



Join-In

Senior Citizens Overcoming Barriers by Joining Fun Activities

AAL Joint Programme: Project No. 031121

Deliverable: 3.1

Computer Based Games for Adaptation/Development

Date of deliverable: 30-11-2011

Lead contractor for this deliverable:

ITC

Contributors:

NST, Norut, IT Carlow, PAS, DMM, HMGU

Dissemination Level: Public

Project Duration: Nov. 2010 – Oct. 2013

Project co-funded by

Disclaimer

The content of the document is owned by the Join-In Consortium and is protected by the applicable copyright laws. Any duplication, processing, distribution or any form of utilization is not authorized without prior written consent.

The commercial use of any information and data from the Join-In web sites requires a license from the owner of the information.

The Join-In Consortium members were committed to publishing correct information. The Join-In Consortium members do not assume responsibility for any errors or omissions nor do they accept liability for any direct, indirect, special, consequential or other losses or damages of any kind arising out of the use of this information.

When citing the deliverable please use the following information

Join-In Project Report D<Nr> <Title>, <Year>. Retrieved <The date on which you retrieved the information> from <URL>.

A short note on the publication to the Coordinator (contact@join-in-for-all.eu) would be very much appreciated.

Table of Content

About Join-In.....	1
1 Introduction.....	3
1.1 Games.....	3
1.1.1 What is a Game?	3
2 Elements.....	4
2.1 Story and Theme	4
2.2 Mechanics	8
2.2.1. Space.....	8
2.2.2. Objects.....	9
2.2.3. Attributes.....	9
2.2.4. Actions	10
2.2.5. Rules.....	11
2.2.6. Skills.....	13
2.2.7. Chance.....	15
2.3 User Interface	16
2.4 Game Balancing and Experience	18
2.5 Goals and Challenges	20
2.5.1. Reaction Speed.....	21
2.5.2. Accuracy and Precision.....	23
2.5.3. Puzzles.....	24
2.5.4. Rhythm.....	26
2.5.5. Memory	28
2.6 Feedback.....	29
3 Serious Games.....	34
3.1 What is a Serious Game?.....	34
3.2 Serious Games for Elderly.....	35
3.2.1. Story and Themes in Serious Games	37
3.2.2. Mechanics in Serious Games.....	38
3.2.3. User Interface in Serious Games	39
3.2.4. Game Balancing and Experience.....	41
3.2.5. Feedback in Serious Games.....	41

D6.2 Results from the trials

2	Recommendations for Join-In	42
3	Conclusion	44
4	References	46

About Join-In

Join-In aims at providing the methodology and the technologies for elderly persons to participate in social activities and have fun via digital media.

Loneliness in the elderly is a major problem in elderly care. Studies in Britain show that more than half of the people over the age of 75 live by themselves. Many of these suffer from loneliness and social isolation¹. Activities offered by social services do, however, often not reach those most in need. Challenges for the elderly include: social deprivation, low self-esteem or physical inability. Social isolation and health are closely related and may lead to a variety of physical disorders and even depression. Studies have shown the correlation between loneliness and poor health. Especially the effects on immune system, the cardiovascular system and the onset of Alzheimer's disease could be shown²³⁴.

The Join-In project aims at counteracting loneliness in the elderly by providing a concept, the methodology and technologies for elderly persons to participate in social activities.



Fig.1 Join-In Platform

¹ Office of National Statistics: Older people, Living arrangements. At: <http://www.statistics.gov.uk/cci/nugget.asp?id=1264>

² CARMA – Care for the Aged at Risk of Marginalization (QLK6-CT-2002-03421) - Recommendations and Guidelines to Policy Makers. (2005). <http://www.egga.ee/RecommendationsFinalwCoverTOC.pdf> Last accessed:2/10

³ Sorkin D, Rook KS, Lu JL: Loneliness, lack of emotional support, lack of companionship, and the likelihood of having a heart condition in an elderly sample. *Ann Behav Med.* 2002 Fall; 24(4):290-8

⁴ Tomaka J, Thompson S, Palacios R: The relation of social isolation, loneliness, and social support to disease outcomes among the elderly. *J Aging Health.* 2006 Jun; 18(3):359-84

D6.2 Results from the trials

Join-In is setting up a social platform for the elderly; it allows communication by TV, Tablet and PC. A multi-player serious game for the elderly is being developed. The interest in gaming is high in seniors: In a survey performed in Germany with 1200 participants, age above 61, two out of three PC users stated that they enjoy playing games regularly on the internet⁵. Studies⁶ could demonstrate the increase of cognitive skills, reaction times, self-esteem and the sense of well-being in the elderly when playing computer games. Another positive effect is that gaming is multigenerational and enables the elder generation socialising with the younger one, e.g. grandchildren. The concept includes exercising either by exergames or by moderated exercises as physical activity -besides supporting good health- counteracts the feeling of loneliness, while loneliness leads to less physical activity⁷. Recent results indicate that exergames create physical benefits and counteract loneliness⁸. Join-In encourages contacts with peers in the region and with family and friends living further afield - if necessary facilitated by an assistant.

Active participation is vital if the individual is to profit from the Join-In developments. Yet motivation for participation among the elderly is a challenge. One of the problems is the heterogeneity of the elderly, among other things regarding interests and health. Join-In is developing a methodology for elderly persons to participate in social activities. This is based on a thorough user requirement analysis. User groups are set up in Germany, Hungary, Ireland and Norway. The lead user group is based in Munich. Based on the results of the user requirement analysis and the analysis of relevant studies and related work a methodology for setting up a social networking platform which will encourage and enable involving homebound senior persons in social networking activities being developed. Digital inclusion and factors hampering its acceptance -such as accessibility, motivation, lack of skills and confidence- will be tackled and form part of the methodology. The involvement of user groups in four different countries will help us to achieve a European solution which will also be useful in other countries.

The Join-In project web-page:

<http://www.join-in-for-all.eu>

⁵ OE24.at. Deutsche Studie - Sechs von zehn Senioren spielen am Computer.
<http://www.oe24.at/zeitung/digital/article318942.ece>. Last accessed: 2/10

⁶ Basak C, Boot WR, Voss MW, Kramer AF: Can training in a real-time strategy video game attenuate cognitive decline in older adults? Psychol Aging. 2008 Dec; 23(4): 765-77).OE24.at

⁷ Hawkey LC, Thisted RA, Cacioppo JT: Loneliness predicts reduced physical activity: Cross-sectional & longitudinal analyses. Health Psychol. 2009 May; 28(3):354-63

⁸ <http://www.theatlantic.com/technology/archive/2011/02/physical-video-games-may-help-the-elderly-psychologically/71184>

1 Introduction

The purpose of this report is to define what a game is, and identify the common elements and mechanics that are present in games. By doing this it will then be possible to identify which of these elements and mechanics should be considered for inclusion in the Join-In game. Recommendations for Join-In are made before the conclusions of the report. The general requirements provided by the user groups and how these are implemented in the developments are described in D 3.2 (Technical Design Document).

1.1 Games

1.1.1 What is a Game?

A game is defined by Jesse Schell as “a problem-solving activity, approached with a playful attitude” (Schell, 2008).

A game designer is responsible for the experiences a game can provide to a player. It is important for a designer to efficiently articulate what they mean when say a certain design is good or bad, and how it can be improved or adapted. It is not important to know the vocabulary, but to understand the ideas of game design (Schell, 2008).

Although understanding and communicating design ideas is the most important goal for a designer, it should not mean that some form of definition not be attempted. Definitions can help the designer think more clearly and better analysis different design elements. Nevertheless, a designer needs to bear in mind that a term such as “experience,” “immersion”, and “game”, are defined differently between individuals and change over time (Schell, 2008).

There are many elements to be considered when developing a video game. The elements detailed in section 2 are common elements found in most video games. Section 3 describes how these elements are relevant to the design and development of games for the elderly.

2 Elements

2.1 Story and Theme

A story is defined as “an account of a series of events, either historical or fictitious” (Adams, 2009). The purpose of a story in a video game is to increase the entertainment value and immerse the user thus motivating the user to play the game for longer. An interesting and engaging story is a key selling point for marketing commercial games (Adams, 2009). Adams identifies four factors that affect the importance and depth of the story in a game. These factors are length, characters, degree of realism and emotional richness. Longer games benefit from a detailed story as it keeps the users engaged even if the gameplay is repetitive. The role playing game (RPG) *Final Fantasy VII* features a long story mode with an average completion time ranging from 35 to 50 hours (Figure 1).

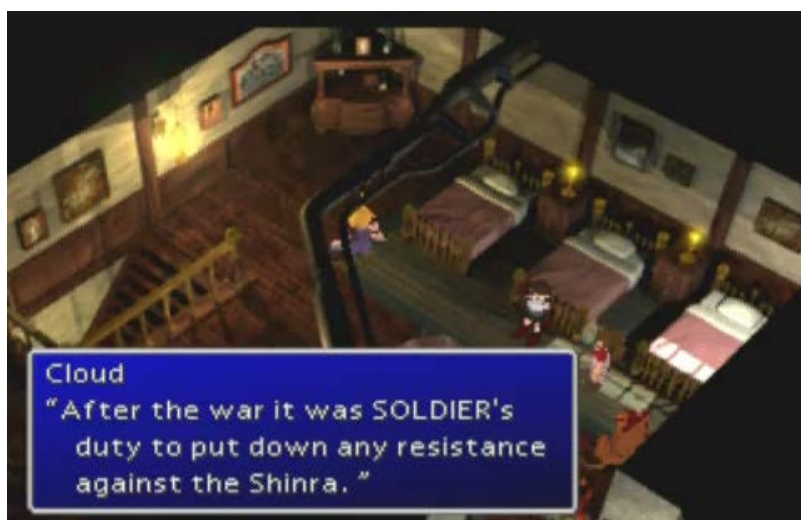


Figure 1 '*Final Fantasy 7*' in-game story section.

Games that feature a small number of main characters profit from a storyline more than games where there are many unnamed characters or no main characters at all (Adams, 2009, Figure 2, Figure 3).



Figure 2 '*Chrono Trigger*' is an RPG with a detailed storyline involving the main protagonist 'Chrono' and his friends.



Figure 3 '*Theme Hospital*' features many characters while having no storyline.

Join in - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

The emotional richness of the story is linked to how connected the player should feel to the character. *Super Mario Bros* did not require the player to feel connected to *Mario* so the game only featured a minor storyline (Figure 4). In the game *Metal Gear Solid 4* the player should feel deeply connected to the main character *Solid Snake* as the game contains lengthy story sequences designed to create a rich storyline (Figure 5).



Figure 4 The story in 'Super Mario Bros' is simply to save the Princess. The only story progression is at the end of each series of levels where 'Mario' is told that the princess is not in this castle.



Figure 5 A standoff between the main characters of 'Metal Gear Solid 4'

The degree of realism of a game can also affect the depth of a story. Generally games such as *Uncharted* and *Call of Duty Modern Warfare* contain more story elements than games such as *Kirby* or *Donkey Kong* (Figure 6, Figure 7). This is not always the case as realistic games such as *MAG* have no storyline while games based on cartoons such as *Pokémon* can have rich stories (Figure 8, Figure 9).



Figure 6 The game 'Uncharted Drake's Fortune' is a graphically realistic game which follows Drake as he searches for treasures.



Figure 7 The game 'Kirby's Return to Dreamland' is a multiplayer game with cartoon graphics.

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials



Figure 8 'MAG' is an online only multiplayer first person shooter. The game has no storyline other than levels featuring a set of objectives such as disarm a bomb.



Figure 9 'Pokémon Black & White' is based on the cartoon 'Pokémon'. The games have a storyline which involves the main character having to battle a group trying to steal his 'Pokémon'.

A story in a game can be either linear or nonlinear. A linear story is comparable to the types of stories found in books or films, the audience has no control over how the story progresses. The majority of games also follow this structure. In *Batman Arkham Asylum* the user has no control over the story or scripted events. In *Final Fantasy 7* the user can make many decisions such as who to talk with and who to include on their team. While these decisions affect the immediate event the overall storyline is not altered by these actions.

Interactive stories in video games are storylines which are affected by the player's actions throughout the game. The impact that the player's actions have on a story varies. In the game *Half-Life* the player is given a choice at the end of the game. The answer the player gives leads to one of two endings (Figure 10). *Half-Life* has a linear story until this final moment.



Figure 10 'Half-Life' ending where the outcome changes depending on if the player walks into the portal.

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

The key selling point of the game *Heavy Rain* is its interactive story. The game features 22 different endings, which are decided by the player's actions throughout the entire game (Figure 11). This nonlinear structure branches at an early stage in the game which increases the effect the user's actions have on the outcome compared to *Half-Life* (Figure 12).



Figure 11 '*Heavy Rain*' shop scene which is the first scene in the game where the players choices affect the final outcome.

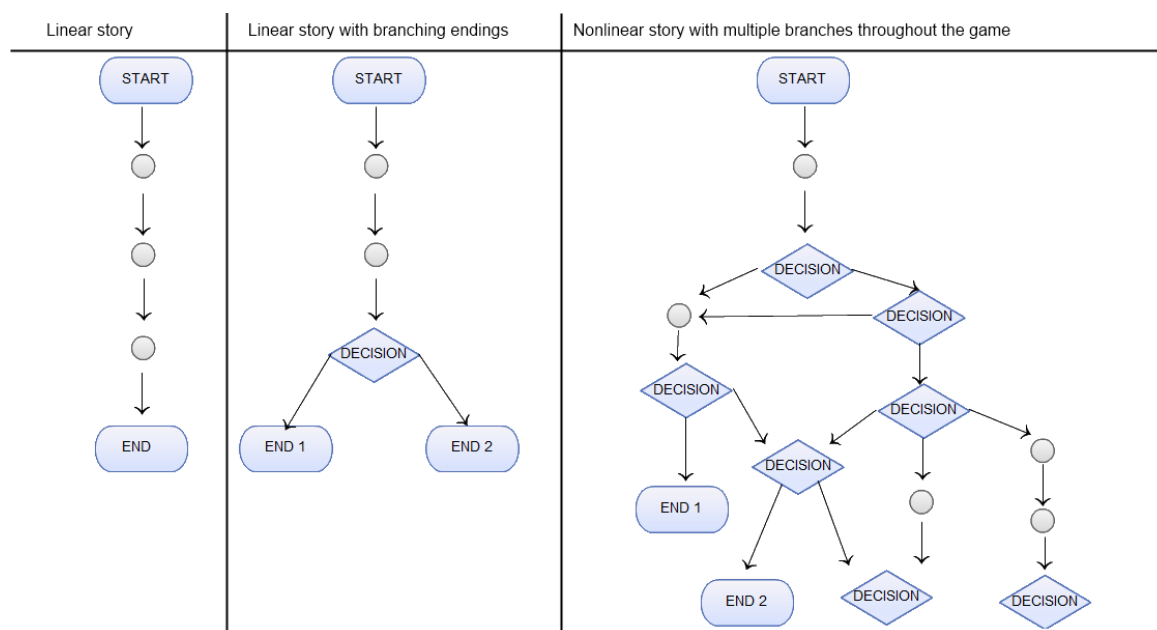


Figure 12 Diagram displaying alternate story designs. The first design is a linear story as seen in '*Batman Arkham Asylum*'. The second is a linear story with branching endings as seen in '*Half-Life*'. The third design is a nonlinear story which represents the type of design in games such as '*Heavy Rain*'.

Join in - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

A theme in a video game is used to align all of the game elements (Schell, 2008). Without having a unified theme a game may feel disjointed for example the art assets may not match the music used. *Freelancer* is a space themed game which has dark graphics and ambient music to reinforce the theme (Figure 13). *Age of Booty* is a pirate themed game which uses pirate style music to reinforce its theme (Figure 14). Schell describes the two steps for using a theme as figuring out what the theme is and then using every means possible to reinforce that theme. If the pirate style music for *Age of Booty* was used in *Freelancer* the unified theme of the game would be ruined.



Figure 13 '*Freelancer*' is a space themed game.



Figure 14 '*Age of Booty*' is a pirate themed game.

2.2 Mechanics

Game mechanics are described as “the roots of gameplay and form a system by which a game is progressed” (Thompson et al. 2007). Every video game consists of a set of mechanics. These mechanics have been grouped into six categories in the *Art of Video Games* which are: ‘space’, ‘objects, attributes and states’, ‘actions’, ‘rules’, ‘skill’ and ‘chance’ (Schell, 2008).

2.2.1. Space

Space is the world or area a game takes place in. This can range from a football stadium to a mythical world (Figure 15).

D6.2 Results from the trials



Figure 15 'Minecraft' contains large open worlds comprised of blocks.

2.2.2. Objects

An object describes an entity that exists within the game space. These range from props to playable characters (Figure 16).



Figure 16 'Zelda Ocarina of Time' in-game 'Hyrule City' containing a variety of objects including the main character, non-playable characters and props.

2.2.3. Attributes

The attributes are the characteristics and data which describe an object for example movement speed, health and abilities such as the ability to jump.

A state is a current setting of an attribute for example a light switch state is either on or off. An example of this in video games is the ghosts artificial intelligence (AI) setting in *Pacman*. The ghosts switch their AI attribute between states to try to catch *Pacman*

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

(Figure 17, Figure 18). In chess an overall game state occurs when a player is in 'Check' (Figure 19). A game state can be used to evaluate when the game is won or lost or to describe the overall current event in the game such as paused and at menu screen (Figure 20).

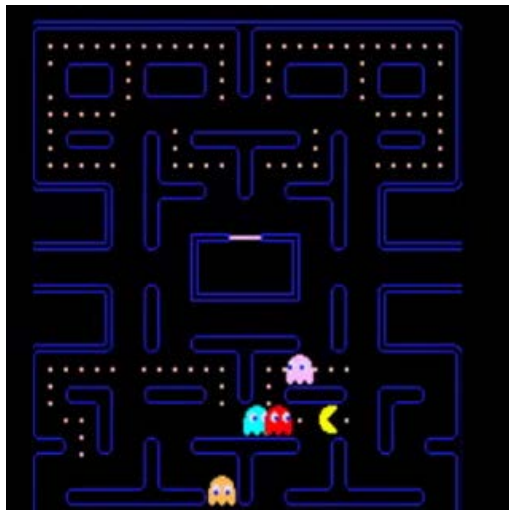


Figure 17 The red and blue ghosts are in the chase state in 'Pacman'

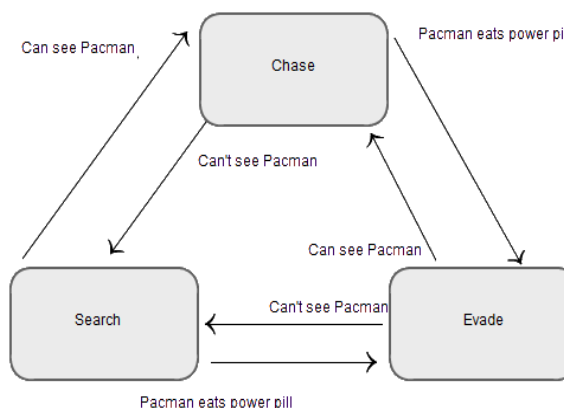


Figure 18 State diagram of a ghost in Pacman

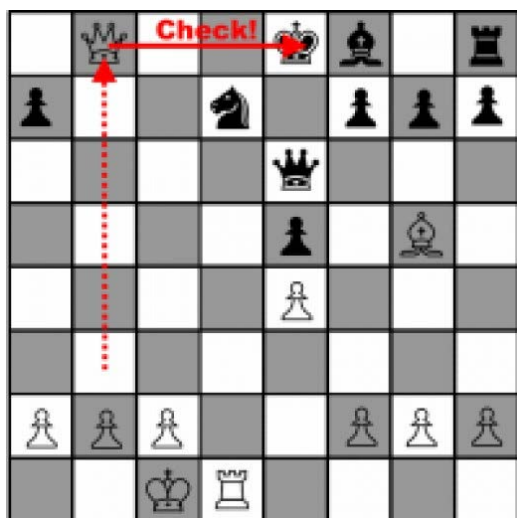


Figure 19 An example of a state of Check in 'Chess'

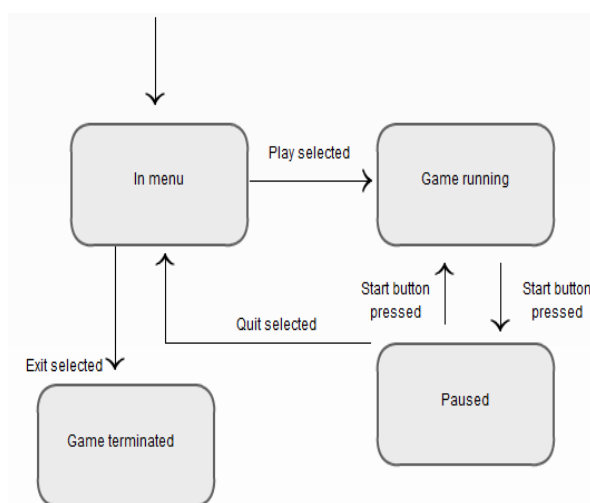


Figure 20 State diagram of a typical game loop

2.2.4. Actions

Actions are the ability or skill a player possess. An action can be categorised as an operative action or a resultant action. In *Super Mario Bros* an action the player can perform is jump (Figure 21). This is an example of an operative action. A resultant action

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

refers to “how the player is using the operational actions to achieve a goal” (Schell, 2008). In the example of Mario jumping, a resultant action could be how to kill an enemy or how to make it across a large hole.



Figure 21 *The playable character 'Mario' performing a jump action in the original 'Super Mario Bros' game.*

2.2.5. Rules

Rules are the goals of a game. They are the most important mechanic and are in every game to a degree. A video game is comprised of a primary objective and a set of smaller goals to achieve it. Games may also have bonus goals which are not required for completion but add an additional challenge. The primary objective of the game *Sonic the Hedgehog* is to complete the game, finish the last level. The set of rules to get there involve beating enemies and bosses, collecting rings and powerups and completing each level in the allocated time limit (Figure 22). The additional challenge in Sonic is to collect items known as the 'chaos emeralds' which are obtained by completing bonus rounds (Figure 23).



Figure 22 *'Sonic' avoiding enemies whilst collecting rings.*

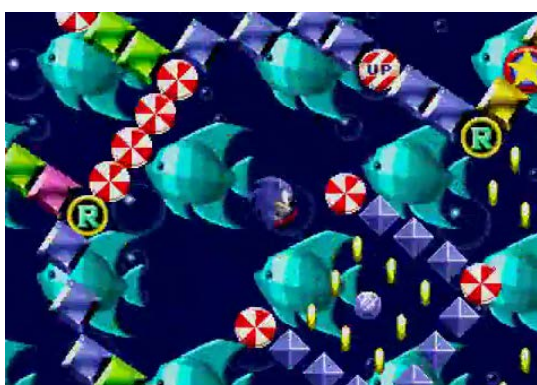


Figure 23 *'Sonic' navigating the optional bonus round to attempt to collect the emerald in the centre of the screen.*

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

David Parlett illustrates the types of rules and their relationship (Figure 24, Parlett, 2005). Parlett categorises rules into seven headings: foundational, operational, behavioural, laws, written, official and advisory rules.

Foundational rules are described as mathematical rules. In *Sonic* a foundational rule is when the ring counter reaches one hundred the life counter is increased by one.

An operational rule is one that the player needs to understand to play the game. An example is if the user presses the 'A' button the Sonic character jumps.

Behavioural rules are also known as unwritten rules (Steven Sniderman, 1999). These rules essentially describe fair practices and good sportsmanship. Such rules apply to multiplayer games, for example if one user is losing a race and is aware that it is no longer possible to achieve victory, why not quit the game rather than lose. This is common in online video games and is frowned on by the gaming community. On modern gaming consoles such as the Xbox 360 it is possible for one user to report another for unsportsmanlike conduct. These reports lower a user's reputation, which discourages others willingness to play online with that user.

Laws are used in a tournament situation such as the EVO championship series. EVO specialises in fighting games tournaments such as *Street Fighter 4*. There are set rules during these tournaments such as double blind selection where both players cannot see who their opponent has selected to play as.

Written rules are those found in a game manual. In the modern era of video games there is a decline in written manuals as games are now available for digital download. Written rules are typically now found in the game menu under help and options or in tutorial modes.

The combination of laws and written rules create the official rules.

Advisory rules are hints and tips devised to improve a player's skill. These can be referred to as rules of strategy. An example can be seen in *Sonic where* it is advisable to always have at least one ring collected to prevent losing a life when injured.



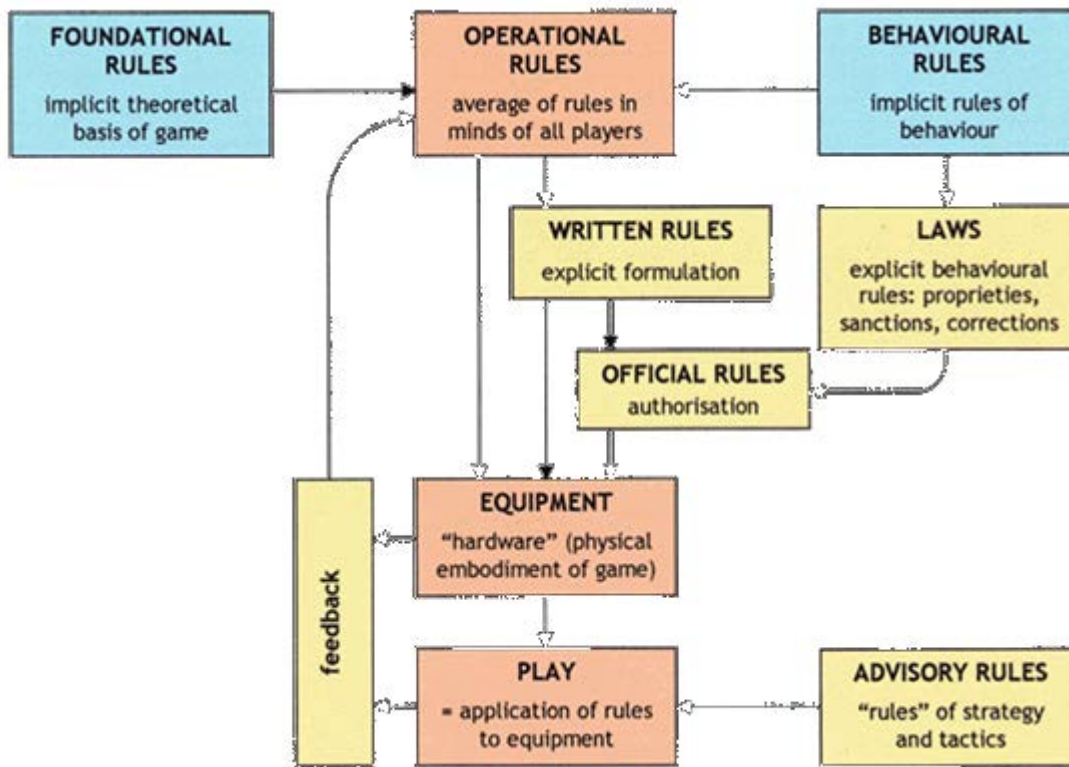


Figure 24 David Parlett's image on the types of rule.

2.2.6. Skills

Skills are the human factor to be considered when designing a game. The primary question is what skills are required of the user to complete the goals of the game. It is also important to consider the level of skill required to complete a goal. These are known as real skills. Virtual skills are those of the in-game characters, for example *Link* from *The Legend of Zelda* series is a skilled sword fighter.

The *Art of Video Game Design* groups real skills into three primary categories: physical, mental and social.

Physical skills are most relevant to exercise games (exergames). Cardiovascular and muscular endurance, muscular strength, coordination, flexibility, agility and balance are examples of physical skills (Franklin, et al. 2000). A variety of these skills are trained and improved in games such as *Dance Dance Revolution* (DDR) and *Wii Fit*. In DDR the arrows scroll up the screen, when these arrows line up with an arrow silhouette the user must step in that direction (Figure 25). The user dances on a dance mat with corresponding arrow buttons to the in-game arrows (Figure 26). Dancing is a popular form of exercise and it was discovered in a study of 40 young adults that DDR met the intensity standards for cardio respiratory fitness set by the American College of Sports Medicine (ACS) (Tan et al. 2002).

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials



Figure 25 'Dance Dance Revolution' in game screenshot.



Figure 26 'Dance Dance Revolution' dance mat controller.

Mental skills such as logical puzzle solving, observation and memory are common elements of games. *Push Over* required users to solve a domino puzzle to progress to the next level (Figure 27). The user must solve several types of puzzles in the game *Tomb Raider* (Figure 28). Cognitive games primarily test mental skills (Figure 29, Figure 30).



Figure 27 Example of a 'Push Over' domino puzzle requires logical puzzle solving.



Figure 28 'Tomb Raider' Damocles sword puzzle requires precise observation.



Figure 29 'Brain Age' Sudoku puzzle



Figure 30 'Brain Age' puzzle

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

Social skills in relation to video games refer to working with a team and trying to read an opponent's moves. In team based games such as *Little Big Planet*, the players must work well together to solve puzzles and beat bosses (Figure 31). In fighting games such as *Street Fighter* the ability to read or predict an opponent's next move is essential (Figure 32).



Figure 31 'Little Big Planet 2' four players working together.



Figure 32 'Street Fighter 3' professional gamer Daigo predicts the moves of his opponent Justin Wong to win the match.

The user's skill level is a deciding factor in the perceived level of difficulty of a game. If a game is perceived by the user to be too easy it can lead to boredom, and if the game is perceived as too difficult it may cause frustration. Games have static difficulty settings for the purpose of allowing a user to select the challenge level that suits them best. Adaptive difficulty programmatically alters game difficulty based on the user's performance; the goal of this is to ensure a user is constantly challenged without ever feeling the game is too difficult.

2.2.7. Chance

Chance is the element of randomness and unpredictability of a game. The chance mechanic is a primary factor in role playing games (RPG), dice games and card games (Figure 33). It is not present in games like chess or exergames such as *Wii Fit*. Chance could be implemented in an exergame in many ways. One example of implementing an element of chance would be to add random challenges to an exercise. If the exergame task is to walk a certain distance, a random challenge such as balancing on a tight rope can be added.



Figure 33 'Poker Night at the Inventory' is an example of a game where chance is a key factor.

2.3 User Interface

A user interface (UI) is described by Ernest Adams in the *Fundamentals of Game Design* as creating “the player’s experience, making the game visible, audible, and playable”. Adams continues to state the importance of a UI, “It has an enormous effect on whether the player perceives the game as satisfying or disappointing, elegant or graceless, fun or frustrating” (Adams, 2009).

A menu system is a key component of a user interface and is the first section of a game displayed to a user. A good menu system needs to have options that are clear to read and the terms used are obvious to the player. A widely accepted design of a main menu will include the options ‘play’, ‘help and options’, ‘high scores’ and ‘exit’ (Figure 34, Figure 35).

‘Play game’ is the first option which will bring the user to the primary game mode. This option is also commonly written as ‘story’, ‘campaign’ or ‘start’.

Selecting ‘help and options’ displays a submenu, which contains instructions and settings such as a method to change the static difficulty selection and volume controls. This option is also commonly displayed as settings or options.

‘Highscores’, otherwise known as ‘leaderboards’, shows the user a list of scores obtained in the game. These can be local or online scores.

The ‘exit’ or ‘quit’ option is primarily not used in modern consoles such as the PlayStation 3 as there is a built in menu for returning to the system menu. An ‘exit’ option is common

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

practice for developing a video game for a home computer. It is not necessary when developing a web application.

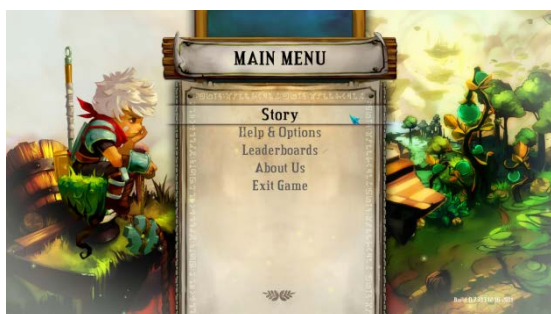


Figure 34 *Bastion* main menu

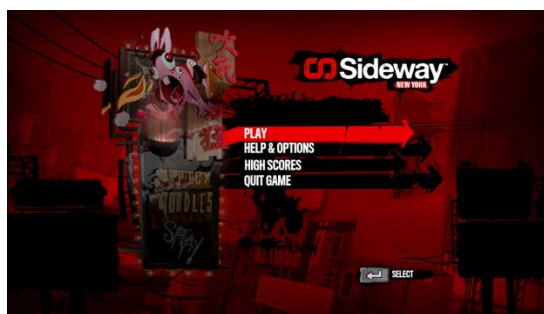


Figure 35 *Sideway* main menu

The other core element of designing a UI for a video game is the heads up display (HUD). A HUD is described as “any visual element that communicates information to the player” (Rogers, 2010). A HUD can include “control aspects on the game screen such as mini-maps, target crosshairs, and player scores” (Tavinor, 2009). The HUD in *Zelda* contains several common elements of a HUD in an adventure or action games (Figure 36). This HUD displays important data to the user such as current health and ammunition for weapons. The *Dance Central* HUD displays relevant exercise data, calories burnt and time spent exercising. It also shows how tutorials and tips can be displayed constantly as part of the HUD (Figure 37).



Figure 36 An in-game screenshot of ‘*The Legend of Zelda: A Link to the Past*’ displaying along the top of the screen an example HUD. The HUD shows health as hearts on the top right, the number of bombs and arrows in the middle and a magic bar on the far left.

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>



Figure 37 An in-game screenshot of 'Dance Central' workout mode. The calories burnt and the time spend exercising is displayed on the top left, the dance moves the user needs to perform next are in a list to the right.

2.4 Game Balancing and Experience

The goal of game balancing is to design a game that is not too easy or too difficult. A balanced game will need to constantly provide a challenge to players of all skill levels.

A game is balanced by adjusting the difficulty; this may be done by two methods, static and dynamic balancing (Westra et al. 2008).

Static or pre-defined balancing implements the traditional option system prompting the user to select "easy", "medium" and "hard" difficulty setting (Figure 38, Figure 39), The static model may lead to less than optimal uptake of the game in the case where players do not fit well with the expected stereotypes (Westra et al. 2008).



Figure 38 The difficulty selection screen of 'Cave Story Plus' on easy.



Figure 39 The difficulty selection screen of 'Cave Story Plus' on hard.

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

How the static difficulty affects the game varies. It may alter the enemies artificial intelligence for example the computer controlled opponents in *Street Fighter IV*. *Rock Band* is a rhythm action game, which requires the user to match the colours displayed on screen to the buttons on the controller (Figure 40). The difference between the easy to expert difficulties is the speed the notes travel, the amount of notes on screen and the number of buttons the player may need to press (Figure 41, Figure 42).



Figure 40 The 'Rock Band' guitar peripheral.



Figure 41 The easy mode only requires the user to operate the green, red and yellow buttons to complete a song.



Figure 42 The expert mode requires users to use all the buttons on the guitar, from green to orange.

Dynamic balancing is the ability of the game to adjust its difficulty relative to the player's skill. There are three important aspects that must be considered when performing dynamic

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

balancing. The first is the game must identify the player's skill level as quickly as possible and adapt accordingly. Second, the game must track as closely and quickly as possible, the player's evolution and regression in performance. Finally, the game behaviour must remain believable throughout (Andrade et al. 2006).

Video games that provide in-game adaptive difficulty based on player performance tend to result in players enjoying them more than games that implement static difficulties (Missura and Gartner, 2009).

Dynamic balancing can be implemented using many different methods. One such method is a heuristic function called "challenge function". This function maps a given game state to a value that represents how challenging the game is for a user at a given time. Examples of these heuristics can be: number of successfully answered questions, time taken to complete a task, or any other metric that can be used to calculate an in-game score (Demasi and Cruz 2002). An alternative method implements dynamic scripting of opponents in an attempt to provide dynamic balancing (Spronck et al. 2004).

An approach to measuring the success of dynamic balancing was to associate it with player stratification. This allowed data to be collected using usability tests and collecting user opinions in both structured and open-ended questionnaires. In order to take into account all the aspects that influence game balancing and user satisfaction, testing included controlled user testing, satisfaction questionnaires and post-experience interviews (Andrade et al. 2006, Maguire 2001).

2.5 Goals and Challenges

An important part of game design is balancing the difficulty of a challenge that can be presented to a player. Because of this it is important to understand some of the basic factors that can influence the difficulty of a game. The following are some factors which can affect the difficulty of games:

- **Intrinsic Skill:** Is the amount of skill a user needs in order to overcome a challenge, given unlimited time (Adams, 2009).
- **Stress:** Is a challenge that includes the added factor of time pressure (Adams, 2009). The shorter the time allocated for a challenge the increased amount of stress a player is under. This can be used to make relatively easy challenges more difficult by removing unlimited time for decision making.
- **Absolute Difficulty:** This refers to intrinsic skill and stress as part of one challenge (Figure 43) (Adams, 2009).

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>



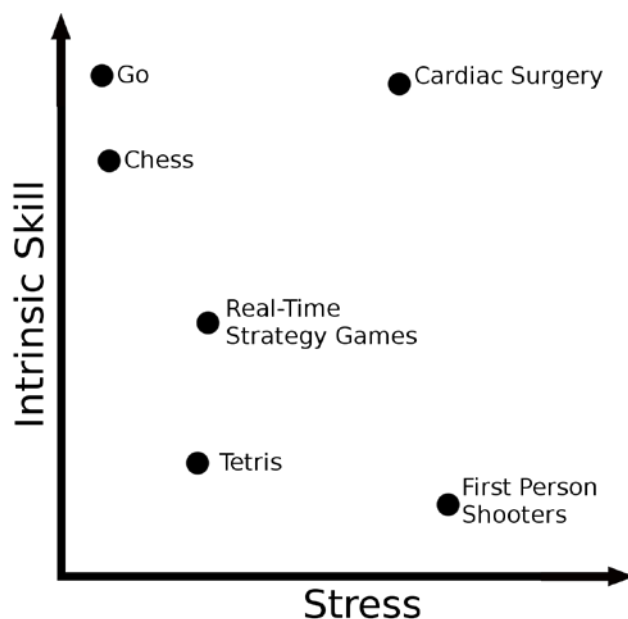


Figure 43 *Absolute Difficulty: A graph of intrinsic skill required versus stress in different tasks* (Adams, 2009).

Goals are used as one of the motivational factors in games. It is described by Ernest Adams as “the desired results or conditions that the player seeks to achieve. The goals of a game need not be achievable, so long as players can work towards them.” (Adams, 2009).

Challenges are the method by which a player proceeds through a game. Ernest Adams describes a challenge as “a nontrivial task the player seeks to perform in order to move forward with the game’s goals.” (Adams, 2009).

The following is a list of a goals and challenges which are common within games and should be considered for implementation into the Join-In game:

2.5.1. Reaction Speed

This challenge requires the player to respond to an event or task in the game, using a controller to give input within a specific time limit.

One example of this is Tetris, where the player must orientate a block into the correct position before it reaches the bottom of the screen (Figure 44). If the player fails to do this then the game will end and the player will lose (Figure 45).

D6.2 Results from the trials



Figure 44: The player is reacting by placing the blocks correctly.

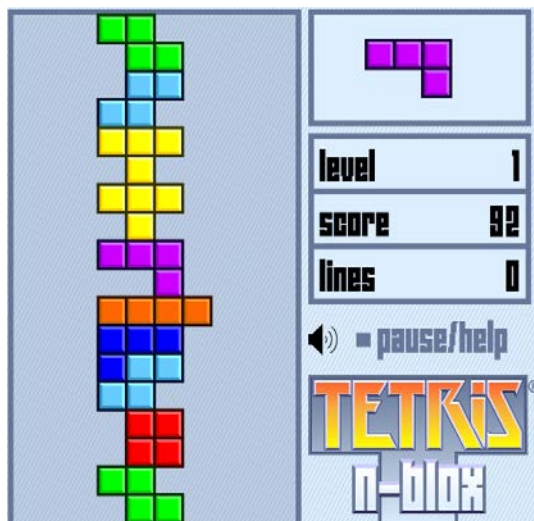


Figure 45: The player has failed to react, no more blocks can fall, and the game is over.

While Tetris uses reaction speed to create tension in the game, reaction speed can also be used alternatively for calculating a player's score without creating this time based tension. One game that uses this method is Dr Kawashima's Body and Brain Exercises.

While it may not be obvious to the player, some of the mini-games use reaction speed as one of several methods for gauging the performance of the player (Figure 46, Figure 47).



Figure 46 The player's score is based on reaction speed, amount correct and number of errors.



Figure 47 Another mini-game that uses reaction speed as one of several methods for gauging performance.

Initial tests with users suggested that most participants preferred games that do not use time as a factor in decision making or to create tension. The users also indicated that they enjoyed the reaction challenges presented by the mini-games *What Time Is It* and *Traffic Controller* from *Dr. Kawashima's Body and Brain Exercises*.

If this type of challenge is to be used in the Join-In game, then consideration should be given to the inclusion of a time constraint. One approach to implementing this challenge

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

would be to use adaptive difficulty to scale the influence of time on the game.

Age Invaders' is one project that adapts its reaction-speed difficulty based on details provided by the player. Before a game starts, the players enter their name and age and the system provides additional assistance to compensate for any disadvantages the elderly might face. These assists are also adjustable while the game is being played. By implementing this kind of adjustability the game is able to simultaneously host a game that can be played by both elderly and young people (Khoo and Cheok, 2006).

2.5.2. Accuracy and Precision

Accuracy and Precision challenges are designed to test a user's hand-eye co-ordination. Accuracy measures how close the user is to completing a task, while precision measures the ability of the user to repeat the same action with similar results. These challenges generally take the form of shooting or steering, although there can be many other variants. Steering can also include such things as controlling an in-game avatar.

The mini-game *Shooting Range* for *Wii Play* is one example of an accuracy challenge that involves shooting. This game is similar to Clay Pigeon shooting, with other target practice challenges incorporated (Figure 48).

Games such as *Big Brain Academy for Wii* implement various steering challenges, usually getting the player to select the correct item from a list of choices (Figure 49).



Figure 48 The target practice challenge requires the player to shoot targets. The closer to the centre of the target they hit, the more points the player is awarded.

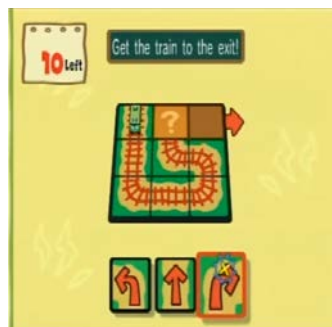


Figure 49 The player must select the correct direction for the next piece of track. By doing so correctly they will allow the train to make it to the other side of the screen.

Accuracy challenges are present to some degree in nearly every game. The Join-In game may implement a form of accuracy challenge, even if it just controlling an in-game avatar or menu system. Consequently, it is important that some form of adjustability be implemented in order to aid the user's precision in accurately hitting targets, when they

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

lack the necessary skill to do so.

This adjustability can be done in multiple ways, such as guiding the cursor towards the target in shooting challenges (also known as auto-aim), or giving hints to the player in steering challenges.

2.5.3. Puzzles

According to Jesse Schell “A puzzle is a game with a dominant strategy.” (Schell, 2008). Puzzles require the player to find the single strategy (dominant strategy) to solve the challenge, while games try and avoid a dominant strategy which leads to the game becoming predictable and boring.

The Legend of Zelda: The Wind Waker, presents the player with many puzzles throughout the game, most of these are integrated into the environment so it's not obvious to the player that they are attempting to solve a puzzle. One such puzzle involves the player having to damage enemies from behind so it can remove its armour, only then will the player be able to defeat them (Figure 50). While others can involve the player having to figure out what items they need to use to get to otherwise blocked off locations (Figure 51).



Figure 50 *The player must get behind the enemy to be able to hurt and defeat it.*



Figure 51 *The player must use their giant leaf, with the wind to glide themselves across to a cliff.*

Another example of a puzzle in a game is Tetris. In Tetris the player must figure out the dominant strategy to getting a Tetris (Figure 52), which is the best way to get the highest score possible. Once the dominant strategy for puzzle has been solved, the player can then focus on other elements of the game such as the reaction time needed to keep up with the increasing pace of the game.

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials



Figure 52 A Tetris is when a player completes a row of four high at once. This is the maximum score a player can get in one action.

Dr. Kawashima's Body and Brain Exercises present many forms of puzzles. For example, in one mini-game called Traffic Controller, the user is asked to direct vehicles from one side of the screen to the other (Figure 53). During the game the user should realise the dominant strategy is to get the coloured vehicles towards the same coloured exit. After this dominant strategy has been solved, the user must then focus on their reaction speed to increase their score.



Figure 53 The player must realise the colour association and direct the vehicles to the destination of matching colour.

In 'The Art of Game Design', Jesse Schell says there are ten principles to good puzzles.

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

- 1) **Make the Goal Easy to Understand:** To motivate the player to try a puzzle, it is important that the puzzle be easy to understand.
- 2) **Make it Easy to Start:** Once the puzzle is understood by the player, it then needs to be clear how to start solving the puzzle.
- 3) **Give a Sense of Progress:** It is important that a player is able to see progress. This will help them have a sense of hope that they can solve it.
- 4) **Give a Sense of Solvability:** The player needs to know that the puzzle is solvable, otherwise they will stop trying.
- 5) **Increase Difficult Gradually:** Most puzzles require multiple steps in order to succeed. In a good puzzle the difficult increases with each step, which makes it more appealing to a player.
- 6) **Parallelisms Lets the Player Rest:** Providing several puzzles at once, makes it less likely that the player will give up if they are unable to solve a single puzzle.
- 7) **Pyramid Structure Extends Interest:** This happens when a small series of puzzles leads to solving a larger puzzle. This structure can help motivate a player, by creating a clear goal for completing the puzzles.
- 8) **Hints Extend Interest:** This helps stop a player from being frustrated and giving up. These hints should be well timed, so that they don't make the puzzle too easy and bore the player.
- 9) **Give the Answer:** What is most pleasurable about solving a puzzle is experiencing that "Aha!" moment when the right answer is found. This experience is not triggered by solving the puzzle, but by seeing the answer. One way you can provide this is by giving a method of seeing the answer within the game, even if the puzzle can't be solved.
- 10) **Perceptual Shifts are a Double-Edged Sword:** A perceptual shift is a big leap in a player's assumption that allows them to come up with the right answer. This can be extremely exciting for a player, but results in puzzles where "either you get it or you don't". If the player cannot make this perceptual shift, then they will never be able to solve the puzzle.

2.5.4. Rhythm

These challenges ask a user to enter a specific input at a specific time. This type of challenge can be implemented via buttons, such as in *Guitar Hero* (Figure 54), touch screen, as shown in *Elite Beat Agents* (Figure 55), or with physical movement as seen in *Dance Central* for the Kinect (Figure 56).



Figure 54 *Guitar Hero*: The player must hit the corresponding coloured buttons on the controller when the icon reaches the bottom of



Figure 55 *Elite Beat Agents*: The player

D6.2 Results from the trials

the screen.

must press the buttons in order from lowest to highest.



Figure 56 *Dance Central: The players must perform the actions themselves as shown by the in game avatar.*

Initial feedback from the Irish user group suggested that they would be interested in some sort of rhythm game, since several users already participated in line dancing. They also indicated that they would be more motivated to play a rhythm game that did not punish them for missing inputs.

One alternative to this punishment system could be what is presented in *Wii Music* (Figure 57). *Wii Music* is a free form music game developed for the Nintendo Wii, which focuses on creativity through music rather than on punishment for missing timed input. While rhythm challenges are still incorporated into the game, it is not the focus of the game, but rather one of many elements. By doing this, the game allows the player to have more freedom.

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

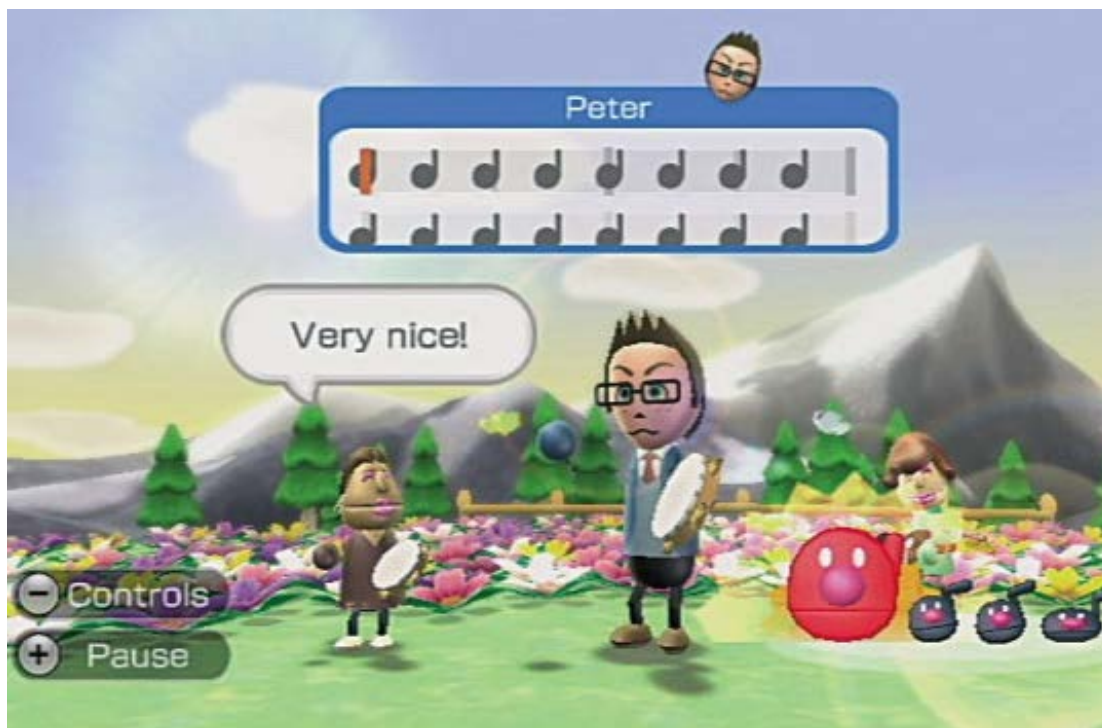


Figure 57 *Wii Music: A basic 4/4 timing rhythm challenge.*

2.5.5. Memory

These challenges require the user to recall things they've seen in the game. Dr. Kawashima's Body and Brain Exercises for Kinect has a section of the game devoted to memory challenges. One such memory challenge shows the user a number of avatars, in different poses (Figure 58), then hides one avatar and asks the user to position them into this hidden pose (Figure 59).



Figure 58 The player is shown the poses of all four avatars.



Figure 59 The player must remember 2's pose, and position themselves into that pose.

Memory challenges like this also have the opportunity to enable adaptive difficulty by limiting the number of avatars on screen, so that the users have less poses to remember (Figure 60, Figure 61). This can be effective in lowering the difficulty for more novice users, and allowing them to enjoy the game without the experience needed for the harder

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

difficulty.



Figure 60 The player has only two avatar poses to remember.



Figure 61 The player only needs to recall two poses to get the answer right. This makes the challenge a lot easier than if there was four.

2.6 Feedback

Feedback provides information about the user's performance in a game. It is described by Andrew J. Elliot as "it informs the individual how well he or she is progressing in the activity, and dictates whether to adjust or maintain the present course of action" (Elliot, 2005). It is a valuable element of any game as described in Flow by Mihály Csíkszentmihályi, "What makes this information valuable is the symbolic message it contains: that I have succeeded in my goal" (Csíkszentmihályi, 2008).

In a video game, the user may be given feedback in several of ways.

Feedback may be presented in the form of a reward or judgement (ref Art of Video Games). Judgement can be presented as a grade (Figure 62) or a number (Figure 63). These grades/scores can be determined by a number of factors such as collectable items and time limits. The purpose of this type of feedback is to provide the user with an additional challenge as well as a method of comparing a user's performance against others. If the user gets a grade B, it is clear that the score can be improved upon, thus the user is given an incentive to replay the level.



Figure 62 The player has achieved an A+ grade in 'Super Meat Boy'



Figure 63 The player receiving a numerical score based on performance in a level of 'Little

Big Planet'

Rewards may be a new item or character to play in game (Figure 64). Microsoft Xbox Live *Achievements* and Playstation Network *Trophies* are methods of rewarding a player for completion of a specific task (Figure 65). Every game on the Xbox 360 contains a set of Achievements and the PlayStation 3 contains a set of Trophies. These are a method of tracking score across all games a user has played (Figure 66, Figure 67).

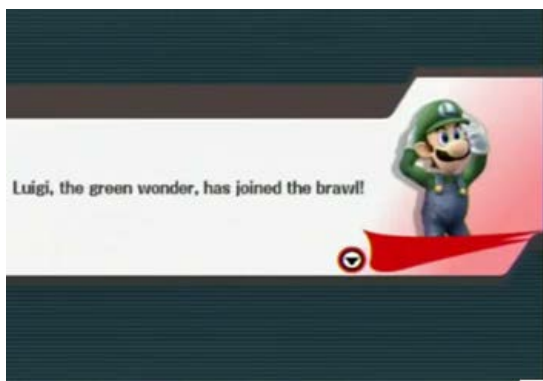


Figure 64 A new character unlocked in 'Super Smash Bros Brawl'



Figure 65 The achievement 'Fast Marble' is unlocked in 'Sonic' for completing the level in under 80 seconds.



Figure 66 An example of a selection of scores from individual games and the users total 'gamerscore', 292,806 in this example.

D6.2 Results from the trials

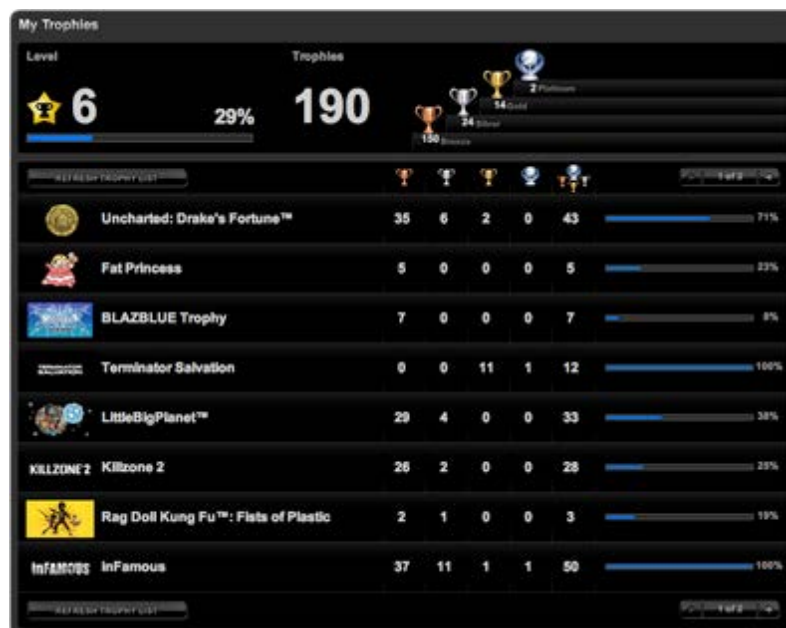
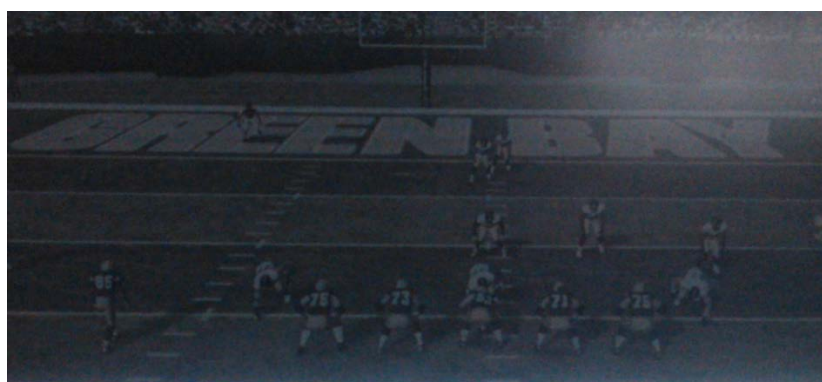



Figure 67 An example of trophies collected across games and the users level (total progress), 6 in this case.

Feedback may also take the form of instruction and encouragement (Schell, 2008). Instructions are a key element that affects the usability of a video game. Generally instructions are presented to a user at the start of a game and when new elements are introduced. Instructions presented to a user in cases where they are failing to complete a task are a form of feedback. American Football is a team sport where the team is penalised for the quarterback not hiking the ball before the time limit runs out. In the game *Madden 2012*, if the player frequently receives these penalties, and even after the original instruction is displayed, the player is reminded of this rule (Figure 68). Encouragement is a form of immediate feedback that is found in most exergames. Encouragement in exergames normally comes from an in-game avatar playing the role of coach or personal trainer. This avatar attempts to motivate the user by encouraging them to train for longer or provides information to improve how the user exercises (Figure 69).



Hike the Ball

Press  to hike the ball prior to the play clock running out to avoid a penalty.

 Dismiss  Disable Tips

Join Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

Figure 68 'Madden 2012' prompts the user with a tip in order to avoid a penalty.



Figure 69 'Wii Fit Plus' encourages the user to burn more calories by swinging their arms while jogging.

In exergames, feedback is expressed to the user in both immediate and long term formats. Immediate feedback suits goals such as reaction speed and accuracy while long term feedback addressed memory and logic goals. Reaction speed and accuracy can be addressed as long term feedback results are stored and compared over time. Examples of these can be seen in *Wii Fit* and *EA Sports*. Immediate feedback such as encouragement and instructions were present in both titles (Figure 70, Figure 71). This type of feedback is available as both text and an audio cue from the motivational avatar.



Figure 70 'Wii Fit' example of immediate feedback.

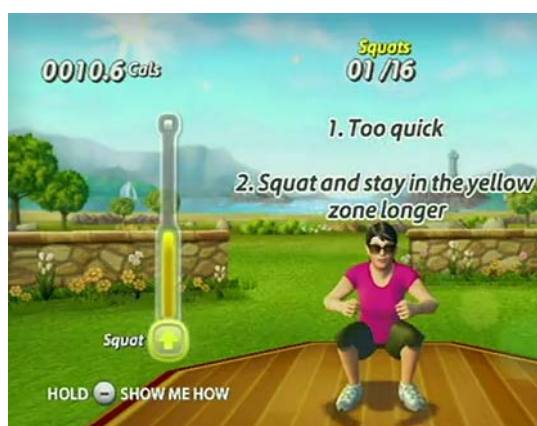


Figure 71 'EA Sports Active' example of immediate feedback.

Long term feedback has been used in arcade games such as *Donkey Kong* in the form of a highscore table (Figure 72). A highscore table is displayed upon completion of a game which displays the total score obtained by a user. The user is prompted to enter their name which is then sorted for comparison with others. This method is elaborated upon in

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

exergames. *Wii Fit* keeps track of both the amount of time spent, the scores of each game and the weight of each user on a system. A user can compare their progress to others on a chart (Figure 73). A user can set milestones which they aim to complete in a set amount of time, for example lose 2 kilograms in 3 weeks. The user's progress is examined regularly by the game with suggestions being made to address issues if the user is not on track. The user is questioned in regard to what they perceive as the cause of not meeting their target. The game asks the user if they feel it was due to drinking alcohol, eating junk food or not exercising enough. After the user answers the game explains how they can improve.



Figure 72 'Donkey Kong' high score table.

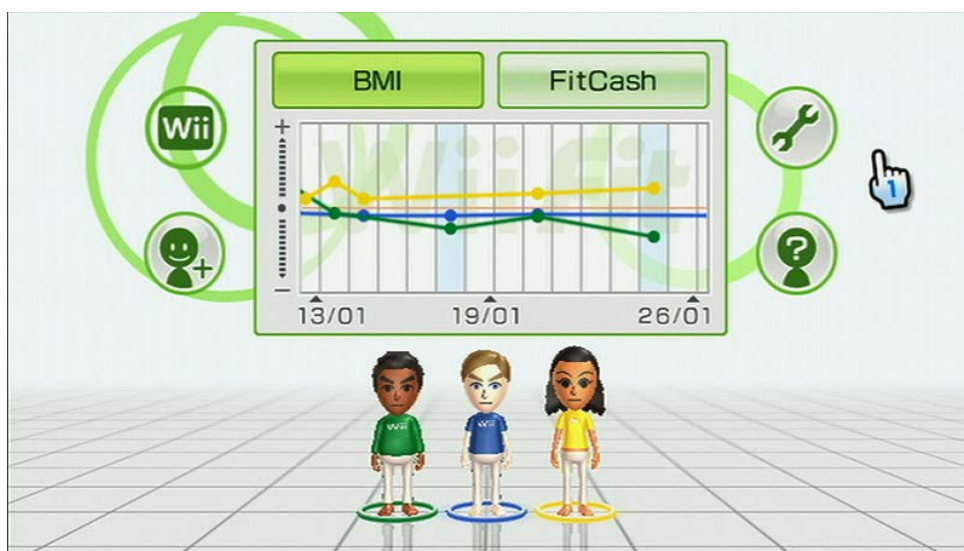


Figure 73 'Wii Fit' results of three users displayed on a graph of weight over time

3 Serious Games

3.1 What is a Serious Game?

While a game is seen as a form of entertainment, serious games are designed to have additional goals. Serious games aim to educate or instruct the player, so that they may gain additional knowledge or skills (Zyda, 2005). This traditionally takes the form of military games, government games, educational games, corporate games, and healthcare games (Susi et al, 2007).

Zyda argues that this goal must be secondary to the entertainment component of the game. Once the entertainment component has been worked out, then this alternative goal can follow (Zyda, 2005).

It has also been stated that for a serious game to be considered a useful tool to educators and trainers, it must have a method of testing and progress tracking (Michael et al., 2006). This should therefore be considered to be an important element for inclusion in any Join-In game.

An example of serious game which has an alternative goal other than entertainment is *America's Army*, which is developed by the United States Army as a recruiting tool. While intended for civilians, the game can also be an entertaining experience, for enlisted soldiers it is used as a training tool to simulate military exercises (Figure 74).

Research later conducted by the army to assess its recruiting effectiveness found that among adults aged 16 to 24, the game had given them a more positive impression than any other form of recruitment the army had previously developed (Michael et al., 2006).



Figure 74 An in-game screenshot of 'America's Army'.

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

Exergames and cognitive game are subcategories of serious games. Commercial exergames have become popular on modern consoles such as the *Nintendo Wii*. Cognitive games have found mainstream success on the *Nintendo DS* system, the most successful title is *Dr. Kawashima's Brain Training: How Old Is Your Brain?*

3.2 Serious Games for Elderly

While serious games include a wide range of game types including military first person shooters such as *America's Army* to games that teach children the alphabet such as *My First Alphabet* on the *Atari 800*. These serious games are not designed for an elderly audience. Serious games developed for an elderly audience generally focus on targeting physical and cognitive decline. Successful commercial examples of serious games that are accessible by the elderly are *Wii Fit* and *Dr. Kawashima's Brain Training: How Old Is Your Brain?*

Wii Fit is an exergame for the *Nintendo Wii* platform which has sold over 20 million copies worldwide (Mazel, 2009). *Wii Fit* has become popular with the elderly audience and has been used in many research projects. One study using *Wii Fit* found that the level of intensity of the exercises in *Wii Fit* allowed patients suffering from chronic obstructive pulmonary disease (COPD) to perform at 60 to 70 percentage of their maximum heart rate (Albores 2011). *Wii Fit* uses a peripheral balance board. The balance board is designed like a body scale which can measure the user's weight as well application and distribution of pressure (Figure 75).

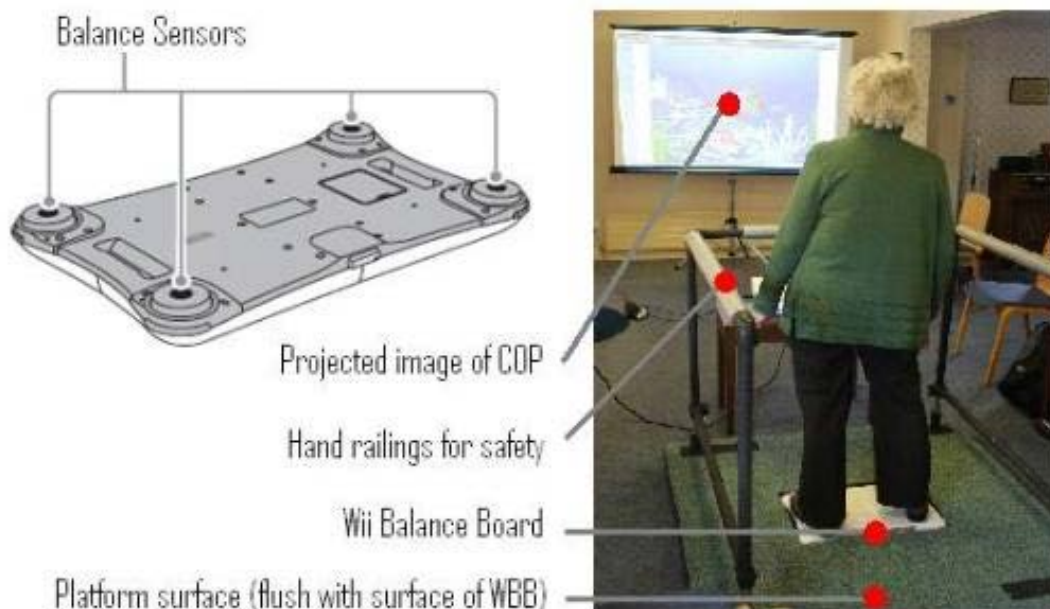


Figure 75 Demonstration of the 'Wii balance board' being operated by an elderly user. The left of the diagram displays the position of the sensors on the board.

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

The game is comprised of several mini-games, all of which range in difficulty and targeted skills, for example the tightrope walking mini-game tests a user's ability to balance. These mini-games are categorised as strength training, yoga, aerobics and balance games. The sequel *Wii Fit Plus* contains all the original *Wii Fit* exercises with additional challenges such as cycling, rhythmic Kung-Fu and a golf driving range (Figure 76, Figure 77).



Figure 76 'Wii Fit' tightrope exercise



Figure 77 'Wii Fit Plus' rhythmic Kung-Fu exercise

An example of a serious game which focuses on the elderly is *Age Invaders*, which was developed by the Keio-NUS CUTE Centre in Singapore (Figure 78). The game aimed to be “a novel interactive inter-generation social-physical game which allows the elderly to play harmoniously together with children in physical space while parents can participate in the game play in real time remotely through the internet” (Khoo et al., 2006).

The purpose of the game was to help increase inter-generational interaction. The project adapted the game *Space Invaders* to including a touch sensitive floor as a means of controlling the game. They claimed this addition would help increase immersion through physical activity and would encourage users to collaborate actively (Khoo et al., 2006).

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>

D6.2 Results from the trials



Figure 78 People playing 'Age Invaders'.

3.2.1. Story and Themes in Serious Games

As serious games aim to educate or train the user they typically do not make use of a storyline. Video games such as *Wii Fit* and *Brain Training* have no form of storyline. This is not universally true as there are some serious games that use a storyline to educate the user about a topic. An example of a storyline in a serious game is *Global Conflicts: Palestine* (Figure 79).

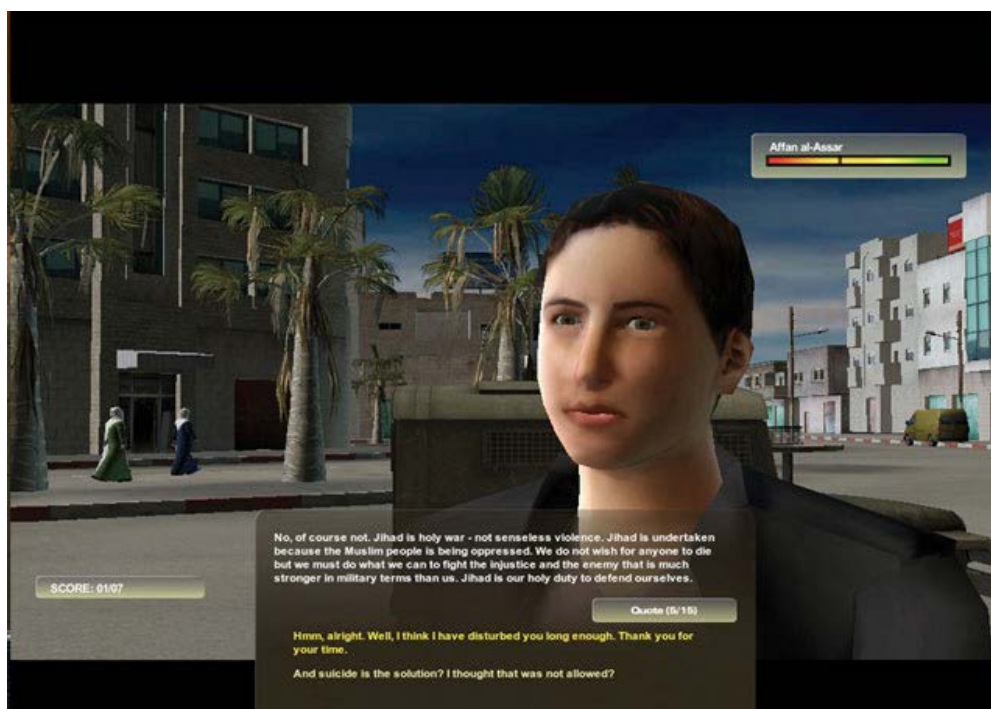


Figure 79 'Global Conflicts: Palestine' is a serious game centred on a journalist operating in Jerusalem.
<http://www.join-in-for-all.eu/>

D6.2 Results from the trials

The games developed for the Join-In project may not require a story to be implemented. The reason for this is that the length of a game may not suit a story. The games are designed to be played frequently for short periods of time. RPGs are developed to provide over 30 hours of gameplay giving the user time to appreciate the storyline. There may be no main character in the games, as the current plan is that each user will play the game using a personalised avatar. The reason for using self-avatar representation is to increase the user's immersion in a virtual environment. This is achieved by translating the user's sense of proprioception from the real world to the virtual world (Slater and Usoh, 1994). Exergames don't have a specific theme; the common setting in exergames is that of a realistic environment. The environments in games such as *Wii Fit* and *EA Sports Active* are basketball courts, parks and indoor living rooms with yoga mats. The goal of these environments is to support the player's immersion which would be ruined by adding a fantasy theme. In the Join-In walking prototype, it is a goal to implement a virtual world which represents a real world location, for example a walk around Paris city. As a requirement of the project is that the "Layout/graphics should be adequate for elderly" a realistic theme would be the best option (page 28, deliverable 2.1).

3.2.2. Mechanics in Serious Games

Every game including serious games contains mechanics. There are no guidelines that outline which mechanics should be implemented for different game genres or to cater for different demographics. The categories described in section 2.2 should be addressed by the Join-In project.

The game space or world of an exergame ranges from indoor locations for yoga to tightropes above buildings as seen in *Wii Fit* (Figure 76). On the basis of results from user group testing, a popular activity in the elderly community is walking. In *Wii Fit* the jogging mini-game takes place on a small island consisting primarily of parks (Figure 80).



Activities

D6.2 Results from the trials

Figure 80 'Wii Fit' jogging in a park

The objects used in the game will vary depending on the goals and challenges. If the Join-In project decided to implement a balance challenge, a likely object to be used with this challenge is a tightrope or balance beam. Each object in the game will have a set of attributes. In the case of the tightrope an attribute could be the tensile strength which would dictate the flexibility of the rope.

The specific rules of each game or mini-game will differ. The “Rules of the games should not be complicated” applies to all the mini-games (page 27, deliverable 2.1). In the walking game, the rules need to define the target walking speed for elderly, the suggested amount of time to spend during each session and the goals of any additional challenges.

The skills required will depend on whether the game is an exergame which will focus on physical skills or a cognitive game which will focus on mental skills. Where possible social skills should be integrated into every game as this will address the issue of social isolation. An example application of social skills in the walking game would be synchronised walking, which would require the users to walk at the same speed as the other users in the group in order to progress. The activity of walking is a physical skill, and a mental skill such as memory could be tested by presenting information to the user during a walking session and asking questions on the information at the end of the walk.

The chance mechanic is not required for most exercising. It could be added to a game to avoid user boredom caused by predictability. In the walking game additional challenges such as walking a tightrope can be issued at random times during the walk. Additionally different routes could be randomly selected during a walk.

“The possibility to play cooperative and competitive” is a requirement of the Join-In project (page 28, deliverable 2.1). This requirement means that the games developed need to feature online or local multiplayer. As the games are for a casual audience it is recommended that a drop in drop out system such as the system featured in *Little Big Planet* is implemented. A drop in drop out system allows users to play the game in a single player fashion while other users can join and leave at any time. The advantage of this system over a traditional lobby system is that it reduces the confusion and complications caused by creating a lobby and waiting for users to join.

3.2.3. User Interface in Serious Games

As the Join-In project is designed for an elderly audience it stipulates the requirement for “A simple and intuitive interface” to be designed (page 27, deliverable 2.1).

Guidelines have been suggested for designing a user interface for the elderly. One such set of guidelines describes four primary guidelines as: reduce the complexity, clear structure for tasks, consistency of information and immediate feedback (Rudinger, 1992).

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>



D6.2 Results from the trials

To reduce the complexity it is suggested that functionality that is rarely used should be removed to simplify the interface. Each task should have a clear starting point and every step of the task should be easy to understand. The information provided by the interface and the layout of the interface must remain consistent. The final step states that feedback should be provided continuously, informing a user of the success or failure of every action.

A similar set of four guidelines devised are: reduce choice where possible, keep output messages as short as possible, use mnemonic letters to indicate key press menu selections, display confirmation statements when possible (Zajicek, 2004).

A study by Hawthorn details a series of guidelines for designing a user interface under six categories: layout and style, colour, text, general usability, accessibility and user customisation (Hawthorn, 2006).

“The possibility to play/interact/communicate with limited eyesight” is a requirement which needs to be addressed by the Join-In project (page 27, deliverable 2.1). The text in the menu system and HUD needs to be in a large font size so it is accessible to visually impaired users. When an option is hovered over, an audio cue such as a beep could be used to alert the user that an option is selectable. This design produces a multimodal interface. A multimodal interface provides the user with multiple methods of controlling the system other than the standard controller setup for example the *Xbox 360 Gamepad* or a Mouse and Keyboard setup. The goal of a successful multimodal design is an application “that can be used by people with a wide variety of impairments” which means “the weakness of one modality or sensory ability can be offset by the strengths of another” (Stephanidis, 2009).

The Join-In project plans to use a motion tracking camera such as the *Microsoft Kinect* to assist the user’s interaction with the system without requiring familiarity with a traditional button based controller or mouse and keyboard setup. Speech recognition is a method implemented to address visual impairments. The Kinect controller features a high quality microphone array used for speech recognition, which will be investigated during the design of the Join-In project. The use of speech recognition presents a localisation issue as the software needs to recognise not only different languages but also specific accents.

The menu should avoid terms such as story or campaign and use simple and relevant terms such as play game. It is important that the number of submenus or levels required to begin an exercise is kept to a minimum to reduce the opportunities for a user to select the wrong option. Less steps required to get to the destination means less time spent navigating a menu and an easier to learn menu (Galitz, 2007).

Accessibility issues need to be addressed when presenting feedback to an elderly audience. These issues include visual and audio impairments. To increase the level of

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>



D6.2 Results from the trials

accessibility, where possible, both audio and visual aids should be used. This should be applied to both instructions and encouragement. When audio cues are added to software this adds a localisation issue as both text and speech need to be translated.

It is also important for the Join-In project to make navigation of menus and gameplay accessible to users that have issues with fine motor skills as a requirement for the project is “The possibility to play/interact/communicate with limited fine motor skills” (page 27, deliverable 2.1). There are software solutions to this issue such as *SUPPLE++* “automatically generate personalised interfaces given a model of the user”. The results from testing this system found that user’s with motor impairments performed on average 26% faster and generated on average 73% fewer errors (Gajos et. al. 2008).

3.2.4. Game Balancing and Experience

One of the technical requirements for this project is "The possibility to choose difficulty and speed levels, for each person" (page 27, deliverable 2.1).

A core element of flow is that a user is continuously challenged. In order to reduce the complexity of selecting a static difficulty and requiring the user to know what static difficulty applies to them an adaptive difficulty setting can be implemented. An adaptive setting takes the user progress and can alter a games difficulty without the user needing to select any options. As the target audience may not even understand the concept of selecting difficulties an adaptive system may avoid confusing the users.

3.2.5. Feedback in Serious Games

Feedback is a vital element of game design and is especially necessary when designing a game for an elderly audience and “The possibility of following progress” is a requirement for the Join-In project (page 27, deliverable 2.1). The Join-In game should implement both immediate and long term feedback. The immediate feedback will require user testing in order to identify difficulties with the game so that instructions and encouragement provided are relevant and effective. By displaying immediate feedback the requirement “The possibility to correct ones mistakes” is fulfilled (page 28, deliverable 2.1). The long term feedback should follow a structure similar to *Wii Fit* as it is important to allow the user to set milestones, in order to rate the user’s progress and to provide a form of motivation (Figure 73). The Join-In game could improve on the *Wii Fit* model, which is only concerned with progression in relation to weight, by allowing the user to set specific goals. In Join-In several factors could be evaluated such as balance and reaction speed. If the game records more factors it will allow the user to better identify and address specific issues.

Join-In - Senior Citizens Overcoming Barriers by Joining Fun Activities

<http://www.join-in-for-all.eu/>



2 Recommendations for Join-In

In the previous sections of this document the various elements of games have been described. These include but are not limited to the following:

- the story or theme of the game
- the mechanics of game such as the game space, objects, rules and skills
- the user interface
- game balancing and the game experience
- the goals and challenges of the game such as reaction time, accuracy and precision, and memory tests
- the feedback that the game provides to the player.

The primary recommendation for Join-In and the games that are created as part of this project is that during the design of each game, consideration is given to each of these elements and whether or not they are necessary for that component of Join-In. As a result of this the game design documents for the games developed will include a section on each game element described above and provide a justification on their inclusion or exclusion from the game.

Therefore, for example, in the walking game, consideration of the story/theme will be required in the design. This might be that the players walk to a particular destination such as from one Paris/Rome/Munich landmark to another (as mentioned above). The story/theme in this walking game must be relevant and familiar to the players and ideally the virtual world in which the walk takes place is local or world renowned. As the players will be geographically distant, the second option to include world renowned places seems the more prudent option. Once the general story or theme is decided, the designers will need to consider the mechanics of the game, the user interface, the goals and challenges of the game and so on. These game elements will be decided based on the requirements elicited from the users in the different countries and with regard to the needs of the varied abilities of the players.

Similarly, in the memory card game, decisions with respect to the required game elements will be necessary. For example, the memory card game will probably not have a story or theme and there will be no defined space required in the game. The main objects in the game will be the memory cards and the main attributes of these cards will likely be very similar to traditional physical playing cards. These attributes may be extended to allow the pictures on the card to change and so on. All other game elements as described above will be also decided based on the requirements elicited from the users in the different countries and with regard to the needs of the varied abilities of the players with respect to

D6.2 Results from the trials

the memory card game.

The goals and challenges provided by the games developed will be essential to maintaining and improving player motivation and to target the appropriate cognitive or physical skills. It is recommended that dynamic game balancing be included in the games. This will be crucial, given the differing abilities of the elderly playing the games, for motivating the players to replay the game to maximise the benefits, cognitively/physically and socially.

3 Conclusion

A game is a problem solving activity with a playful attitude. When designing a game, the game designer is responsible for the experience a game can provide. A video game is comprised of many elements. The elements addressed in this document are: story and theme, mechanics, user interface, game balancing and experience, goals and challenges and feedback.

A story is used to keep a user engaged and motivated to play for longer. Generally longer games and games with a small number of primary characters gain from having a story. If a game chooses to follow a theme it is vital that all the elements of the game are aligned to reinforce this theme. Stories are not present in the majority of serious games as they are not necessary to educate the user in topics like exercise or math. As the Join-In project is a serious game for the elderly focusing on improving cognitive and physical skills it may not require a story. By using the concept of self-avatar representation the user will feel connected to the character without a story.

Game mechanics are at the heart of gameplay and form a system by which a game is progressed. The mechanics described in this document are grouped into seven categories: 'space', 'objects, attributes and states', 'actions', 'rules', 'skill' and 'chance'. The Join-In game, like all other games will contain mechanics. The walking prototype should feature virtual worlds as the game space. The objects and their attributes and states, may not all be predetermined prior to development. Certain objects such as an avatar and additional challenges such balancing may be decided on before development. The actions that the player will have depend on the challenges in the game. In the case of the walking prototype the primary action is that the player must be able to walk. The real world skills required to play the walking game should match the actions the player has. This is because the avatar is matching the user's input from a motion controller. An example of this is if the player has a balance action, the user needs to have the skill to balance. The chance mechanic is not a necessity in the Join-In game. It may be used to introduce an element of unpredictability in regards to which route the user takes or when the user has to tackle additional challenges.

A user interface is what allows a user to interact with a game. A core element of a UI is the menu system; it is typically the first controllable element of a game. It is important to follow the guidelines for designing a UI. The four primary guidelines are: reduce the complexity, clear structure for tasks, consistency of information and immediate feedback. Another possible structure suggests six guidelines: layout and style, colour, text, general usability, accessibility and user customisation. The other core element of a UI is the HUD. A HUD is designed to show the user important data such as current health and score. It is important

D6.2 Results from the trials

that a HUD does not interfere with the gameplay by taking up too much of the play area. The menu system should be easy to use as the target audience may not be familiar with video games. This should not be an issue if Join-In project follows one of the suggested set of guidelines.

To produce a game that constantly provides a challenge to the user an adaptive difficulty setting can be used. This setting can check the user's records such as average number of steps taken per minute and then increase or decrease the next challenge based on this score.

Feedback informs users of the progress they have made. The primary types of feedback are immediate and long term. Immediate feedback is presented to the user continuously and is an important part of making a game accessible. Long term feedback is used to show user progress over time such as weight loss in *Wii Fit*. In an exergame designed for the elderly both types of feedback are important for the user.

The development team is currently working on the walking game prototype for deliverable 5.2. The next steps for developing the multiplayer social game (deliverable 3.3) are to create a framework that facilitates either competitive or co-operative play for the cognitive challenges. Competitive play involves two or more players competing at the same time, while co-operative play gives each player an allocated period of time to play/make their move. These challenges could be integrated into the walking game prototype and 'unlocked' as rewards for completing certain exercises. A simple cognitive challenge, such as the Sustained Attention to Response Task (SART) test will be developed, integrated into the initial prototype and playtested with the user groups. Feedback from the user groups will be used to drive the development of the multiplayer social game.

4 References

- Adams, E. (2009). *Fundamentals of Game Design*, Second Edition. New Riders Publishing.
- Albores, J. (2011) *COPD patients may breathe easier, thanks to the Wii*.
- Andrade, G., Ramalho, G. Gomes, A. S. Corruble, V. (2006). *Dynamic game balancing: An evaluation of user satisfaction*
- Csikszentmihályi, M. (2008). *Flow: The Psychology of Optimal Experience*
- Demasi, P. Cruz, A. (2002). *Online Coevolution for Action Games*.
- Elliot, J. A. (2005). *Handbook of competence and motivation*
- Franklin, B. A., Whaley, M. H., Howley, E. T., and Balady, G. J. (2000). *ACSM's guidelines for exercise testing and prescription, Sixth Edition*. Philadelphia: Lippincott Williams & Wilkins.
- Galitz, W. O. (2007). *The Essential Guide to User Interface Design: An Introduction to GUI Design Principles and Techniques*
- Gajos, K. Z., Wobbrock, J. O. Weld, D. S. (2008). *Improving the performance of motor-impaired users with automatically-generated, ability-based interfaces*. In CHI '08: Proceeding of the twenty-sixth annual SIGCHI conference on Human factors in computing systems, pp. 1257{1266, New York, NY, USA. ACM.
- Hawthorn, D. (2006). *Designing Effective Interfaces for Older Users*. The University of Waikato.
- Mazel, J. (2009). *Wii Fit Sales Top 20m Worldwide, Revenue Nearing \$2 billion*. <http://www.vgchartz.com/article/4018/wii-fit-sales-top-20m-worldwide-revenue-nearing-2-billion/> (date retrieved 26th January 2012)
- Khoo, E.T., Cheok, A.D. (2006). *Age Invaders: Inter-generational mixed reality family game*. The International Journal of Virtual Reality 5(2), 45–50.
- Maguire, M. (2001). *Methods to support human-centred design*.
- Michael, D. and Chen, S. (2006). *Serious Games: Games That Educate, Train and Inform*. Boston, MA. Thomson Course Technology.
- Missura, O., Gärtner, T. (2009). *Player Modeling for Intelligent Difficulty Adjustment*.
- Parlett, D. (2005). *The Incomplete Gamer*. Board Games Studies Conference, Oxford.
- Rogers, S. (2010). *Level Up!: The Guide to Great Video Game Design*
- Schell, J. (2008). *The Art of Game Design: A book of lenses*. Morgan Kaufmann Publishers.
- Slater, M., Usoh, M. (1994). *Body Centered Interaction in Immersive Virtual Environments*. Magnenat Thalmann and Daniel Thalmann, Artificial Life and Virtual reality, John Wiley,
- Sniderman, S. (1999.) *Unwritten Rules The Life of Games*, No 1.
- Spronck, P. Sprinkhuizen-Kuyper, I. Postma, E., (2004). *Difficulty Scaling of Game AI*.
- Stephanidis, C. (2009). *Universal Access in Human-Computer Interaction. Intelligent and Ubiquitous Interaction Environments*

D6.2 Results from the trials

- Susi T., Johannesson M., and Backlund P. (2007) *Serious Games – An Overview, in Technical Report HS-IKI-TR-07-001*, School of Humanities and Informatics University of Skövde, Sweden, 5 February 2007.
- Tan B., Aziz A. R., Chua K. and Teh K.C. (2002). *Aerobic demands of the dance simulation game*.
- Tavinor, G. (2009). *The Art of Videogames*
- Thomson, J., Berbank-Green, B and Cusworth, N. (2007). *Game design course: principles, practice, and techniques--the ultimate guide for the aspiring game designer*
- Westra, J., van Hasselt, H. Dignum, V. Dignum, F. (2008). *On-line Adapting Games using Agent Organizations*.
- Zyda, M. (2005). From Visual Simulation to Virtual Reality to Games.