicates, that the lack of previous gaming experience or prior knowledge about the LAN-party event didn’t have a negative effect on the descriptions students wrote in their field notes. Most detailed descriptions of the game sessions were written by students who were novices to games and first timers in a LAN-party environment. The field notes showed that these students were surprised and amazed at some of the features of the LAN-party event and in some cases clearly struggled to understand what they were witnessing. It was also interesting to find out that however unfamiliar these situations were for the students they still remembered to write down even the smallest
perceptions and did not consider them neither stupid nor insignificant. In their observation reports and learning journals these students also more easily brought up and analyzed prejudices they had towards the LAN-party event and how these prejudices were either overruled or strengthened during the event. (InsomniaGame Research Field Notes and Reports 2010).

For students who were more familiar with the social context of a LAN-party event it was easier to get started with the participant observation work and to blend in with the participants of the event. The analysis of the field notes of these students indicates that preserving the required distance from the objects of study proved out to be more difficult for them than for students to whom the social environment were more unfamiliar. We also noticed that the descriptions of these students more easily included assumptions that were not questioned or interpretations that were not separated from the actual perception. (Research field notes and reports 2010) Our remarks about students’ ability to precisely describe familiar social contexts resemble ones made by José Zagal and Amy Bruckman who discuss the difficulties students who identify themselves as “gamers” might have in analyzing subjects that are personally both familiar and important to them. (Zagal & Bruckman 2008).

3.2 Participatory Observer is one of the Players?

Preliminary analysis of the students’ observation reports and learning journals indicates, that other players positive or negative reactions towards the game were easier to identify if the observer him/herself took part in one of the sub-games of InsomniaGame and was familiar with particular game mechanics and understood the rules. In this sense it is easy to agree with Espen Aareth’s statement that it is essential to play the game that is examined to reach a deeper understanding of it. (Aarseth 2003. See also Williams 2005; Lammes 2007).

While InsomniaGame became more familiar to the students by playing, active participation in game sessions also enabled informal conversations between students and InsomniaGame players. As it can be seen in the students field notes interaction and possibility to present clarifying questions also deepened and strengthened insights acquired during the observation. In ethnographic research participatory observers have the opportunity to gain knowledge about the research objects also by asking. Intense interaction between observers and the objects researched can cause certain ethical problems but in our case it might have helped in avoiding misinterpretations during the observation process. In addition it might have given better opportunities for students in gaining an understanding of the social context of LAN-parties, which might have otherwise remained unfamiliar for most students during the rather short field work period.

In the more detailed analysis of the research data we are going to pay attention to differences in the students field notes and reports and to find out how our preliminary remarks about the complicated relationship between participatory observers and objects of study authenticates with the rest of the research data.

4. CONCLUSION

In this paper we wanted to present an ethnographic case study of InsomniaGame, examine the position of the participant observers in InsomniaGame study and discuss their influence on emergence of the research data. In our paper we have demonstrated how every observer’s field notes were written from a different perspective and how the observers’ personalities and their prior knowledge about the objects of study affected on emergence of the research data.

Our preliminary analysis of the observation data indicates that students who were novices to games and first timers in a LAN-party environment were able to produce more precise contextual knowledge about the research environment than the students to whom the social context of a LAN-party event was more familiar. As outsiders these students paid attention to details that appeared too obvious and not worth observing for the students who identified themselves as LAN-party insiders.

While observing the InsomniaGame and its players it was important that observers understood the objective of the game and its rules. When observers also played the game it was easier for them to interpret other players’ feelings about the game. Our preliminary analysis of the observation data indicates that observers should be familiar with the game that is the object of study and also gain their own gameplay
experiences by playing the game.

The research group has the opportunity to do a follow-up study within the next InsomniaGame in October 2011. It is possible to consider the gained knowledge and research results of the pilot study directly in the research plan of InsomniaGame 2.0. Based upon the experiences from last year’s research data collection process, the participatory observation method will still be used but in a manner which more resembles peer observation and includes both active playing of the game as well as observing others who play.

ACKNOWLEDGEMENT

The research group thanks warmly the organizers of the Insomnia Game Event for cooperation in the research.

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Reflection Papers
DIFFERENCES IN USER EXPERIENCE ON VIDEO GAMES AND SERIOUS GAMES

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ABSTRACT
User Experience in games is often described by psychologists with the player’s motives correlated with elements of game play. In order to prove differences of user experience in video games and serious games, user’s self reported motives from playing the one or other game are compared and conclusions are drawn on differences in user experience when interacting with a video game or with a serious game. This may have consequences for the design of serious games.

KEYWORDS
Video games, serious games, user experience, motivation, schema theory, genre-theory

1. INTRODUCTION
According to a common understanding, a human being’s experience is the result of interacting with the environment. When considering Human-Computer Interaction, therefore, we have to consider the user, the task and the context of the application in use (Buxton, 2007). But the problem with analysis of user experience is that users are individuals with personal experiences and accordingly, evaluating user experience means evaluating the subjective appreciation of the user.

Nevertheless, a method is needed to compare these subjective appreciations of the users. User experiences in games are often described by psychologists with the gamers’ motives correlated with elements of game play (as reported in chapter 2). This seemed to be useful as a basis of comparison of user experience in video games and user experience in serious games, covering user, task and context of the human-computer interaction.

In order to show differences of user experience in video games and serious games, user’s self reported motives from playing the one or other were compared in case studies. They showed differences when interacting with the two kinds of games. This may strengthen the argument of different schemas constructed from players of video games and of serious games. Furthermore, if this hypothesis is strengthened there may be evidence for genre-differences.

2. USER EXPERIENCE IN VIDEO GAMES AND SERIOUS GAMES
The question is, if user experience in video games and serious games, which look like a video game, is exactly the same. There is some doubt for the hypothesis that both are experienced in the same way, because the context is different and maybe the task or at least parts of the task are different.

In the following chapters first a review of motives of video game players, as stated in the literature, is given. A subset of these motives was used in a case study comparing user experiences when playing a video game and when playing a serious game. Starting from a short review on motives of video game players we compare the statements of players on the motives they found when playing video game and a very similar serious game.
2.1 Motives of Gamers for Playing Video Games

The attraction of video games for players is a phenomenon. Psychologists tried to identify several motives to explain it.

One group of motives results from the entertaining quality of video games, especially from effects of narration with motives like fantasy, suspense (Lucas & Sherry, 2004) and curiosity. Furthermore, players enjoy a stimulation of their visual sense (e.g. visual dynamics, sensomotoric synchronization, causal coherence or authenticity), like to experience elements of self efficacy (e.g. acquisition of competence, mastering the game, self-reference, Interactivity, Exploration) (Taylor, 2003), or master challenging elements (like contest) (Lucas & Sherry, 2004; Sherry et al., 2006).

Last but not least there is the flow concept (Csikszentmihalyi, 2005), which often serves as a concept to describe the mental states of the gamer during playing video games (see for example Fritz, 2003). This mental state is also described as an entertainment experience of game users: „one or more casually linked series of challenges in a simulated environment“ (Rollings & Adams, 2003). There are connections between demands of the game and personal traits of the player, which has for example been reported for children’s level of development and the demands of the video game, such as concerning spatial skills (see for example DeLisi & Wolford, 2002), problem solving and inductive reasoning (see for example Rosas et al., 2003) and visual attention (see for example Green & Bevalier, 2006). For a longer overview on this subject see Blumberg & Ismailer (cf. Blumberg & Ismailer, 2009).

Some motives have been found different concerning female and male players of video games. Mainly the motive of challenge is very important for female gamers. They want to be successful (Morlock, Yando & Nigolean, 1985). And they also estimate the experience of self efficacy (Taylor, 2003; Barnett et al., 1997; Jansz & Martens, 2005).

2.2 Are there Differences in Users Experiences on Video Games and Serious Games?

Video games for learning in form of serious games have become very popular, because they promise to integrate the engaging and entertaining aspects of games with serious goals of education (cf. O’Neil & Perez, 2008; Stone, 2005; Vogel et al., 2006). It is taken for serious that elements of video games can be transferred into the learning context with the result of having the same effects as they have in the entertainment products.

There are some hints from schema theory that cause doubt that the video game and the serious game cause exactly the same user experience. Schema theory is sometimes used to provide a basis for the analysis of game play patterns created by the player during interaction with the game and provide an explanatory framework for the cognitive processes underlying game play (Lindlay & Sennersten, 2006).

If we may be able to compare a video game and a serious game with similar genre elements (derived from the same schema), we may get deeper insight into the nature of user experience. As at the moment no schema theory is available (cf. Kritzenberger, 2011a) further results on user experience in video games and serious games were collected in case studies, including a comparison of both game genres with an experiment constructed for direct comparison of two very similar games, where one is a commercial shooter and the other one is a serious game mod of this shooter (Kritzenberger, 2011b; Petzold, 2011). The experiment was based on the commercial first-person shooter “Half-Life 2 – Deathmatch” (Valve Corporation, 2004) and an online available serious game, called “1378(km)” (Stober, 2010), which is a mod of “Half-Life 2 – Deathmatch”. The two games, of course were not designed for the purpose of the comparison reported here, but were used in our study, because of their genre-similarity.

Both games are very similar according to game play, the players in the serious game use the guns available from the original Half-Life 2 game. Further similarity is given by the same game engine on which both games are based. The game principle is competition between the gamers in restricted game worlds (maps). The player acts with the avatar character by the gun from the first person perspective. There are several game modes, like the regular “death match” (everyone against everyone), the team match (two teams against each other), the “capture the flag” (occupy strategic important places) and many other. Experienced users may even have the opportunity to generate own maps and scenarios.

Apart from the game principles which are very similar, the serious game, of course, has educational goals like showing the conflict of the former german-german border. By playing the shooter the player should
experience the conflicts caused by the situation of the guards to have the duty to shoot those persons who
want to escape to the western part of Germany. That is there is an educational goal connected with playing
the serious game.

The comparison between Half Life 2 and its serious game mod 1378 km showed differences between the
two as far as the users’ reporting on their motives were concerned. We tested motives like curiosity,
challenge, self-efficacy, contest, social, power etc.). There was a visible difference in some of the motives,
especially in contest, power and challenge, which user obviously experienced in the video game but not so
much or seldom in the serious game.

3. CONCLUSION

The study which showed a difference in the reported motives for two very similar games suggests that there
is a different user experience in playing the video game and the serious game. Contest, power and challenge
are very central motives for playing video games. As the video game and the serious game did not only
belong to the same game-genre, but also were very similar in look-and-feel and game mechanism, the
expectation would be that users report the same motives.

What might be the reasons for the users reported obviously not the same motives when asked for their
user needs met by the game they played? Reasons might be in the task and in the context of the human-
computer interaction, which are entertainment for leisure in the one case and exploring the german-german
border for learning purposes in the other case. Both, tasks and context must have influence on the user
experience, as we know from human-computer interaction research in other areas. In the case of the two
games users mental models of the situation they faced with in the one case and in the other case are different.
In the video game case they are playing a game with all the elements the game-genre instantiated, including
motives that will be met by the game. In the serious game case the players are doing a learning task, which
may not be entirely compatible with the video game schema. Therefore, other experiences coming from the
learning task schema, which may exist in any form, will be dominant in user experience.

Although further research is needed to support this thesis, there may be first hints for an explanation of
user experience in serious games. If this difference hypothesis would get further support, this could have
consequences for serious game design and for considerations on the applicability of the transfer model of
video game elements to serious games. It could probably also give a deeper explanation for the fact that most
serious games designed like their video game models are found worse than their reference model of the video
game genre.

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SERIOUS GAMES IN PSYCHOLOGY – CASE STUDY

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ABSTRACT
The term serious game is generally used for an application that is developed using computer game technology and game design principles, but is used for non-entertainment purposes. In few last years we can observe very fast market development of serious games. That games could be used for more serious purposes such as education, simulating real world phenomenon, rehabilitation and therapy application. This paper describes the main features of serious games used in psychology. This paper also presents a prototype of serious game Mission – Master Your Fear with some psychology goals. This game focuses on issues and problems of preschool children.

KEYWORDS
Serious games in psychology, goal-oriented games

1. INTRODUCTION

Today many people especially young generation spend their time in front of the computer playing games. Such games are often regarded as negative because of their violent content creating aggressive behavior, and can be associated with school failure and weight problems. On the other hand we can see other group of games which are serious games.

Serious games is a general term used for applications that are developed using a computer game technology and game design principles but are used for non-entertainment purposes. We can say that these applications are entertaining games with non-entertainment goals [Prensky, 2004]. The idea is that games could be used for more serious purposes such as education, simulating real world phenomenon and relations in the world, increasing life quality through health, rehabilitation and therapy applications or raising interest to the problems in our global world. That games can be commercial, entertaining but should teach or improve life of players. In this case the informal learning process is significantly supported. The player chooses a game simply for entertainment (not only for serious purposes) during leisure time. The examples are Wii Sports, Dance Central and concerns the term edutainment – education through entertainment.

This paper discusses games for health which are account for about 8% of serious games [Ritterfeld, 2009]. In this group of serious games we can find following examples:

• health promotion games [Baranowski, 2008] (for example Re-Mission game which help improving the lives of young people living with cancer),
• games containing information about diseases and treatment procedures,
• training and simulation games which can be used for training medical personnel for example Dental Implant Training Simulation,
• rehabilitation games (for example serious game for upper limb rehabilitation following a stroke [Burke, 2009]),
• games with psychological content which are described in the next section.

2. SERIOUS GAMES IN PSYCHOLOGY

Psychotherapy is an area in which innovative use of computer in the form of psychotherapeutic games may enhance patient cooperation and offer new ways of treatment [Wilkinson, 2008]. This helps to attract and sustain the interest especially in children and adolescents which are groups that therapists often have
difficulty engaging with. It is important to notice that a computer is a powerful medium because it is an accepted part of teenage culture. The popularity of games among the young may qualify them as a useful tool in psychotherapy for children and adolescents. Such games could be attractive homework assignments between sessions, tools for structure therapy sessions, and a way for better communication and understanding between therapist and patient, parents and children etc. They can help young patients become more cooperative and enthusiastic about psychotherapy [Ceranoglu, 2010].

We can distinguish two groups of games used by specialists in therapy which have been reported in publications. The first group includes commercially available games modified or used with limited functionality to meet therapeutic needs [Kokish, 1994, Gardner, 1991]. The second group includes serious games which was projected and development strict for use in the therapy. In publications there are very few examples of such games. Also we can not find any objective judgment of their results. Game examples used in psychology area are:

- Treasure Hunt for cognitive behavior therapy [Brezinka, 2008, 2007];
- Earthquake in Zipland for family therapy to support children whose parents have divorced;
- Personal Investigator a game based on brief solution focused therapy [Coyle, 2004, 2005] with modeled five therapeutic conversational strategies: setting goals, recognizing exceptions, coping, identifying resources and the miracle question;
- Free Dive Pediatric Pain Managements game is used as distraction therapeutic tools, to help chronically ill children to deal with pain, distract them during uncomfortable treatments.

Generally, in psychology games users are represented by their avatar and can interact with the word and other game characters [Magnenat-Thalmann, 2009]. In such as games like in bibliotherapy or storytelling the story itself has a therapeutic component so much as it evokes identification, empathy, resistance, opposition and disclosure of many confusing emotions. This goal oriented gaming can be used in goal oriented therapy methods (for example solution focused therapy). The game is played according to a scenario where the user can observe and react to different situations. This acts as powerful tool for helping users understand and reflect on their own behavior and gives them the opportunity to learn from this virtual experience. The next thing is testing the user’s new abilities with new situations by applying different games goals. Games support self-reflection and behavior change through: providing detailed and objective feedback, presenting in virtual world (mostly 3D) the implication of choices, provoking emotional reactions, leading the user step-by-step through the decision making process.

Limited literature on use of games in psychology suggest that they can help especially young patients become more cooperative and enthusiastic about therapy [Ceranoglu, 2010], [Baranowski, 2008], [Wilkinson, 2008]. Games may facilitate relations with therapist, evaluate cognitive skills (for example memory, motor skills and planning skills, frustration, tolerance, academic skills) and elaborate on and clarify problems during the therapy process. Limited use of this tool in psychology process we can explain with concerns about game content, perceived effect on the young and lack of specialists familiarity with this medium.

Scenario of a game with therapeutic points should be prepared by psychotherapists. This scenario describes the main game idea and should present the game world and behaviors (artificial intelligence) of all characters in a game [Buckland, 2004]. Based on this scenario the formal definition of game mechanics: actions, behaviors, and control mechanisms affecting the player within a game context should be prepared. Games are systems which are designed for fun but where rules limit player’s behavior, mechanics provide interaction and challenges create fun. In case of psychology serious games such systems are mostly created for achieving the therapeutic goals. So in this context the challenging should be created. But to keep the game interesting some elements to rise the enjoyment should also be introduced.

3. GAME PROTOTYPE

The prototype of serious game Mission - Master Your Fear (Figure 1) based on specialist scenario [Tomaszek, 2011] founded on bibliotherapy with some therapeutic goals is implemented with use of the ScriptarIn [Grudzinski, 2006] language and FRS 3D engine [Grudzinski, 2007]. This game has cognitive, behavior and developmental elements and is based on principles of behavior modification. It concerns issues
and problems of preschool children. This is a kind of guide with exercises where player can practice how to manage children with different kinds of fears: fear of darkness, weather occurrences, public performance, a figments of children’s imagination. The game take place in a ZOO. With the help of animals, a player can learn how deal with strong emotions and to learn ways to overcome fear (in the form of game - “magically”). This strengthen the feeling of security and courage of children.

The game **Mission - Master Your Fear** is the psychoeducation game. This is not a strict therapeutic game because it does not treat pathological fears and phobias. Children can play without a psychotherapist but parents presence is very important. A child can share observations with the parent. In some cases when the child has more serious problems the save log (text log and journal) may be very helpful to next therapy.

The scenario of the game consists of five main episodes each with specific therapeutic goals. In each episode the Player has to find the way to help animals overcome theirs fears and strong emotions. This allows finish the episode next start the next one. Episodes are as follows:

- Episode one is an introduction to the game. To better identify with the game character, a player can pick a boy or a girl character. The player gets to know the main characters of the game - the Director of the ZOO who is the guide of the game and gives advice and support to a player and the Monkey who is an assistant of the Director and also helps throughout the game. The Player, the Director and the Monkey are going to help animals overcome their fears. The Player is packing briefcase with equipment which can be used to overcome different fears.
  - Episode with the Monkey who is afraid of a storm.
  - Adventure with Leo who is afraid of a doctor and injection.
  - Episode with Seals. They are afraid of a public performance.
  - Episode with Bar who is afraid of darkness.

In every episode the Player has to help an animal overcome fear so the children learn: what is fear and what is its meaning; in what situations we can feel fear; what we can be afraid of; how to identify symptoms of fear.
In scenes with animals Player is learning different "magical" ways to overcome fear, for example: by turning attention by singing, reciting a rhyme; by drawing fear and next decorating it; by drawing fear and next burying it; by eating something good.

Throughout the game the Player can go to the Journal mode where they can write his/her impressions and their ideas for managing fears. Because this game is directed to children who can not write, the Journal allows writing by pictographs. This Journal can be the base to further conversation with the parents or a specialist. The game also creates very detailed log with a record about the Player’s activity during the game. This also may be a very valuable element in the session with a specialist.

4. CONCLUSION

This paper presents the example of serious game in psychology Mission – Master Your Fear. This is goal oriented game with implemented psychology content for preschool children. How use of this serious game may influence children remain to be explored with collaboration with specialists.

ACKNOWLEDGEMENT

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THE PSYCHOSOCIAL DIMENSION OF VIDEOGAME USAGE IN CHILDHOOD: A STUDY IN GREECE

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ABSTRACT

It is widely accepted that differences exist among videogames and classic games that are played by children. Given the characteristics of childhood (a child is not a young adult) research questions have been raised with regards to the sensitive relationship between videogames and children. This paper is an attempt to study the psychosocial dimension of videogame use in a sample of Greek students 10 to 12 years old.

KEYWORDS

Videogames, psychosocial dimension, students, parental involvement

1. INTRODUCTION

Videogames is a sociological phenomenon since they are widely accepted as an entertainment medium for children and thus affect the development of their cultural and psychological characteristics. Apart from their socialization dimension, they are currently investigated also in terms of their pedagogical characteristics (Shaffer, 2006; Shaffer et al, 2005). The purpose of this study is to investigate the affects of videogames on the socialization process of children 10 to 12 in Greece. Outcomes where produced via a questionnaire that was distributed at various primary school students within the Thessaloniki prefecture. The research focused on videogame popularity as a mean of entertainment, their affect on social behavior participation and last but not least on parental intervention to the content and the duration of usage for videogames.

2. PSYCHOSOCIAL DIMENSION

2.1 The Virtual Reality of Video Games

Games in general are a process that formulates the identity of a person during his/her childhood age and it affects the pedagogical, physiological and sociological characteristics of the child (Vygotsky, 1977).

Videogames are considered as an important activity in the everyday routine of children (Lenhart et al, 2008). Recent research has shown that, at least for adults, interaction with other players during computer gameplay is a crucial factor of enjoyment (Simon, 2006). Videogames are a gateway for players in the virtual reality of the internet, thrusting them to interact with artificial intelligence in a global scale from the early stages of their development. Thus, they could prepare children to socialize and participate in the “technological world”. According to Fileni, children that interact with videogames develop unconsciously socializing skills and are equipped with cognitive models that will assist them later on in the society of information (Fileni, 1988), while for Reese (2007) they enable them to construct cognitive maps, enhancing their learning skills.

Videogames with the magic of image, fantasy and "competition" are a catalytic stimulus that attracts children to engage with the activity (Amory, et al, 1999).
2.2 Sociological Phenomenon

Videogames are a sociological phenomenon since they are broadly spread and play an important role in the formulation of culture for children.

Videogames have a greater effect on the behavior of individuals from television and movies, because users do not participate as spectators but they actively make choices and take decisions. Videogames allow the child to handle situations in the way he/she wishes through interaction, to the point that it is permitted by the rules of the game, maximizing by this way the element of emancipation.

Recent research concerning videogames, focuses on the positive aspects of gameplay, such as interactivity (Lee & Hoadley, 2006), cooperation and team-playing (The Games-to-teach Research Team, 2003: 22; Ke, 2008), and even competition (Vorderer et. al., 2003), finding that they all constitute major factors of engagement.

Videogames are perceived by optimists, as a portal to the future, training children in the virtual reality of cyberspace. They believe that affiliation with videogames increases the perceptual skills and furthermore increases the abilities of children concerning learning abilities. Lastly, that videogames can become a valuable tool for acquisition and consolidation of knowledge. (Yawn et. al., 2000; Din & Calao, 2001).

On the other hand, pessimists point out that the contents of computer games, are mainly composed of violent, sexist and racist material, leading children to a possible aggressive behavior, desensitization, fear and hatred, destroying mental processes, social relationships and their education (Funk, 1999; Anderson & Buschman, 2001). Researchers believe the attraction of videogames and the time commitment required from the children for their involvement with them, are a factor that distances them from other activities (Walsh, 2002).

3. THE RESEARCH

The lack of data in Greece, concerning the use of videogames from children, raises the interest for a comprehensive study concerning this matter. The authors of this paper have made use of the data provided by a research conducted by Hatzis (2006) with the title “Videogames, Socialization and Education: The social and psychological dimensions of virtual reality for children and its functional use in teaching and learning.” This paper studies the profile of children playing videogames in a population sample of 817 children aged 10-12. It explores their relationship with digital technology, frequency of use of videogames, the influence of videogames in the socialization process of children, as a possible isolation, loneliness and alienation factor from group activities and social events. Last but not least, the investigation focuses on parental involvement in the selection videogames and time involvement of children with videogames.

A questionnaire was distributed to students of primary schools in Thessaloniki prefecture, and the procedure of collecting the questionnaires lasted three months. A pilot survey was conducted at the 69th Primary School of Thessaloniki, in order to assess the functionality of the questionnaire. The original research conducted by Hatzis, covered a broad variety of aspects. For the purpose of this paper, questions concerning frequency of use, social isolation and parental intervention were selected and analyzed. A presentation of the key results follows.

3.1 Frequency of use

The students were asked to answer the question concerning the frequency of which they play videogames (Table 1). The evaluation of research data suggests that videogames are part of the entertainment of children in our country and their popularity is high. All children have in one way or another contact with this activity. The highest frequency of use was during the weekend. A percentage (19.7%) of children belongs to the group of users who use videogames on a daily basis.
Table 1. How often do I play videogames

<table>
<thead>
<tr>
<th></th>
<th>No</th>
<th>Maybe</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Every day</td>
<td>66.4%</td>
<td>13.9%</td>
<td>19.7%</td>
</tr>
<tr>
<td>Once per week</td>
<td>66.0%</td>
<td>16.5%</td>
<td>17.5%</td>
</tr>
<tr>
<td>Twice or three times a week</td>
<td>67.5%</td>
<td>16.5%</td>
<td>16.0%</td>
</tr>
<tr>
<td>Every Saturday</td>
<td>35.4%</td>
<td>15.8%</td>
<td>48.8%</td>
</tr>
</tbody>
</table>

3.2 Social Isolation

Secondly, the students were asked why they would leave a video game with the purpose of doing something else alternatively (Table 2). The research data showed that children are not distancing themselves from group activities nor from participating in social events through the use of videogames. A high percentage of children (73.4%) indicated that they would abandon their interaction with a videogame, in order to participate at the birthday party of a friend, the percentage (55.9%) of children corresponded positively preferring to play with friends at their neighborhood, furthermore the rest of the results suggest that there is no isolation from social activities.

Table 2. For which reason would I leave a videogame

<table>
<thead>
<tr>
<th>Reason</th>
<th>No</th>
<th>Maybe</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>To participate in a very important family discussion that concerns you</td>
<td>49.1%</td>
<td>19.3%</td>
<td>31.6%</td>
</tr>
<tr>
<td>To go out with your family to a theater or cinema</td>
<td>27.7%</td>
<td>19.0%</td>
<td>53.3%</td>
</tr>
<tr>
<td>To play with your friends in the neighborhood</td>
<td>25.6%</td>
<td>18.5%</td>
<td>55.9%</td>
</tr>
<tr>
<td>To play together with a friend at home something else than a videogame</td>
<td>31.3%</td>
<td>20.1%</td>
<td>48.6%</td>
</tr>
<tr>
<td>To go to a friend’s birthday</td>
<td>14.9%</td>
<td>11.7%</td>
<td>73.4%</td>
</tr>
<tr>
<td>To go out with your friends to a football match, or a theater or cinema</td>
<td>26.9%</td>
<td>11.6%</td>
<td>61.5%</td>
</tr>
</tbody>
</table>

3.3 Parents' Intervention

Thirdly, a set of questions concerning parental control over the content and the extent of use of videogames was answered (Table 3 and Table 4). The results show that there is parental involvement in the selection videogames content for children and parental involvement concerning the time of use by children with videogames. 64.2% of parents are informed of the contents of the computer game, before the children obtain the software they want. 58.3% of children accept parental intervention to stop playing videogames after a period of three hours.

Table 3. When I want to buy a videogame

<table>
<thead>
<tr>
<th>Reason</th>
<th>No</th>
<th>Maybe</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>I choose it by myself and my parents don’t know the content</td>
<td>85.7%</td>
<td>4.3%</td>
<td>10.0%</td>
</tr>
<tr>
<td>I choose it by myself after I have informed my parents about the content</td>
<td>23.5%</td>
<td>12.3%</td>
<td>64.2%</td>
</tr>
<tr>
<td>My parents choose it</td>
<td>79.5%</td>
<td>8.8%</td>
<td>11.7%</td>
</tr>
<tr>
<td>I choose it by myself but my parents simply criticize the content (positively or negatively)</td>
<td>61.1%</td>
<td>14.7%</td>
<td>24.2%</td>
</tr>
<tr>
<td>I choose it by myself and my parents are informed about the content afterwards</td>
<td>62.9%</td>
<td>12.9%</td>
<td>24.2%</td>
</tr>
</tbody>
</table>

Table 4. Videogames playtime is censured by parents

<table>
<thead>
<tr>
<th>Time</th>
<th>No</th>
<th>Maybe</th>
<th>Yes</th>
</tr>
</thead>
<tbody>
<tr>
<td>When I play continuously up to one hour</td>
<td>67.3%</td>
<td>14.0%</td>
<td>18.7%</td>
</tr>
<tr>
<td>When I play continuously from one to three hours</td>
<td>37.5%</td>
<td>19.0%</td>
<td>43.5%</td>
</tr>
<tr>
<td>When I play continuously over three hours</td>
<td>34.3%</td>
<td>7.3%</td>
<td>58.4%</td>
</tr>
<tr>
<td>When I have to stay alone at home</td>
<td>56.2%</td>
<td>16.0%</td>
<td>27.8%</td>
</tr>
</tbody>
</table>
4. CONCLUSION

The outcome of the survey showed that the popularity of videogames amongst children in our sample is high. Negative characteristics of videogame users such as isolation from group and social activities were observed to a minor segment of the total sample. Parental supervision concerning the time involvement of children with videogames and the contents of it was found at high numbers. Data showed that the majority of parents were informed as to the content of videogame software that was purchased for their children and also that parents intervened to the use of videogames after the three hour margin. Due to the constant development of hardware capabilities that videogames take advantage of and the variation of psychosocial elements within society structures, further research should be conducted in acceptable time margins in order to be coherent with new conditions that might be formulated.

REFERENCES

THE AUDITORIUM PAC-MAN – USES OF A GAME CULTURAL HISTORY

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ABSTRACT
The paper introduces the Auditorium Pac-Man -project, conducted by the Department of Digital Culture, University of Turku, Finland. During the project, which was a part of a larger InsomniaGame pervasive game production, the research group developed a live remake of classic Pac-Man game, which was played in an auditorium by human protagonists and other game characters. The aim of the project, funded by Tekes, the Finnish Funding Agency for Technology and Innovation, was to create new values and contents for a LAN-party happening with over 400 participants and demonstrate how different technologies, live performances and classical video games can be intermixed. The paper discusses the technological products as well as technology-aided collective experiences and happenings.

KEYWORDS
Pac-Man, retrogaming, pervasive games, cultural history of games, game cultures, LAN-parties

1. INTRODUCTION
The paper introduces the Auditorium Pac-Man -project conducted by the Department of Digital Culture, University of Turku, Finland. During the project, which was a part of a larger pervasive game (on pervasive game genre, see Montola - Stenros - Waern 2009) production, the research group developed a live remake of classic Pac-Man game, which was played in an auditorium by human protagonists and “humanized versions” other game characters.

The aim of the project, funded by Tekes, the Finnish Funding Agency for Technology and Innovation, was to create new values and contents for a Lan-party happening with over 400 participants (see http://www.insomnia.fi/), and demonstrate how information technologies, live performances and classical video games can be intermixed. Thus, the paper contributes theoretically and practically to research dealing with technology added user-experiences and its design as well as studies on “re-newing” old technologies and convergence cultures (Gunning 2003; Swalwell 2007; Suominen 2008; Jenkins 2006). The project is bounded theoretically also to Svetlana Boym’s (2001) idea of reflective nostalgia, which can be an ironic, humorous as well as prospective way to create new interpretations and uses for cultural objects of the past. Participatory observation and thematic interviews were used as research methods for studying playing experiences. The paper discusses the challenges of such experiments and possibilities of uses of game cultural history in the making of novel technological products as well as technology-aided collective experiences and happenings.

2. PAC-MAN AS A GAME CULTURAL ICON
Pac-Man (designed by Toru Iwatami and published by Taito, 1980, 1981) is one of the most famous arcade and videogames and pioneer of maze-type games. It was not first in its kind but a “perfection of the maze game genre” like Maliet and de Meyer (2005, 29) call it. Already shortly after its introduction Pac-Man became common popular cultural icon which symbolized a turn to “the Age of Videogames” and recreational computing. Pac-Man and its sequels, such as Ms. Pac-Man did not penetrate popular culture only as game artefacts and clone games for arcade halls and homes but also as plethora of other products such as pop songs, television programmes, textiles, comics, even cereals and accessory products as well as hundreds of
collectibles – and eventually as street art. It is claimed that Pac-Man received more revenue than Star Wars movie and generated one billion dollars in one year. The game has been called as the “most successful coin-operated game in history.” (See e. g. Loguidice & Barton 2009; Mackay 1997; Burnham 2001, 234).

Almost every academic or popular history book on digital gaming mentions Pac-Man as one of game cultural the turning points and as a classic game. Since the early 1980s, there has emerged a whole line of industry related to Pac-Man and other game cultural icons like Super Mario, Donkey Kong and Space Invaders (Suominen 2008). Still, Pac-Man has been reused and recycled, even though younger gaming generations are not that familiar with the game. They might recognize the game, but they have not necessary played it, albeit there are newer (retro) versions of Pac-Man in the Internet, for mobile phones or gaming consoles. According to Loguidice and Barton, Pac-Man has been suitable for different platforms such as mobile devices, because it is an early example of a casual game, typically played short periods, for example when waiting something (Loguidice & Barton 2009, 184. See also Burnham 2001, 234). There have been, however, hard core Pac-Man players (such as Billy Michell who made a first “perfect” Pac-Man game with 3,333,360 points ever recorded, in 1999) who have studied every detail of game tactics for gaining optimal and perfect gaming result (Burnham 2001, 225). Leslie Haddon argues that Pac-Man was also more gender neutral and approachable for general public than its predecessor coin-up games (Haddon 2002, 65-66. See also Herz 1997, 132).

3. EARLIER PAC-MAN REMAKES

Because of its rather simple rules, maze setting and funny personal characters as well as to its cultural familiarity, Pac-Man, in a manner of speaking, allures to creation of new versions of game which would not be pure digital, but typically can be played with non-virtual spaces and new technologies. Many of the Pac-Man remakes, nowadays represented in the Internet or YouTube, are related to artistic and/or technological experiments or humoristic performances, which construct a comical incongruence when setting Pac-Man characters to spaces where they do not belong to but where people recognizes such game cultural reference (see e. g. Pac-Man: The Movie, a trailer, http://www.youtube.com/watch?v=fWL6j05vqV0). The projects are fine examples of Svetlana Boym’s idea of reflective nostalgia, which is a process where the past is wistfully and ironically reconsidered. According to Boym (2001, xviii), reflective nostalgia “dwells on the ambivalences of human longing and belonging and does not shy away from the contradictions of modernity.”

The whole game can be remade, then, or the sole Pac-Man character with its opponent ghost is able to be re-situated. In Pac Manhattan project (2004, http://www.pacmanhattan.com/about.php) for example, the game was situated in to urban street setting and played with live characters who were commanded with mobile technology. The French-Swiss artist Guillaume Reymond for his part has developed a whole series of classic game remakes in his project, called GAME-OVER (see e. g. http://www.youtube.com/watch?v=M3D0JvYJKc). The project consists of game-based performances in auditoriums, and the shows have been filmed with a stop motion technique and published in the Internet. The games by Reymond have been acted with human performers, but they have not been actual games any more. Also the artist Rémi Gaillard has produced Pac-Man interventional performances (as well as other game related performances such as Remi-Kart (urban life parody and intervention inspired by Nintendo’s Mario kart game) in public places such as in shopping malls and golf courses by using Pac-Man key characters (see e. g. http://www.youtube.com/watch?v=pIrVPN3k9A4).

Therefore it seems that Pac-Man inspired performances and artwork are more typical nowadays than genuine remakes of the whole game. During the 1980s, for its part, was characteristic to create clone digital games based on Pac-Man maze idea.

4. CASE AUDITORIUM PAC-MAN

Due to Pac-Man’s cultural familiarity, research group’s early experiments with the particular game, research interest of cultural history of digital gaming and knowledge about spatial settings led the group to remake a new version of Pac-Man with human characters in an auditorium in Insomnia LAN-Party event (http://www.insomnia.fi) in Pori, Finland in October 2010. Even though the remake resembles some of its
predecessors, it is still a unique and detailed experiment in new spatial premises and in combination of different technologies.

The game mechanics were designed by students of Digital Culture, Aliisa and Tuomas Sinkkonen, and discussed and elaborated within research group of six people. The planning process took few months, and production of introductory videos (made by Aliisa and Tuomas Sinkkonen http://www.youtube.com/watch?v=duHqef2q1Lg ; http://www.youtube.com/watch?v=2hO23BgxN4Q) and purchasing of needed equipments required most work. Students tested the game plan in advance in another class room. Four members of Pori student theatre were recruited as Pac-Man ghosts.

Before actual gaming event, the auditorium was decorated as a Pac-Man maze (see figure and linked videos) and beta-tested. The game setting required five people: a judge who counted players’ points, person who played Pac-Man live music during every game, a person who directed and performed light effects, and a person who started an introductory video, which was showed to players before every game session. There was also a person who shot a live video which was transmitted onto the Internet and to the main hall of the LAN-party. In addition to this, a couple of people observed and took research notes during game sessions. We also tested live commentary which was broadcasted online. This, however, will require more elaboration for being totally functionally additional for gaming experience.

Two players could play the Auditorium Pac-Man at one time. After seeing the introductory video they started to walk slowly with the pace of sound effects at the auditorium starting from the upper side (see video: http://www.youtube.com/watch?v=7lyg6R-aBQI). If they moved too quickly they received penalty (minus points). The players were chased by three ghosts, which had “self-programmed” unique movement styles like in the original Pac-Man game. Players collected to their “Pac-Bags” glooming ice hockey pucks, which were painted with phosphorus paint. If they managed to switch off one of two table lamps, they had some time to chase ghosts. The hunters become the hunted (see also Pac-Man: The Movie, a trailer, http://www.youtube.com/watch?v=fWL6j0SvqV0). 20 players trialed the game which was one sub-game of a larger InsomniaGame experiments (See Stenfors, forthcoming). Almost all of the players filled a feedback form afterwards (InsomniaGame Survey 2010) or wrote about the game in their own research field notes (InsomniaGame Research Field Notes 2010), if they were students doing participatory observation of the course of digital culture.

5. GAMING EXPERIENCE

The research group took probably for a granted the fact that all of the players would be familiar with the Pac-Man game and thus able to play the auditorium version without major explanations. After viewing the introductory video, all the players were asked to pose questions if they had anything to ask about the game. Although the actual gaming went quite well, one of the players wrote afterwards in the survey that they would have needed a little more guidance about the game, and not everybody had played any version of Pac-Man beforehand. However, also observation proved that players enjoyed the game, and five of them played it again after thinking carefully about the best tactics to obtain as much points as possible.

The game with all lights and sounds and rules was also described as hypnotising (in a newspaper article, written by a journalist who participated in the game, Karonen 2010), and it provided a strange and immersive opportunity to go inside of a classical videogame. 11 participants answered the survey questions involving the Auditorium Pac-Man. The participants mostly liked the game and thought that it was well organized, fun and challenging enough. The game was commented as being “fun and interesting”, “entertaining, even surprisingly entertaining.”: “It was exciting as being yourself as a game character instead of a pixel Pac-Man.” One of the players criticized that instructions were not explained clearly enough (for example use of lamps), and one of the players commented that there should have been more step marks on the floor for getting the right length for the steps and movements. (InsomniaGame Survey 2010).

6. CONCLUSION

The Auditorium Pac-Man experiment was very successful in general. The game acted as a good and different additional value in the Insomnia LAN-party event, and gave an opportunity to construct experiences of
reflective nostalgia (Boym 2001): different kinds of game cultural meanings related to retrogaming even though not all of the players were totally familiar with Pac-Man game in advance.

In the next Insomnia event in October 2011 we will re-test the Auditorium Pac-Man game concept and make small modifications to it. More organizers will be recruited, for example, to count of points and to promote the gaming session. Moreover, the game instructions will be made and explained more carefully. In addition, it will be possible to organise an exhibition about Pac-Man and its legacy in digital game culture. Therefore, potential players (larger amount than last time) are able to get to know Pac-Man phenomenon more comprehensively before they themselves try the Auditorium Pac-Man.

The research, conducted in 2010, could be expanded next time with more detailed interviews about players’ experiences on game cultures and histories. On the other hand, the research can focus more, on creation of immersive gaming.

ACKNOWLEDGEMENT

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USING GAME ELEMENTS TO MOTIVATE ENVIRONMENTALLY RESPONSIBLE BEHAVIOUR

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ABSTRACT
This paper describes the application of game elements in improving environmentally responsible behaviour in domestic energy consumption. A product that implements game elements was designed for families with children. The product is based on a EU founded project called SOFIA that aims to connect the physical world to the information world through smart objects. A short evaluation was done on the relevance of applying game elements to improve environmentally responsible behaviour. The evaluation showed that the design had a positive effect on raising the awareness of children about their ERB.

KEYWORDS
Game elements, sustainability, motivation, environmentally responsible behaviour, product design

1. INTRODUCTION
People are leaving an increasingly noticeable environmental footprint on the planet. The causes and effects of this footprint have been the subject of many scientific studies, but remain a source for much debate and development. A study by Burgess et al (2008) indicates that of all the energy that people consume, 30% is consumed in a domestic setting, roughly 30% of which can be attributed to behavioural choices. By stimulating more Environmentally Responsible Behaviour (ERB), our energy consumption can be reduced by up to 10%. The purpose of the work presented in this paper is to look for new designs to improve ERB.

This paper aims to contribute to both the fields of serious gaming and motivating people for ERB. During the last couple of years a number of very popular multiplayer network games have emerged. MMORPGs (e.g. World of Warcraft), are very well designed for attracting and sustaining people's interest and providing them with the motivation to play for many hours a day. The qualities of such games could be used in other situations to stimulate certain behaviour in people (McGonigal, 2010). A possible way in which game elements can be applied in the area of ERB will be described next. The contribution of this paper is to suggest a new application of game elements in design, in order to improve people’s motivation for ERB.

2. DESIGN
The work presented in this paper is part of the ongoing research in the context of the SOFIA project\(^1\). SOFIA (Smart Objects for Intelligent Applications) is a European research project addressing the challenges of the Artemis sub-programme 3 on Smart Environments. The overall goal of this project is to connect the physical world with the information world, by enabling and maintaining interoperability between electronic systems and devices. Our involvement in the project includes developing smart applications for the smart home environment, and by developing novel ways of user interaction (Van der Vlist et al, 2010a, 2010b; Kwak et al, 2011). In this context, devices in a home environment can be connected to each other and exchange information. The SOFIA project provides the middleware infrastructure for these connections, enabling

\(^1\) www.sofia-project.eu
device interoperability and information exchange (Niezen, 2010). This enables us to use existing interaction data in the environment as well as information captured by various sensors as input to our design.

2.1 Design Description

Using these advances as enabling technologies, a product was designed for such an environment that would improve people’s ERB by raising awareness of energy consumption. The product consists of local feedback devices and a central feedback device. The local feedback devices give direct feedback to the user on their consumption and the central feedback device gives overall feedback on ERB of the different people in a household. The overall feedback is represented by a tree and the trees are placed together in a “garden” (Figure 1). These trees consist of building blocks and each individual user can construct their personal tree in any way they want. There are 3 different kinds of building blocks (straight, angled and split pieces) and they provide endless building possibilities. The amount of building blocks and thus the size of the tree represents the user’s personal effort on reducing resource consumption. The user can earn building blocks with good ERB and direct feedback on ERB is given by the local feedback devices (triggers). These triggers show when the user earns points for ERB by changing shape and standing upright. These points are represented by lights in the building blocks for that person’s tree. When all building blocks are lit up, the user can add a piece to it.

![Figure 1. A garden with several (personal) trees (left) and several triggers (right)](image)

The target group of this design are families with young children (8 - 12 years old). Children at the age of 8 are getting to a stage of cognition where they can make sense of cause and effect of their actions (Schlottman, 1999). The involvement of the entire family adds to the social aspect of (extrinsic) motivation. The aesthetics of the design are based on a plant/tree metaphor. This metaphor is associated with our natural environment and that the better the ERB of the user, the larger the tree will grow. Each domestic device connected to the SOFIA platform can communicate information on who is using it, and how much resources that person consumes. This is the foundation for the interaction with the design. The input for user interaction will be everyday interaction with domestic appliances (e.g. shower or television). The feedback is facilitated by the design as is explained in Figure 2.

![Figure 2. Model of the user interaction with the design](image)
2.2 Game Elements

The design contains game elements, which are derived from the work of Chatfield (2010). Chatfield has abstracted the qualities of games into basic elements that make (online multiplayer) games so engaging to play. These elements were implemented in this project to create motivation for ERB (Figure 3):

- Gaining levels: the size of the tree represents the level of good ERB from a person.
- Long and short term goals: The trigger is short-term, the tree represent a long-term goal.
- Always reward effort: users get rewarded for trying to behave well.
- Rapid, clear and frequent feedback: A trigger responds to each resource consuming event.
- An element of uncertainty: Users do not know what kind of building block they will get next.
- Involving other people: Users can compare their trees and compete for the best building results.

![Visual representation of the implementation of game elements in the design](image)

3. USER EVALUATION

3.1 Setup

A small-scale user evaluation was executed to evaluate two main motivating aspects of the design: competition with other people and building a personalized tree. The evaluation was done with 5 people from the target user group (children between 8 – 12 years old). These children were all Dutch and either in the final years of primary or the first years of secondary school. The evaluation was performed in a home situation and the results were recorded with a camera and by taking notes of events and comments. The evaluation was performed with a prototype of the tree that allowed the participants to build a tree out of building blocks. This prototype consisted of a base unit and 30 building blocks, which allowed for complete freedom to build a unique tree.

3.2 Procedure

The test started with an introduction to the design and how the participants could build their own tree later in the test. The purpose of this introduction was to test whether the prospect of building this tree (later in the evaluation) would motivate the participants to think about ways in which they could improve their ERB. The competition element was evaluated by having each participant build their own tree and compare them in the final discussion. The next step was a questionnaire about ways to improve ERB. Each right answer would result in a point, and for each point a participant would get two building blocks to build a tree with. After the questionnaire each person was asked to build a tree, and in the end the child with the nicest/biggest tree would “win”. Judging the beauty or quality of a tree is arguable, but for this test its purpose was to create the element of competition between the participants. In the discussion the nicest tree would be chosen by voting.

Five children participated in the test and their correct answers (counted as points) are shown in table 1.
Table 1. Results of the questionnaire about ways to improve ERB

<table>
<thead>
<tr>
<th>Participants</th>
<th>Age &amp; Gender</th>
<th>ERB improvements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mario</td>
<td>11 Y/O; male</td>
<td>7 points</td>
</tr>
<tr>
<td>Siem</td>
<td>9 Y/O; male</td>
<td>9 points</td>
</tr>
<tr>
<td>Evi</td>
<td>10 Y/O; female</td>
<td>9 points</td>
</tr>
<tr>
<td>Huub</td>
<td>10 Y/O; male</td>
<td>8 points</td>
</tr>
<tr>
<td>Dimme</td>
<td>11 Y/O; male</td>
<td>9 points</td>
</tr>
</tbody>
</table>

Building the trees was a fun experience for all the children. It was a social process, where they advised and commented on each other’s trees. Every participant tried to make their tree unique and as different from the others as possible. The prospect of earning building blocks and building their own tree was a big motivation for the children and they were very concentrated on thinking of ways to improve ERB.

4. CONCLUDING REMARKS

The way in which the game elements were implemented in the design was engaging for the children. Both the competition and the building of the tree were a good stimulation to get children to think about ways they could reduce their environmental footprint.

The preliminary evaluation performed was informal and it could not be used as hard evidence that the game elements really improved ERB and if so, to what extent. Whether this would really lead to significant and sustained behaviour change is something that needs more research. A more controlled experiment is needed, possibly in a new context, to draw definitive conclusions.

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MAXIMIZING USER COMFORT & IMMERSION
A GAME DESIGNERS GUIDE TO 3D DISPLAYS

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ABSTRACT
Recent months have seen the introduction of several solutions to introduce stereoscopic vision to computer games. Although the technical aspects are all well understood, design approaches taking human factors and view quality into account have yet to be developed. This paper give a short introduction in the area, an overview of the already published work in the area of autostereoscopic vision for both computer games and video, as well as useful hints for the game designer and a few first design principles.

KEYWORDS
User comfort, stereoscopy, computer games

1. INTRODUCTION

One of the key elements of game development is to heighten the immersion of the user, i.e. all means that increase the user experience of perceiving the game as reality. This can be done by e.g. using realistic graphics, whose effect can be heightened further by using a 3D display solutions, like NVIDIA's 3D Vision, Nintendos 3DS, and Sony's enhancement of the Playstation 3. Although many reports have been done on the more technical aspects of these display systems (see (NVIDIA), (Schneider and Matveev, 2008), (Flack et al., 2009) and (Sony) for examples), much research still needs to be done on more subjective aspects like user comfort and corresponding guidelines have to be developed. This paper is meant as a first step to close this gap.

Many different 3D displays are available, however this paper concentrates on autostereoscopic and glasses-based (both polarization and shutter) displays, since these share common problems and all systems available to the customer fall in these categories. All these systems have in common that they create the illusion of three-dimensional images by showing each eye a slightly different image. Thus the eyes of the user are tricked to see objects in places were they are not, which can however confuse the human focusing system and ultimately lead to eye-strain. Reducing the discomfort for the eyes while at the same time maintaining a vivid 3D effect is the main challenge a modern game designer faces in this regard.

Although only few studies have been conducted on 3D quality in computer games (see (Häkkinen et al., 2006) or (Ogniewski and Ragnemalm, 2010) for examples), the problem is much better researched by the video society, and much can be learned from their results. For example, Lambooij et al. (2009) and Kalva et al. (2006) examined stereoscopic systems for video applications in regards to user comfort. Speranza et al. (2006) analyzed how spatial motion effects the visual comfort in autostereoscopic 3D devices, while Wopking (1995) formulated equations to find comfortable viewing zones, i.e. the zone in which the objects can be virtually placed to minimize eye-strain. Chen (2011) developed rules on how the two cameras should be correlated, while Jones et al. (2001) described how the perceived depth can be controlled. Finally, Meesters (2004) presented an overview of different artifacts that can occur in stereoscopic image systems, and Konrad and Halle (2007) suggested different solutions to overcome some of these shortcomings. Although most of the results apply to video games as well, a few problems do not arise there (like e.g. blocking artifacts due to the video compression), while others are introduced.
2. SHORTCOMING OF CURRENT STEREOSCOPIC DISPLAYS

The main problem of stereoscopic displays is that it forces the human eye to perceive objects in another place than where they are actually located, thus introducing an accommodation problem since the vergence distance and the focal distance are not the same (see also (Shibata et al., 2011)). This effect can lead to severe eye strain if the display is observed over a longer time. The effect and its strength is very different from user to user, a certain percentage of the populace is even not able to see the such images in 3D at all. The eye strain can further be increased if the user is presented with contradicting depth cues, like e.g. wrong occlusion (the importance of occlusion as depth cue was already presented in (Cutting and Vishton, 1995)). Furthermore, Speranza et al. (2006) showed that movements towards to resp. away from the user (i.e. in depth or the z-direction) increases eye strain as well. Although it is often assumed that all kind of motion can increase the stress on the users eyes, the author could not find a study which confirmed this.

The main task is to reduce this stress on the eyes of the user and their “workload” as far as possible. This can be done by obliging to the following basic rules: 1. keeping the scene as realistic (in terms of using correct depths and occlusion) and 2. as simple (i.e. including as less objects and depth variation) as possible (both to lessen the burden on the user eyes) and 3. to give the user possibilities to adjust settings, thus accommodate to the fact that the perceived 3D effect and the discomfort it causes varies from user to user. In most cases the display supplier already provides these settings which can easily be incorporated in an application.

Note that eye strain is not limited to 3D displays and in fact occurs even if using 2D displays. However, due to the unnaturalness of the presented images in case of 3D displays and the higher stress this induces on the eyes, 3D displays are more prone to lead to user discomfort.

3. DESIGN SUGGESTIONS

The main problem (as mentioned earlier) is the difficulty of the eyes to focus correctly on the scene. This should not be made even more difficult by e.g. introducing a focus blur (like is often done in (2D) movies). Flack et al. (2009) suggested an auto-focus procedure which is designed to ease the focusing for the eyes of the user. Furthermore, problems can arise if the user does not reside in the “sweetspot” in front of the display, which leads to viewpoint distortion of the image. If the display in question is an autostereoscopic display, this can further introduce ghosting artifacts (i.e. that one view “leaks” to the other one, see (Konrad and Halle, 2007)). These problems occur especially if the display contains an accelerometer or gyroscope which is used as input device, which should better be avoided if the different user positions cannot be treated appropriately. This can be done by detecting the user via e.g. headtracking and adjusting the image accordingly, which can also be used to introduce motion parallax (another very important depth cue), i.e. calculating the stereoscopic image based on the viewpoint of the user. See (Ogniewski and Ragnemalm, 2010) on more information on user tracking and motion parallax.

Although objects “popping out” of the screen are more eye-catching, many individual statements indicate that they lead to higher eye-strain as well than. A study proving this has still to be conducted, but looking at the maximum distance the objects can be placed in front / behind the screen in the comfortable zone according to Wopking (1995), it can be noticed that this zone stretches farther behind the screen than in front of it. Or, to put it in another way, an object placed at a certain distance in front of the screen causes higher eye strain than an object placed at the same distance behind the screen.
Furthermore, placing objects in front of the screen can lead to problems where objects are cut by the edge of the screen thus introducing unnaturalness to the scene which both decreases the immersion and increases the discomfort (see also figure 1), especially if the object is only truncated in one of the two views. Another problem occurs if the screen is in question is a touchscreen which is used as an input device as well. The control elements should then be placed on the same plane as the screen itself, because any other placement (above or below the screen) would lead to confusion of the user and at least to a decreased immersion. In the worst case it hinders the user of making correct inputs. Placing objects in front of the control elements would either hide them or lead to an unnatural scene where objects farther away occlude nearer objects, which of course heightens user discomfort and lessen their immersion. It is therefore the recommendation of the author to place objects behind the scene rather than in front. That said, in a few cases objects could be placed in front of the screen, in which they should be placed in the middle to avoid the problem of truncated objects. If used sparsely, the pop-out effect will be even more spectacular and effective. An example could be a trench penetrating the windshield after the user crashed with his car in a racing game.

Autostereoscopic displays are using irregular masks which can introduce aliasing artifacts, which the game designer should deal with (for more on that see (Konrad and Halle, 2007)). However, even in the case of glasses-based display systems anti-alias is desirable, since the effects of the alias may vary between the two different images – in extreme cases fine structures may even only be visible in one view, but hidden in the other thus leading to a very artificial looking scene and higher discomfort and lesser immersion of the user.

Finding out which effects work only in 2D and which are possible in 3D as well is another important part of game design for 3D displays. A list of popular techniques and suggestions how they could be implemented if using 3D displays can be found in (NVIDIA). One important point should be noted here: all objects needs to be rendered at the correct depth and using the same depth range since otherwise the scene will look unnatural. Thus effect using wrong depths, like e.g. billboardung, bump-mapping, and skyboxes, should better be avoided. In the case of skyboxes, this might be compensated by placing them as far from the user as possible and introducing distance blur, which also minimizes problems due to missing anti-aliasing (since the most notable aliasing probably occurs in objects placed far away). Furthermore, distance blur also another important depth cue (see also (McNamara et al., 2010) and figure 2), and therefore it is the recommendation of the author to introduce such an effect.

On a final thought, the game designer should be aware that 3D displays (especially glass-based ones) can decrease the illumination of the display significantly. Darker scenes are therefore best avoided. Furthermore, high contrasts can lead to ghosting artifacts, i.e. that part of the image, which is destined for one eye can be seen by the other one as well. This can happen due to imperfections of the optical system in case of the an autostereoscopic display, and due to the time needed to switch between a lighter and a darker color in the case of glass-based systems. If the display system is known in advance, ghosts can be treated accordingly. For more information on that see (Konrad and Halle, 2007)).

As might have become clear, not every game is suited to be played on a stereoscopic display. The game designer should made sure that their game works on a 3D displays if one should be used. Furthermore, a game should not depend that it is played with a 3D display. Instead, the 3D display should be used as a mere instrument to heighten the immersion. In fact, Nintendo issued a statement that they will make no game which makes the use of the autostereoscopic display on the 3DS obligatory (Nintendo 2011). Bearing that in mind, there are games which can profit from the added depth, like platformer or racing / flying simulators. Also, the 3D effect is be more impressive in slow-paced games, giving the user the possibility to really observe it. This furthermore helps avoiding problems with rapid motions as mentioned earlier.

Figure 2. Distance blur as depth cue. 2a) (left) without distance blur, 2b) (right) with distance blur
4. CONCLUSION

3D displays can considerably heighten the immersion of the user, but can also lead to severe discomfort. Therefore, content for such displays has to be designed carefully to both heighten immersion and decrease discomfort. This paper gives guidelines to which a game designer should adhere if designing games for stereoscopic displays. Keeping the scene simple yet realistic and giving the user possibility to adjust settings like perceived depth all work towards minimizing the discomfort the user might experience due to the unnaturalness of the display system. Although stereoscopy should be considered only as a mean to increase immersion and not as a necessary game play mechanism, certain games may profit from it.

Even though only limited studies have been conducted on the usage of 3D displays in computer games, their application in video systems is much better researched, and many of the results can be directly applied to computer games as well. The game designer should therefore make use of these publications to optimize the usage of 3D displays.

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Posters
XENUBI: THE DEVELOPMENT OF A CHEMISTRY EDUCATIONAL GAME FOR MOBILE PHONES

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ABSTRACT
The purpose of this paper is to discuss general and methodological aspects for the production of digital contents for teaching chemistry at the intermediate level. The digital contents covered herein are electronic educational games that may stimulate learning through mobile phones, or m-learning. In that sense, the project presented is a super trump type game.

KEYWORDS
Games, mobile, m-learning, chemistry.

1. INTRODUCTION

The teaching institutions are broadening the use of information and communication technologies to offer students interactive media that can enliven classes. Digital games appear within this context as a didactic resource that features characteristics that may bring several benefits to the teaching and learning practices. This project is based in the sense of promoting the production of electronic games for mobile phones.

Towards that sense, Motiwalla (2007) indicates that the majority of constructive learning pedagogy can be adapted to a mobile learning environment. The key is to understand the potentialities and difficulties in a particular technology when implementing good pedagogical practices to attain specific learning objectives. Thus, besides focusing on the decision system and the network architecture, an overlook of learning pedagogy is indispensible when elaborating a global strategy for \textit{m-learning}. Therefore, we are adapting within the scope of this project experiences that are proven to be successful, as is the case of Godoi, Oliveira & Codognoto (2010) proposed approach for the periodic table in the production of electronic games for mobile phones.

In turn, Wang, Wu & Wang (2009) point out the characteristics of learning with mobile phones (\textit{m-learning}, ‘m’ for \textit{mobile}) and indicate that \textit{m-learning} can covert into the possibility of learning activities for students at any time, any place using wireless internet and mobile devices (such as 3G mobile phones, PDAs and handsets).

Lastly, according to Churchill & Hedberg (2008), although the use of handheld devices has the potential to create more inciting pedagogies, the main limitation of handheld technologies for their use in education is the small screen size available to effectively display the planned activities. The smallness of the screen not only affects clarity of information, it may also lead to negative impacts on the acceptance and integration of this potentially useful technology for education.

2. A FEW METHODOLOGICAL ISSUES

Developing applications for mobile phones is a challenge. From the design point of view, the medium characteristics that impose restrictions to the project are the following: i) disk space and processing (there
is a need to “gain bits”, that is, optimize graphics; ii) wording (actions that require writing must not be encouraged due to the inappropriate keyboard function); iii) browsing (when designing interaction for mobile phones we see how comfortable we are with the mouse-based interaction model), iv) screen size (there are several screen sizes that can be classed as small - iPhone: 960 x 640 -, very small -E63: 320 x 240 - and extremely small - 128 x 160), v) screen luminosity (mobile phone screens enter a “hibernation” state to save the battery, that action delays interaction and interrupts the flow).

2.1 Periodic Table Super Trump Application

This application has almost the same objective and rules as the card game Super Trump but instead of aircraft and racing cars, the theme is the periodic table, initially (Godói, Oliveira & Cognoto, 2010). The differences between the version of card game and the mobile game are:

- There is a chance to see the information about the chemical element in the mobile device, for knowing the location of the chemical element in the periodic table the player can make a more informed decision.
- In each round is always the human player who chooses the property that will be compared.
- The choice of property to be compared has a time limit for bringing a sense of challenge.

Another difference is the identity of the game, see Figure 1. The name chosen was Xenubi, which comes from "chem noob" (the slang term "noob" is often used by people who enjoy digital games), which means "beginner in chemistry". From the name was developed for a communication line that mimics the school environment, using a sheet of notebook and hand-made types. Later, it was decided to use a character to promote navigation through the game. The character is a caricature of Henry Moseley, the scientist who proposed the existence of the atomic number and that produced the periodic table in a form closer to the present.

For later on there is the intention of developing games with other themes and for other fields of knowledge. Any device that supports Java can receive this game.

3. CONCLUDING REMARKS

The distribution of learning settings over the internet is in itself an important form of disclosing the results that are to be attained with the development of this project. The products made available over the internet will be free of access and distribution charge, which considerably broadens the expansion for this product to reach their target public: basic education teachers and students, mainly.

After finishing the development of this product, courses will be provided for teachers in the same way as those provided in previous projects of the same type, without costs for this project, aimed at disclosing them and discussing pedagogical strategies for their use in different school realities.
REFERENCES


USING GAME-BASED ANIMATION TO ASSIST OLDER ADULTS IN LEARNING HEALTHCARE KNOWLEDGE

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ABSTRACT
The present study investigated the extent to which digital games could enhance learning effects of the older adult in the context of multimedia learning. A total of 18 older adults aged over 65, and 18 college students (as a control) participated in an experiment where healthcare information were displayed by paper, animation, and animation with digitized slot/fruit-machine games. Learning effects were operationally defined by recall hit rates of the learned materials and by subjective user experiences. With respect to the hit rate, the preliminary results indicated that the game-based learning significantly outperformed the animation and the traditional paper presentation. With respect to the user preference, the results revealed that both older and young subjects reported higher preference of the game-based learning to the paper-based and animation display. Implications for design of game-based digital learning with age-difference considerations will be discussed in details as the present study progresses.

KEYWORDS
Digital games, animation, multimedia learning, cognitive aging.

1. INTRODUCTION
Research in aging has shown that age is normally negatively correlated with human cognition, including memory, attention and comprehension (Park and Schwarz, 2000). The increasing popularity of digital games thus provides a potentiality where older adults can benefit from the entertainment technology for their digital welfare, e.g., lifelong learning (Ijsselsteijn et al., 2007). Digital games enable a wealth of display effects that traditional paper-based presentations can never achieve (Prensky, 2001). Typical examples include animation and 3D virtual reality. Meanwhile, the various entertaining elements incorporated in the games have been demonstrated to effectively motivate interaction behavior and enhance the performance as a result (de Freitas, 2006; Garris et al., 2002). Considering the existing postulations, the present study aims to empirically investigate the extent to which an animation-based digital game can assist older adults in multimedia learning. The results are expected to provide guidelines for designing game-based digital learning media with age-difference considerations.

2. METHODOLOGY

2.1 Experimental Design
The experiment consisted of two independent variables, namely, age and learning media. Age was a quasi between-group factor and was defined by two levels of treatment: old and young. Learning media was defined by three levels of treatment, consisting of traditional paper-based presentation, animation-based presentation, and animation with game-based presentations. This factor was designed as a within-subject factor, in which the subject was required to receive all the three media treatments that were randomly presented. Performance
measures were operationally defined by the recall hit rate of the presented materials. All subjects were required to report their subjective preference over the three learning media as well.

2.2 Subjects

Eighteen adults aged over 65 years old were recruited from a local learning center as the subjects for the old group. All of the older participants held a high school diploma or above. Eighteen students aged between 18 to 25 years old were recruited from a local university as the subjects for the young group. Both groups received a pre-test concerning their general level of healthcare knowledge. A t test indicated no significant difference between the two groups.

2.3 Materials/Systems

The contents of the three experimental systems were healthcare knowledge in preventing cardiovascular diseases. The paper-based media presented the material in printed text and graphs. The animation media, as exhibited in Figure 1 presented the material by animated visuals programmed by Flash (v. 8.0). The game-based animation system, as exhibited in Figure 2 adopted the slot/fruit machine as the entertainment element where the subject was allowed to play on the various combinations of different foods associated with three scales of health severity – health, warning, and danger.

![Figure 1. A snapshot of the animation system illustrating the stocking of cholesterol in a vessel.](image1)

![Figure 2. A snapshot of the game-based system illustrating a slot-machine combination of foods dangerous to cardiovascular diseases.](image2)
3. RESULTS AND CONCLUSION

Table 1 shows the descriptive statistics for the recall hit rates of the two age groups under the manipulation of the three learning media.

<table>
<thead>
<tr>
<th>Learning Media</th>
<th>Age group</th>
<th>Old group</th>
<th>Young group</th>
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<tr>
<td>Paper-based</td>
<td>0.488 (0.053)</td>
<td>0.640 (0.089)</td>
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<tr>
<td>Animation</td>
<td>0.512 (0.053)</td>
<td>0.582 (0.069)</td>
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<tr>
<td>Animation with game</td>
<td>0.653 (0.085)</td>
<td>0.787 (0.067)</td>
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With respect to recall hit rate, the analysis of variance (ANOVA) indicated that while there was no interaction between the two factors \((F[2, 20]=2.14, p=0.143)\), the main effects of age \((F[1, 10]=13.01, p<0.005)\) and learning media \((F[2, 20]=41.92, p<0.000)\) were both significant. The disadvantage of older adults in cognitive processing was again confirmed in this study. Regarding the source of variation for the leaning media, a post-hoc Tukey analysis revealed that it was mainly derived from the superiority of the game-based treatment over the paper-based presentation \((p<0.000)\) and over the animation alone presentation \((p<0.000)\) respectively. The difference between the paper-based presentation and animation alone was only a random effect \((p>0.81)\). Obviously, incorporation of an entertaining element, the slot-machine in this case, significantly enhanced the learning performance for both the older learners and their young counterpart.

With respect to subjective preference over the three different media, the aspects of entertainability, confidence, and motivation were surveyed. The Freidman rank-sum test indicated that the game-based animation received the most favorable preference over the other two media across the three aspects. Interesting to note was the finding that the preference difference between the animation and the paper-based presentations was only due to a random result, suggesting that in the absence of game-based elements, the seemingly modern animated visuals do not necessarily receive higher likeness over the old fashioned paper-based text and graphs.

In summary, the result of the present study suggested that animation incorporated with game-based elements not only enriched subjective learning experiences but also enhanced objective learning performances. This is true for both older and young learners. Nevertheless, the implication should not be interpreted without cautions as the virtual slot-machine functionality employed in the experimental system was only at a primitive and causal level. Future research is needed to further investigate the effect of more complex and serious digital entertainments on learning or on human-computer interaction in a general sense.

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