PlayMancer: Games for Health with Accessibility in Mind (*)

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Abstract: The term Serious Games has been used to describe computer and video games used as educational technology or as a vehicle for presenting or promoting a point of view. Serious games can be of any genre and many of them can be considered a kind of edutainment. Serious games are intended to provide an engaging, self-reinforcing context in which to motivate and educate the players towards knowledgeable processes, including business operations, training, marketing and advertisement. Serious games can be compelling, educative, provocative, disruptive and inspirational. The potential of games for entertainment and learning has been demonstrated thoroughly from both research and market. Unfortunately, the investments committed to entertainment dwarf what is committed for more serious purposes. In this feature, we will argue that the motives, incentives and expectations of the computer game industry differ from one cultural and economic environment to another. As the game industry is dominated by US companies, computer game products are targeting user groups mostly informed by the marketing departments of those companies. This process creates marginalised user groups and game types that are not addressed effectively by the computer game market. Accessible games and games for health comprise this underdeveloped niche. Research project PlayMancer is a multi-partner effort to tackle both of those issues in a coherent way.

Key words: Computer games, video games, accessibility, e-Inclusion, serious games, Games for Health

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■ Exergames and games for health

The need for delivering higher quality and more accessible healthcare to all its citizens is a major problem for health care systems across Europe. Demographic trends, an aging population, and the raising cost of chronic disease management further complicate this problem (Commission of the European Communities, 2005a). The social and economic cost of mental health problems are just being recognised and European governments and institutions are taking steps to meet this challenge (Commission of the European Communities, 2005b; ADAMS, GREINER & CORRIGAN, 2004).

'Games for Health' and 'Health eGames' are two terms referring to health-related computer games, or similar computer applications that use software tailored to computer games development. Being under the Games for Health umbrella, Exergames define those computer games that promote or assist in user engagement in some form of body exercise. Exergames have started gaining momentum in the game market.

So far over 300 Health eGames have been developed for people and patients. The number and variety according to the Gaming4Health game database are growing rapidly as more and more games are being identified from developers and sponsors in the United States and worldwide. A variety of health problems are tackled such as diabetes, Alzheimer, asthma, cancer, AIDS, obesity, and pain. Other Games for Health promote best practices for a healthy life such as fitness and exercise, weight loss, nutrition and relaxation. Another 35 or more Health eGames target professionals in the health and medical industry.

This new trend is not superficial: A growing body of research indicates that Games for Health do provide measurable health benefits. Previous literature review studies suggest that computer games in general can serve as an alternative form of treatment or an additional intervention in areas such as schizophrenia (BELLACK, DICKINSON *et al.*, 2005), asthma (BUSSEY-SMITH & ROSSEN, 2007) motor rehabilitation (BROEREN, RYDMARK *et al.*, 2007; COOK, MENG *et al.*, 2002; MERIANS, POIZNER *et al.*, 2006), phobias (WALSHE, LEWIS *et al.*, 2003; ROBILLARD, BOUCHARD *et al.*, 2003) and psycho-education (COYLE, MATTHEWS *et al.*, 2005; BEALE, KATO *et al.*, 2007; RASSIN, GUTMAN *et al.*, 2004).

The Health eGames Market is a rapidly expanding market estimated to be more than 7 billion US dollars in the next year. It overlaps the nearly 6 billion US dollars combined markets of Casual, Active and Serious Games [1]. Health eGaming is a new and rapidly expanding segment that delivers aspects of the Casual and Serious Gaming markets to consumers. Currently most of the games for health market data is represented by exergames (Nintendo Wii Sports and Wii Fit) and brain fitness, other niches are developing slowly.

The driving force behind Health eGames are not major computer games development studios or game distributors. Those are focused on the much higher stakes market of computer games for the mass entertainment. Starters, Small-Medium Enterprises (SMEs), research institutions and independent computer software companies are leading this market. One might expect all innovations to come from the U.S. or Japan, two countries that dominate the computer games arena. Still, the U.S. market development model, corporate bound and strongly relying on venture capital funds, does not provide adequate motivation and support for Health eGame development starters. Considering that Games for Health constitute a market niche of computer games market, such a development model cannot sufficiently deal with the uncertainty of predicting strengths and weaknesses. In contrast, welfarist policies for new media supported by European Commission and member states in European Union such as the ICT research funding programme or MEDIA and MEDIA Mundus programmes nurture European game development companies and institutions active in related research. However, their incomplete application on total product life cycle, does not guarantee a sustainable development.

What distinguishes Health eGames from games for entertainment or from other Serious Games is the fact that Health-related domain experts play a critical role as stakeholders in product development. As a result, the competitive ground in this area has moved from visual realism to fulfilling the health-related needs of the product. Game playing and game experience are not thus seen as top priorities for game acceptance. This fact contributes even more to the alienation of major entertainment games developers and producers of this type of games.

[1] iConecto e-games marketing report. Accessed on January 31, 2009 at: http://www.gaming4health.com/hgmr2008

Furthermore the vast majority of Games for Health, excluding Exergames and brain fitness games, are developed with a fraction of the budget of contemporary entertainment game titles. These facts attribute to the slow development of this computer game niche, which is attenuated by the recent economic slowdown.

■ Accessibility in games

In his article, Kevin Bierre (BIERRE, 2009) analyses the major forms of disability that could affect game use, which are presented in Table 1.

Table 1 - Types of disability in game playing (adapted BIERRE, 2009)

Name	*Definition*	*Effect on Games*
Auditory – Deaf or Hard of Hearing	"Partial or total lack of hearing". http://www.answers.com/topic/deafness Depending on the severity, could be referred to as "deafness" or "hard of hearing".	• Prevents gamer from following cut scenes that may contain plot information. • Could prevent gamer from receiving game cues such as footsteps or other sounds.
Visual – Blindness, Low Vision, or Colour Blindness	"Partial or total loss of sight". http://www.answers.com/topic/blindness The term "low vision" is often used for the ability to see using magnification. Colour blindness refers to the inability to see certain colors.	• Colour schemes may make it difficult for the colour blind to see the game. • Small objects on the screen may not be visible to those with low vision. • Visually based games will not be accessible to the blind.
Mobility	Accidents, birth defects, or degenerative neurological diseases could lead to problems moving a mouse or other input device. We are also beginning to see older gamers having problems with games that have high coordination requirements.	• Games that do not support alterative input devices may be inaccessible. • A lack of configurable difficulty levels could prevent gamers from being able to set a usable level.
Psychological	A variety of different problems could be seen in this category: schizophrenia, addictions, neurosis, manias, phobias.	• Game scenes might create or trigger symptoms of psychological nature • The presence of adapted or configurable game content could prevent gamers from experiencing uncomfortable situations • Certain game types might be unsuitable for certain psychological disorders
Cognitive	A variety of different problems could be seen in this category: dyslexia, ADD or ADHD, Asperger Syndrome, memory loss	• Lack of a tutorial mode could be a problem for dyslexics. • A large printed manual may be useless for gamers with ADD or ADHD. • Games that require a lot of micro-management will be difficult for those with memory loss.

Accessibility in computer games is promoted by committees, associations and organisations (IGDA Game Accessibility SIG, AGDev, AudioGames, ACM SIGACCESS) and rarely by commercial entities.

Commercial efforts towards this goal have been sparse and few, relate to closed caption support of dialog in game titles and they were initiated on demand of communities and associations of the deaf: After Half Life was released, deaf gamers complained that the cut scenes were not closed-captioned. As a result, Half Life 2 and its supporting game engine were designed with accessibility in mind from the beginning, including deaf gamers in the design phase and testing loops. Another highly anticipated game in 2004, Doom3, was not closed-captioned, to the disappointment of the Deaf community. An independent team set up with the goal to create a closed caption modification and id Software, the game development studio, provided them with files of the dialog used in the game. The team developed the "Dynamic Closed Captioning system" as part of the project and is allowing the use of this software free of charge by others who are willing to follow the requirements stated on their website.

In contrast to the insignificant commercial involvement, Kevin Bierre (BIERRE, 2009) also points out that there are three main reasons for providing accessible games. The first one is economic. By not providing accessibility in games, the game industry is losing out a potentially larger audience for their games. With anywhere from 10 – 20% of the population considered disabled in one form or another, this could be a fairly significant revenue loss for a given game. More importantly, there is a moral issue involved. A person who has a disability should have equal access to the same services and entertainment as others. Following the same rational that resulted in closed captioning on TV shows and movie theatres, will eventually lead us to games that are accessible to those with disabilities. This becomes a quality of life issue. Finally, there could be legal issues involved. Some countries already have legislation in place mandating equal access to all. Many of these laws are covering access to services. Since a multiplayer online game is a service, sooner or later the game developers, the target-users or even the states will raise the accessibility issue from a legal point of view.

Independent game developers are more inclined towards supporting disabled communities and game players, though their efforts are partially compromised by their limited resources devoted to game development. Exemplar cases are usually co-funded by governmental funding programs or by national or international disabled organizations. Terraformers, which is an

adventure game that can be played by deaf or blind gamers, provides the standard graphics seen in this type of game for sighted gamers, but can be played in a no-graphics mode for the blind. A form of sonar is used by the player in no-graphics mode to locate and identify objects. Puzzles are sound based, with the player using tones to determine what codes to enter to open a door. This game was developed with partial financial support from the Swedish Handicap Institute.

As Shankar and Bayus argue (SHANKAR & BAYUS, 2003) there are two equally important factors that dictate the market position and growth of a product: the size and the strength of the target group or installed base of the product. In the computer games industry this is true for both purely entertaining and serious games.

This strength for contemporary game titles is manifested through discussions in Fora, community building events and creative uses of the games including custom content creation for the game and game modifications. In support of this mechanism, Herz and Macedonia comment (HERZ J. & MACEDONIA, 2002) that the backbone of the business of Blizzard -that leads the market of massive multiplayer on line-games with their title "World of Warcraft" – is the social dynamics of the networked player population.

Contemporary media and computer gaming culture has given birth to another agent in game accessibility: the game player as content and media creator. New game types are emerging by game players that are trying to augment the features offered by commercial games, or because they have seen in the games the tools to express their own creative talent. Thus new media experiences are born aiming at promoting and sharing this altered content, and through user communities, they are getting popular and influential for other users. Examples of such use include political games that raise awareness about political issues, machinima, cinematic story narration using re-purposed game content and animation of an existing game, game modification or "modding" as it is more commonly known, that results in altering the game narration and even the rules of engagement of certain game titles to the extent of producing a different game.

The new class of activist computer game creators, assisted by the openness and availability of knowledge in the internet is contributing to curbing traditional market rules. They help vocalising user needs and

evolving the game market from partially demand-driven to supply-driven. Game accessibility community web sites such as Game Accessibility [2] and Switch Gaming [3] provide an overview of custom game controls manufacturers, accessible games, advice, reviews of commercial game titles both in terms of entertainment value and accessibility support, news and more.

■ PlayMancer

PlayMancer is a Games for Health research project funded by the European Commission, aiming at implementing a framework and a platform for serious games by augmenting existing 3D gaming engines. More specifically, the main objectives of PlayMancer are:

- to construct a next generation gaming environment, mainly augmenting the gaming experience with innovative ICT modes of interaction between the player and the game world;
- to evolve the principles of Universally Accessible Games for application into 3D-based games, following a design for all philosophy, with the ultimate goal of designing games to be equally challenging to players of different abilities;
- to evaluate the proposed framework and gaming infrastructure by developing and testing a series of serious games modules as applied to two application domains: physical rehabilitation, and therapeutic support and lifestyle management programs for behavioral and addictive disorders.

Constructing an evolved gaming environment

Project PlayMancer is conceived to take advantage of the current market momentum towards a next generation gaming platform. After the mass-market adoption of 3D graphics acceleration cards due to the recent game technology advancement, the PlayMancer consortium anticipates a similar trend to happen with new interaction modes in the near future.

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[2] Game Accessibility, Accessed on March 17, 2009 at: http://www.game-accessibility.com/

[3] OneSwitch, Accessed on March 17, 2009 at: http://www.oneswitch.org.uk/index.htm

Progress in gaming interfaces has resulted in the introduction of new more responsive and intuitive ways of experiencing a computer game, both in terms of human input and game feedback. Very substantial work has been carried out in a series of European-funded projects within the FET programme for future and emerging technologies, regarding the study of presence in virtual environments. Projects such as EMMA, PRESENCIA and the on-going integrated project PRESENCCIA are investigating the human response to fake stimuli as if they were real by studying the cellular, neuronal, physiological, psychophysical, cognitive, emotional and behavioral aspects of the phenomenon.

The game core (the PlayMancer platform) is being built by encompassing an Augmented Reality (AR) 3D game-like world. AR has been used so far for scientific applications with success, but due to the fact that these applications are very specialized, AR constitutes a very limited market and as a consequence the average cost of AR products are exaggeratedly high for an average game user. However, we believe that reducing the games production cycle will accelerate the creation of an economy of scale that will drive down the cost and increase the availability of games, games components and technology. Thus it is expected that the cost of AR technology will be considerably dropped, if future game platforms massively exploit them, the same way that 3D games did for 3D acceleration card costs.

In order to enable full body interaction in networked environments, an affordable motion capture system is being developed as a result of the project. Marker-based optical motion capture has become a de facto standard capture technology in the movie and entertainment industry in the previous 10 years. Thereby one or more actors wearing motion suits with retro-reflective markers attached to them, are tracked by a number of cameras (minimum 6). All motions are computed in real time (with millimetre accuracy) and are available for further processing e.g. recording, analyzing, motion transfer to a virtual character and more. Within the project a flexible, affordable motion capture hardware and software platform is being developed with specifications similar to existing high-quality motion capture systems used in the film industry. Main differences are its final price tag of only 1/5th of that of commercially available systems, its increased flexibility and smaller hardware size, therefore higher mobility. In order to achieve this goal technical innovations will be required: A pre-requisite of reliable motion capture is stable ID-based marker tracking even in situations where markers are occluded. This, together with the implementation of high-performance inverse kinematics algorithms and integration of the whole tracking module

into the Playmancer platform will be key aspects of research work to be conducted within the project. Due to lower costs there are a number of fields that would dramatically benefit from affordable motion-capture including rehabilitation clinics (e.g. motor rehabilitation monitoring and analysis, stroke patient therapy and many more) and independent biomedical researchers in many fields. Even veterinary clinics could use accessible motion-tracking systems to examine animal gaits and behaviours for diagnosis. Researchers and artists will benefit since the costs of current motion capture systems are simply too high.

In recent years bio-feedback has become increasingly important as a non-classical user interface. Especially in medical applications where users' bio-signals are of vital importance various sensors have been integrated and used for feedback to patients and medical personnel. Biofeedback in gaming (RAPOSA, 2003) introduces new approaches to training, wearable computing, and computer gaming. It is an exploration in making physiological information entertaining, engaging, and informative. PlayMancer investigates the medium of a biosensor-effected computer game as it examines a hypothesis that fun and playful body monitoring devices are more effective at making people understand the disorders than established rehabilitation programs based on physical exercises.

Within the Playmancer game bio-signals are giving important indications on a patient's medical condition, his motivation, excitement and engagement. These user input signals comprising of vital signals, facial and voice signals, are being integrated into the platform, providing reasoning upon the emotional state of the user. The game itself is able to respond to these signals and provide feedback accordingly.

Given all the aforementioned input and output interaction modes and data streams, the project's innovation lies in the integration of a development platform (based on existing game engines, OS etc.) with tools and mechanisms that will allow binding, integration and access of existing, new and future multimodal I/O devices, recording all interaction data and making them available in a readable way for the creation of Serious Games for Health.

Promoting implicit accessibility and health monitoring features for game runtime engines

For all the reasons described above, and in order to overcome the lack of support by the computer games industry, Savidis *et al.* (GRAMMENOS, SAVIDIS & STEPHANIDIS, 2005) have proposed a framework called Universally Accessible Games (UA-Games) based on a set of design principles that would render common games into accessible for all. UA-Games are computer games that can be potentially played by all gamers on equal terms, independently of their individual characteristics, requirements, preferences and abilities. UA-Games are intended not only for disabled people but also for people experiencing slower reflexes or lower perceptive abilities than other people, such as the elderly and people not experienced in playing games. In particular, there are no computer games that can be concurrently played among able and disabled people, except few minor exceptions.

PlayMancer implements an accessibility configuration utility provided by the runtime game engine that abides by the UA-Games principles. This configuration tailors individual game playing preferences/profiles set by the therapist.

In many e-learning and Computer Supporting Learning Systems, learning sessions do not involve a closed loop between the user/learner of the application and the computer system, but additional roles are identified and supported, such as the human teacher, by providing custom screen interfaces and functionality to each of those roles.

In a similar fashion, PlayMancer introduces an additional agent in the game-player/ computer game interaction loop: the therapist. The game platform of PlayMancer allows for a separate decentralized therapist client, where all game related data are streamed. Game sessions can be observed, controlled and post-processed for post-game assessment by the therapist.

Unfortunately, health monitoring does not come without raising some important ethical issues, such as use and protection of personal data, level of therapist control, susceptibility to risks like game play session data compromise by external agents including the government. In his book *iSpy: Surveillance and Power in the Interactive Era*, Mark Andrejevic (ANDREJEVIC, 2007) criticizes the collusion between the government and the defense-electronics industry in the pursuit of the "War on Terror". He also emphasizes that the people are deceived into the illusion of consumer

sovereignty that comes to replace the popular control that idealized notions of democracy once assigned to the citizen. Having witnessed the recent debate over the unauthorized commercialization of the user preferences and profiles database of the social networked internet service Facebook without prior user consent, the aforementioned risks should be addressed on both the platform and application levels.

PlayMancer project fosters anonymity, privacy and confidentiality. These principles will certainly require that no personal data of any kind will be stored on the platform after each session. Approval from ethical committee, and informed consent for patients will be part of any studied protocol within Playmancer. The project partners will conform to all applicable laws and regulations regarding experiments with human subjects:

- The subjects will be selected among the adult population who can give consent. All participants using the serious games module for eating disorder (bulimia and binge eating disorders), pathological gambling, and motor rehabilitation will be adults.

- The serious games will only be made available to an adult population having been fully informed about the purpose of the games and the application of certain rules of conduct.

- Small populations or closed communities will be selected to take part in the evaluation field trials. Most of the participants will have to be screened or will require individual interviews.

- Health care professionals (therapists) will monitor all study participants using the serious games module for eating disorders or pathological gambling as follows:
  - at least three face-to-face evaluation meetings (Initial screening and evaluation, mid term evaluation, final evaluation);
  - obligatory weekly contact via a secured messaging module throughout the study period (typically 6 months);
  - therapists have to monitor user activity and provide feedback, support and guidance during the weekly e-mail contact;
  - no access will be given to anyone that is not monitored by a therapist.

- Health care professionals will also monitor all study participants using the serious games module for motor rehabilitation therapy:
  - professional medical personnel will monitor user activity, provide feedback, support and guide all the time during the training and evaluation sessions;
  - no access will be given to anyone that is not monitored by a therapist.

Evaluating the proposed framework

All of the review studies of the impact of games for health indicate that computer interventions can be helpful in various treatments and the naturalistic studies strengthen this claim by showing differences between pre and post measures. Presently there are few experimental studies using control groups and moreover the sample sizes in the existing ones are generally low. Therefore there seem to be a need for more studies to be applied before any real conclusions can be made, using control groups of larger numbers and more objective measures such as biosensor, behavioral and physiological measures. It can also be questioned, whether computer games are the most adequate form of treatment in adults. On the other hand, studies of other pathologies, such as cognitive remediation, and language impairments, are not solely limited to psycho-education. They also have the intention to improve the symptomatology of the disease.

Specific game scenarios have been defined in Playmancer, to deal with problems, cognitive traits and risk factors common to a variety of lifestyle related behavioural disorders. These scenarios have been developed within the Playmancer platform and will be evaluated in pilot trials to determine user acceptance and efficacy in improving cognitive beliefs and lifestyle improvement.

By means of the PlayMancer game, chronic pain patients will be trained to improve both their motor skills (e.g. force, coordination, endurance, mobility) while executing functional activities of daily living (e.g. bending forward and backwards, lifting weights, jumping). During the game, both body posture and biosignals will be monitored and provide input for the game as well as motion analysis.

Chronic pain causes motor deficits like deterioration of the general condition or decreased quality of movement patterns and muscle coordination. Although a multidimensional approach for treating chronic pain is commonly accepted, existing rehabilitation treatments still are only moderately effective. This together with the fact that the group of subjects with chronic pain is still growing argues for new more cost effective treatment approaches in near future. So using monitoring and feedback technology in serious gaming aiming at making the patient aware, motivate him and enable him to change his motor functioning are hypothesized to be the necessary ingredients for patients to self manage their complaints and obtain positive changes in their level of functioning. As such these are also considered the key aspects of these treatments.

Playmancer games are part of the growing Games for Health niche, aiming at both end-users and professionals.

■ Conclusions

Games for Health are among the serious games trends that are very promising both for their social benefit and market potential. The information of computer games with exciting new technologies such as bio-feedback and body motion capture is expected to boost their user experience value. Advances in terms of both user experience and medical value are foreseen, given that proper studies will prove their promoted merits.

Research project PlayMancer is attempting to tackle some open issues in Games for Health such as accessibility and multimodal interfaces.

Considering the studies on the effect of games for health, it seems obvious that the work on videogames as a treatment in health is still, to an extent, in its initial phase and is continuously progressing. Independently of their marketing value and potential, the effect of other types of serious games should also be more thoroughly studied in the near future.

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