Game Design for All: The Example of Hammer and Planks

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Designing Health Games and Interfaces for General Public Adoption: the Example of Hammer and Planks

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ABSTRACT
Last years have seen a growing interest on the Serious Games topic - and in particular on Games for Health - from both scientific and industrial communities. However not only the effectiveness of this kind of games is not yet demonstrated but the distribution and adoption of these games from the normal public is still very low. In this paper we present a design strategy we adopted in on the occasion of the development of a game for hemiplegic rehabilitation named "Hammer and Planks". This game strategy allowed us to create a "game for all", as will be demonstrated by the example of the usage of the game on the occasion of a game event in the south of France.

Categories and Subject Descriptors
D.m [Software]: Miscellaneous|Software psychology; K.8.0 [Personal Computing]: General|Games; H.5 [Information Interfaces and Presentation]: User Interfaces

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Design, Experimentation, Human Factors,.

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Health games, social aspects, multimodal interfaces.

1. INTRODUCTION
Last years have seen a growing interest on the Serious Games topic - and in particular on Games for Health - from both scientific and industrial communities. However not only the effectiveness of this kind of games is not yet demonstrated but the distribution and adoption of these games from the normal public is still very low.

While it's true that some Serious Game genre has its own economic and distribution model - e.g. training infantry on serious games applications is much cheaper than making real operations with real ammunitions - this is not the case for all serious games. Pascal Schmidt's keynote at Games for Health Europe addressed the same topic [1]. While research demonstrating the power of games - in particular in the healthcare field - is one step toward ensuring greater legitimacy, other important changes are required to increase their actual usage. At the current state serious gaming isn't able to reach a wide public making the results confined to the research milieu. This is a huge limitation in particular for health games. First of all because one of their purposes is to re-integrate the unhealthy person in the world of healthy people. It's also a huge limitation for the validation of other kinds of serious games because, as researchers, we will never be able to conduct large scale experiments e.g. test the effectiveness of e-learning games without reaching a large amount of people and during enough time. It then becomes important to find strategies able to widen the adoption of serious games and engage the players. For the FDG conference this year we want to address the topic through a little provocation: Isn't it time for serious games to way back to really integrate the fun factor with the serious aspect as is often told in theorist books?

In this paper we present a design strategy we adopted on the occasion of the development of a game for hemiplegic rehabilitation named "Hammer and Planks". This game strategy allowed us to lay the first stone for a "game for all", as will be demonstrated by the example of the usage of the game on the occasion of a game event in the south of France. In our opinion there are interesting advices we can draw from this experience that can help the community to go towards the direction underlined by our provocative question. The rest of this paper is structured as follow. Section 2 describes the state of the art of games for health. Section 3 describes the game we created while in Section 4 the method we adopted during the conception of the game is presented. Section 5 shows the usage of the game during the event which helped us to assess the utility of the method and finally Section 6 draws the conclusions and addresses future works.

2. GAMES FOR HEALTH
In this section we present a quick state of the art of games for health. This field being very huge we don't aim to give a complete overview of the domain but rather an overview of main problems and advantages to take into account when designing games for

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health as a subset of virtual rehabilitation tools. We will focus in particular on physical rehabilitation through games.

2.1 Serious Games For Health

”Serious game for health” or ”Game for health” is considered a promising research domain both for health and ICT sector and for this reason there are interesting studies on the topic. Health application domains are varied and concern different end users such as doctors, students, patients, researchers, the general public, etc. A game for health can be useful in diagnostic, prevention, , training, fitness, rehabilitation, relaxation, etc.

To date there are different research and industrial activities that have a great interest in health games. Their purpose can be focused on using the serious game as: a functional training or rehabilitation tool (Mojos [2]), a prevention tool (Science Pirate [3]), an help for relaxation (MindHabits [4]), a training tool for students in medicine (Pulse [5]) and/or a tool for understanding chronic illness (l’affaire Birman [6]) .

2.1.1 Actual Rehabilitation

During a rehabilitation process patients often recover slowly and hardly in particular in the case of motor abilities. With repeated therapeutic activities, patients often become tired and frustrated. Therefore patients’ motivation has often to be supported during their rehabilitation sessions. As a matter of fact the therapist has to continuously support the patient by encouraging him and adapting the rehabilitation exercises to his ongoing condition.

While this process is very hard for the patient and the therapist it has its usefulness. Most rehabilitation techniques are founded on the principles of motor learning and skill acquisition established for the healthy nervous system. These studies suggest that intensive training (many repetitions) while giving feedbacks [7] and motivation to patients can have an important impact on the patients’ skills recovery [8].

2.1.2 Game Based Rehabilitation

The potential benefit of training based on virtual reality or serious game strategies consists in providing an environment in which the intensity of training, its duration and frequency can be manipulated and enhanced. This manipulation could be used in order to motivate the patient by creating a personalized motor learning paradigm [9]. For instance, integrating gaming features in virtual environments for rehabilitation could enhance patient motivation [10] which, in turn, improves recovery. A person who enjoys what he is doing spends more time developing his skills at this activity.

Furthermore, the personalized motor learning can be achieved using an appropriate game design that must fit accurately personal therapeutic goals. The patient performances can vary since they depend on his/her situation and conditions (both general and day-to-day) that can therefore influence his/her capabilities. Thus, if the therapeutic game has not properly assessed the patients conditions its very likely that the patient will not succeed in the proposed activity, decreasing his motivation at continuing the therapy. To avoid this effect an adaptive approach can be used.

An adaptive therapeutic game can in fact adjust its behavior basing on the ongoing results of the patient. It can thus adapt dynamically the difficulty during the game according to the patient assessment and not only on user profile. Thus, adaptation can fill the gap between the current condition of the patient during the game and the patient profile assumed at the beginning of the therapy.

2.2 Advantages of Virtual Rehabilitation

The challenge for game based rehabilitation is to create exercises able to decrease the monotony of hundreds of repeated motions. The possibility of using 'virtual' rehabilitation has been the subject of experiments by several authors (for example [11][9] [12][13][18]).

To summarize the results from these studies and what we have described in the previous section we will list the factors in which Virtual Rehabilitation (of which serious games are a subset) can give its contribution.

2.2.1 Increasing rehabilitation volume through motivation

The first factor is linked to the motivational aspect from the patient’s point of view:

1) Personalization: Virtual Rehabilitation technologies create an environment in which the intensity of feedback and training can be manipulated to create the most appropriate, individualized motor learning paradigm [9].

2) Interactivity: Virtual Rehabilitation exercises can be made to be engaging so that the patient feels immersed in the virtual world. This is extremely important in terms of patient motivation [10], which in turn, is one of the key factors for recovery.

3) Feedback: Interactive feedback can contribute to motivation. By providing visual and auditory rewards such as displaying gratifying messages in real time, patients are motivated to exercise [14][15].

In the case of Serious Games all this aspects can be integrated in the game design.

2.2.2 Increasing rehabilitation volume through effectiveness

The second factor is linked to the effectiveness aspect:

Tracking: The evolution of patient's performances can be easily stored, analyzed and accessed by therapists [9][10]. The only purpose for the patient (but also for the therapist) is to recover most of his/her body functionalities. It is therefore important to show the patient and the therapist patient’s progression during therapy.

In the case of Serious Games this aspect requires ad hoc analysis and it’s added value is evident when the results are reinserted in the game through personalization.

2.2.3 Increasing rehabilitation volume through ‘telerehabilitation’

The third one is linked to the portability and economical aspect (low cost of the devices):

Telerehabilitation: A Virtual Rehabilitation system could be used outside rehabilitation centers, allowing for ubiquitous rehabilitation. However, before its adoption it is necessary to demonstrate not only its medical efficiency but also that the system is economically sustainable. Cheaper personal equipment (pc-based for example) could eventually allow rehabilitation stations to be placed in locations other than the rehabilitation center, such as patient’s home.

In the case of Serious Games this could mean to create games which exploit technologies already at hand in the patient’s house such as consoles, PCs and tablets.

2.2.4 Increasing rehabilitation volume through social aspects

Another important factor which is often underlined in the case of virtual rehabilitation is the importance of the social aspect.

Researchers are seeing real benefits in the growing popularity of social games, created to connect people with friends and strangers alike to improve health and fitness through contests, prizes, and friendly peer pressure. Games like Zamzee (an obesity-fighting game [16]) and OptumizeMe ([17]a mobile app in which the player can accept health and fitness challenges) but also the Kinect and Wii Sports game play with the idea of doing rehabilitation with friends and family.

As motivation is an important factor in rehabilitation, using social activators in the game design is very important to trigger this motivator.

2.2.5 Limits of virtual rehabilitation

On the other hand, Virtual Rehabilitation does raise significant challenges before its widespread adoption such as clinical acceptance (which relies on proved medical efficacy); therapist's attitude towards the technology (e.g. fears that technology could replace therapists and the like); patient's attitude towards the technology (e.g. the patient may not consider a game to be 'real' rehabilitation); ethical and regulation challenges linked to the kind of technology used; interest in playing the game from the general public (without this interest we lose the possibility of a part of social rehabilitation).

At the current state of the art the above mentioned aspects are taken into account in a more or less in depth way by designers in the Games for Health field but as far as we know there are no general guidelines on how to put into action those elements. In this paper we give our contribution to this topic using a particular point of view. We believe, in fact, that there is a possible extension of the phrase “increasing rehabilitation” we used until now. Increasing rehabilitation can mean increase one person rehabilitation but also increase the number of persons doing rehabilitation.

3. A GAME FOR REHABILITATION OR A GAME FOR ALL?

The importance to design games for all (or the inclusiveness of game design) is not a new topic both under the general label of Universal Design and under the specific game design topic (see e.g. Heron [19] for an analysis of commercial games, or the website Includification [20] for design suggestions).

However the topic of integrating people suffering from vision impairment or reduced motor functions in games is still some kind of “need to do it for political correctness” part of the process - as these gamers where not gamers but only impaired people - from the game industry point of view. On the other hand researchers fail on the upper level integration i.e. they tend to create games for a specific pathology only. As a result we can rarely see games conceived from the beginning to be played intensively by both healthy and impaired people. This creates a huge gap between commercial titles and serious games proposed by researchers. In the rest of this paper we will give our contribution to the topic by demonstrating that the integration of these two different kinds of users from the first steps of design is successful at expanding the global usage of the game, without losing the therapeutic benefits.

3.1 The Initial Context

The idea of the game described in the rest of this paper was born from the interaction with an institute of occupational therapy in France. Following a discussion on the current usage of Wii in rehabilitation and the inability to adapt the game to therapeutic goals, the idea arose to create an adapted game for rehabilitation purposes. The focus was towards the conception of a game able to make people with balance disorders (specifically the case of hemiplegic people) to train their equilibrium. A gameplay requiring the player to move from right to left, and from front to back was then created conceiving a vertical shooter in which the player has to drive a boat (see next section for details on the gameplay).

The game was chosen as rehabilitation method firstly because a task-centered rehabilitation is more effective than asking a person to do different kinds of movements without specific goals (see e.g. [21][22]). This type of training allows a person under rehabilitation to focus not on what he is doing but on the goal (to move the boat in our case). The game allows then to create rehabilitation through activity. As the game is conceived for functional and postural rehabilitation and given the state of the art of interaction devices it was natural to choose the Wiiboard as preferred interaction medium.

From the personalization point of view the doctor can configure game parameters such as difficulty, game speed or areas where enemies should appear through a dedicated web interface (fig.1 shows this aspect). At the end of a game, the interface allows the therapist to view game statistics such as the number of objectives attained, the missed ones, the time spent in different sectors of the screen as well as the patient's center of mass trajectory during the session. This information will allow the doctor to evaluate the patient progression and to adjust the difficulty for the next game.

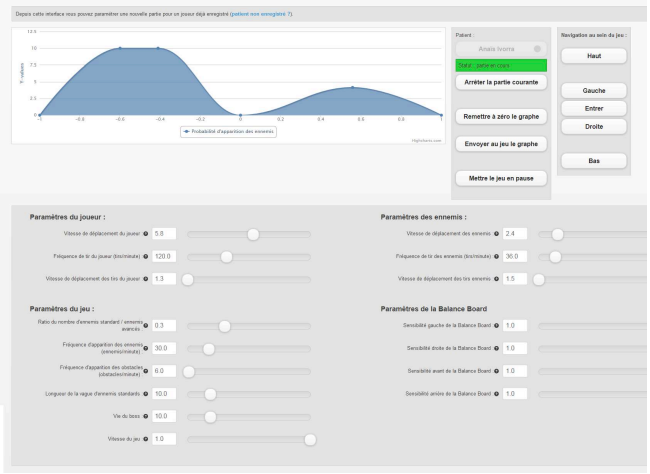

Figure 1. A screenshot from the therapist interface.

4. THE DESIGN METHOD: FROM A THERAPEUTIC GAME TO A GAME FOR ALL

From this rather classic - for a rehabilitation game point of view - set of game specifications we will enhance the design with the addition of game for all points of view.

As we have already said, a main drawback of classic game for health design is the lack of intention to appeal healthy gamers, hindering the possibility of a kind of social rehabilitation. Often this happens because the gameplay is not enough taken into account, while development efforts are only focused on the educational or training message (the so-called seriousness of the game). We can then say that there is a problem in the game design phase.

The second drawback is the high specificity of each movement based rehabilitation game. Most rehabilitation games are constructed around a specific pathology. Then problems arises. What if the game needs to be used in another context, for example a game for post stroke rehabilitation reused in the setting of back pain rehabilitation? The problem is more deep of what it appears if we look at it from the research point of view. While it's true that a game conceived for cognitive rehabilitation may not be adapted for motor rehabilitation, why motor based rehabilitation games are not based on similar interactions as motor laws in human being are general?

This problem in our opinion affects both, the game design and the interaction level.

4.1 The Game and Interaction Design Method for Hammer and Planks.

Our goal for this project was to propose a serious game for the rehabilitation of hemiplegic people which could be used by the general public with only little or no modification. In the rest of this section we detail the main aspects taken into account during this process.

4.1.1 A detailed background story and game design

Our first step was to avoid the main drawback of a gameplay not appealing to gamers. We worked hard on the game design which at the end consisted of about twenty documents detailing the character design, the level design, and so on. Just as a little clarification we want to underline that this is the classical process used in game enterprises even if the game is a vertical shooter game. While we will not enter into detail in the game design of the game a short description of the game design is added to clarify the game concept.

The Game Story: Hammer and Planks

"John K. is a pirate like the others, who lives quietly from his noble profession. Sailing on his brisk boat, robbing the richer to give to himself. A totally peaceful life? Not quite, because in a beautiful summer night a strange ship approaches his boat. A light spinning skyward escapes this mysterious boat and … a meteor crashes down John's ship. Luckily John assists to this tragic scene from the nearest inn and sadly discover what is left of his boat ... not so much. However, it's still enough for him to build a new basic boat from the remains of the old one and to return to the adventure. Now he wants to find this strange ship which showered meteors, but first he needs to rebuild a ship worthy of the name. Nothing could be better than to navigate and collect driftwood and remains of ships he sinks and use them to upgrade his own..."

The Game Dynamics

Hammer and Planks is a vertical shooter. It consists of a 2D environment scrolling from top to bottom in which the player controls a ship that can move from left to right and top to bottom, and use its cannon to shoot enemies and avoid obstacles. The goal of each game is to defeat all enemies without being destroyed by bullets, reefs, or other obstacles. In this way the player will pass through a series of levels and use what he found to improve its ship. Figure 2 shows a screenshot from the actual game.

This kind of game is suitable for high scoring as players seek to improve their performance primarily on criteria such as the number of enemies killed. The gaming experience typically expected in this kind of game is based on a high level of challenge. The phases of the game are generally intense, short but requiring a lot of concentration. Enemies and obstacles arrive in large numbers and it is an important part of the game to respond quickly and staying attentive. Also the idea behind the boat improvement is linked to the patient's rehabilitation: as a player he rebuilt his boat in the game, as a patient hedo the same with his own body.

Figure 2. A screenshot from Hammer and Planks.

4.1.2 - Customization without Discrimination: a Multimodal Implementation

In the therapeutic version the patient was initially considered as a different player. First of all he does not die, and there are also some functionality that can be disabled and will change the gameplay. However this approach works well in a controlled setting with someone who explicitly states that the person playing is a patient – which in literature can go under the label of "Adapting difficulty under therapist control". However this approach will not work with a wide dissemination of the application in a non controlled setting such as in the case of the game event described in next section.

Using the classical approach we would have fallen into the assumption (not necessarily negative but not useful in our setting) that each disease may actually require a different gameplay. Rather than asking the patient which kind of problem he has – which not only implies to have planned every cases in the game, but also to give space for possible discrimination in a social setting – we preferred to propose the same gameplay with adaptable ways of interaction.

As the game was conceived for functional and postural rehabilitation the initial idea of using the Wiiboard as interaction medium was maintained. Figure 3 shows the application of this scenario in the game event. The current implementation of the game has been developed for several platforms: computer, smartphone, and tablet. On the computer version, it is possible to interact with the game using a large set of controllers: gamepad, keyboard, mouse and some NUI (Natural User Interfaces): Kinect or Wiiboard.

The version developed for the mobile device uses the internal sensors – and in particular the accelerometer – to capture the movements of the player. With this set of interactive devices we

were able to propose a large palette of game supports for all the family and for some disabled people.

To reduce development cost, we used a framework called Unity 3D. This tool in conjunction with the framework Play gave us the opportunity to produce a full crossplatform game with an unique leaderboard.

All these different devices open the possibility of a set of totally new experiences for the game, forcing the player to find strategies that he was not required to consider before. The multiplicity of interaction devices can provide then a real novelty. and keep engaged the player.

4.1.3 The Social Approach.

As we said we tried to avoid every kind of discrimination towards non healthy players. As Hammer and Plank is a competitive game we created a generic leaderboard to aggregate all the players. The opportunity of this choice will be discussed in the next section. During the event we added as additional motivator a final price for the best score in the leaderboard which consisted in one license of the game.

Figure 3. Hammer and Planks used with a Wiiboard in the MIG event

To summarize. What we did with this game was to put on the front both the gameplay and the interface, trying to provide complete involvement but also a considerable stimulus from the point of view of interaction. And all the aspects were conceived for a social competitive setting.

5. H&P USAGE: THE MIG

In this section we describe the game event in which we participated and the results of this participation.

5.1 The Event

Montpellier In Game (MIG) is an annual event dedicated to video games. The event targets two audiences, professionals and gamers, separating their access in different days. This year the MIG hosted 47,000 visitors, summing the professional and general public days. In this paragraph we will enter into detail only in the gamers' events as the rest of the experience described in the paper is linked to it.

The part of the event open to the public spreads over two days and offers attendees the opportunity to see live demos of games that have yet to hit the market, play their favorite games for free, see the biggest names in gaming industry in conferences, and so on.MIG also enables small publishers of video games to present their productions to the public and make themselves known. It was in this latter setting that we presented the general public our work.

5.2 H&P usage

Our main question during the event was "Will this game really be played by everybody?". A positive answer to this question would have allowed a first validation of the "game for all" principles described in previous section. Being the game event a non controlled and very informal setting for experimentation we preferred to not ask to fill in a survey but based our analysis on observations and informal discussion.

During the two days of the event we had more than 700 games played by healthy and unhealthy people. The unhealthy people came because they had heard about the game on the radio and wanted to try it. There were different pathologies ranging from manipulation problems, to strokes, to a quadriplegic person.

Hereafter the description of their interaction with the game.

As a first example we can report on a child (10-12 years old) who arrived in a wheelchair pushed by his father.

The child was suffering from a stroke and was installed on the bench to play with his brother (which generates a small challenge between the two). They played together (or better one vs the other) a couple of games using the gamepad.

As a second example we can report on a girl with fine manipulation problems (she wasn't able to play with the gamepad). She was provide with a tabled (a Nexus7) using the accelerometer to drive the boat. As a result she was very happy to be finally able to play again and the tablet demonstrated to be a good interaction technique for this type of pathology.

Finally we will report on a quadriplegic who was barely able to move his hands and thumbs (especially the left one). As for all the other persons he was the one coming to ask to try the game. We provided him with a joypad and he passed 4hrs playing on the stand. His motivation for playing so long was linked mainly to the fact that he wanted to make the best score but also to the fact that Hammer and Planks was one of the few games he was able to play because of his physical limitations.

From the unhealthy players point of view we can say that all of them were very happy with the gaming experience and the event seems to demonstrate that there is a real interest in having a game with different manipulation techniques for everyone.

However the fact that the games was interesting and nice to play for unhealthy people does not means that it's really adapted to everyone.

As elements to support this extension we can cite the fact that we had more than 400 games played on the first day and more than 300 games played on the second day. The healthy person who played the most played 55 games (followed by the hemiplegic player who played 40 games) and around 10 persons came back on the second day to play again. This means that the game was strongly played by healthy people as well.

We can also describe some interesting behavior. We had a young man (around 17 years old) playing the game who came both days trying to beat his best score. Hereafter the comment he left on the Facebook page of the event "Fun and relaxing game with a great gameplay. If I could I would have stayed playing it all night. And I will return tomorrow to try to beat my record!"

Another 10 years old boy came on Saturday and was back at 10am (the opening hour) on Sunday. He stayed on the stand until we ended up saying that even without being in the high score, he would be entitled to his free license.

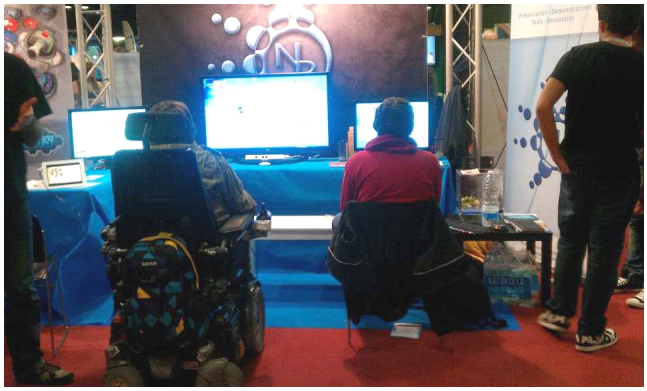

Figure 2. Different players playing together

5.3 Discussion

Apart from particulars examples and despite the informal setting we believe that the number of game played is an indicator that the competition between healthy and unhealthy players took place and the game was considered funny.

We are very well aware that a two day event says nothing about the long term usage of the game. However it's still an interesting result to be checked more in depth.

It's our opinion that this kind of event was huge opportunity from the research point of view to explore the actual usage of the application in a non controlled setting.

We can then argue that our participation in a couple of events of this kind can help us to assess in a definitive way:

- The usability of the game by different kind of healthy and unhealthy people
- The structured game design and fun aspect able to engage different users

At the same time we don't want to hide that we had also comments such as « GTA is better ». It's evident that this game has not the same appeal for all kind of gamers. However it's our opinion that this is not linked to the principles we described in the paper but to personal game preferences.

Another interesting aspect is the social one. As we said we tried to avoid every kind of discrimination towards non healthy players. As we have seen the learderboard acted as activator for competition not only against the others but also against oneself, pushing the player to pass his own limits (as demonstrated by the case of the quadriplegic player).

Finally we had some interesting positive comment from both health and game design professionals which were visiting the event. This opens good hopes and opportunities for the therapeutic validation we will talk about as future work in the final section.

At the end of this quick discussion we want to add that this first validation of the principles for creating a game playable by all is a very important achievement for us as normally the motivational impact of the fact of being able to play again is strongly underestimated.

The fun aspect for someone who has access to everything (from the physical and psychological point of view) is not the same as someone who has access to "something". Maybe for an hardcore gamer moving a boat is not very funny, however when it is the only thing you can do and you have anew the opportunity to play again it takes a lot more sense. What we are trying to say is that we are very well aware that 100% inclusion is not feasible, but access to entertainment is.

6. CONCLUSIONS AND FUTURE WORKS

In this paper we presented a design strategy we adopted on the occasion of the development of a game for hemiplegic rehabilitation called Hammer and Planks. This game strategy allowed us to do a first validation of the principles to create a "game for all", as demonstrated by the example of the usage of the game on the occasion of the MIG event in the south of France.

The game design strategy was constructed around our believing that creating a good game (in terms of successful rehabilitation) and a fun game is only the starting point for a game for health. Without keeping in mind a wide adoption of the game during the design there is no way that the game can be really widely adopted. It's our opinion that there is a huge potential in the collaboration between game professional designers and developers, and research structures on this topic. For the general public what is important is playing games with an addictive content, using the new available interaction technologies. For the unhealthy people what is important is being able to do their rehabilitation. As we demonstrated by the MIG example at some point their paths can cross.

We are very well aware that from the economical point of view making a game really fun, pretty, and with a good gameplay, it's necessarily more expensive than a "simple" game. However if this game can be sold also to non-patients, it will compensate for the higher production costs.
In this way the patient enjoys a better game, and therefore a better rehabilitation, and the company can treat it like a normal game.

As a matter of fact we are working on both the aspects we listed. From the therapeutic validation point of view we are conducting two experiences: the Wiiboard version is used as in the original setting with 5 hemiplegic patients to train their balancing skill. The Kinect version is scheduled for being used in the back pain scenario. At the same time we are working on improving the game design using classical beta testing methods trying to continue to cross the path of research and professional game design.

7. ACKNOWLEDGMENTS

TO BE ADDED

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