

# **Playmancer– FP7 215839**

A European Serious Gaming 3D Environment

*Deliverable*

## **D1.2: Project Final Report**

**FP7 ICT,**

**Period covered from 1/11/2007 to 30/05/2011**

Scientific Representative: Dr. Elias Kalapanidas,  
Systema Technologies

Tel. : +302106743243

Fax : +302106755649

Email : [elias.kalapanidas@systema.gr](mailto:elias.kalapanidas@systema.gr)

Date of delivery: September, 03 2011

Authors: ALL

Date: 03/09/2011      Version: v1.1

## Document Control

<b>Title:</b>	<b>D1.2: Final Report</b>	
<b>Project:</b>	<b>Playmancer (FP7 215839)</b>	
<b>Type:</b>	Deliverable	<b>Status*:</b> Public
<b>Authors:</b>	ST: Elias Kalapanidas	
<b>Origin:</b>	ST	
<b>Doc ID:</b>		

## Amendment History

<b>Version</b>	<b>Date</b>	<b>Author</b>	<b>Description/Comments</b>
v0.1	01. Mar 11	ST	Template
V0.2	16. May 11	ST, ALL	Input in several sections
V1.0	17. Jun 11	ST	Completion
V1.1	28. Aug 11	ST, ALL	Revised and updated version to address the project final review comments and recommendations

The information contained in this report is subject to change without notice and should not be construed as a commitment by any members of the **PLAYMANCER** Consortium. The **PLAYMANCER** Consortium assumes no responsibility for the use or inability to use any software or algorithms, which might be described in this report. The information is provided without any warranty of any kind and the **PLAYMANCER** Consortium expressly disclaims all implied warranties, including but not limited to the implied warranties of merchantability and fitness for a particular use.

# Table of contents

1	FINAL SUMMARY REPORT .....	7
1.1	EXECUTIVE SUMMARY .....	7
1.2	PROJECT CONCEPT AND OBJECTIVES .....	8
1.3	PROJECT EXECUTION, SCIENTIFIC AND TECHNICAL RESULTS AND FOREGROUNDS 13	
1.3.1	<i>First year</i> .....	13
	Project Management .....	13
	Requirements, Architecture and Specifications .....	14
	Implementation .....	15
1.3.2	<i>Second year</i> .....	17
	Project Management .....	17
	Requirements, Architecture and Specifications .....	18
	Implementation .....	20
	Evaluation.....	23
1.3.3	<i>Third year and project extension</i> .....	23
	Project Management .....	23
	Requirements, Architecture and Specifications .....	24
	Implementation .....	25
	Evaluation.....	26
1.3.4	<i>Major project achievements</i> .....	29
	Main game story context .....	31
	Main game story line .....	31
	Decoupling strict linking between game scoring and measured therapeutic progress.....	32
	On balancing player satisfaction and patient therapeutic progress .....	32
	Measuring patient progress through the gaming sessions.....	33
	On affective feedback and how to avoid the “Death Spiral” effect .....	33
1.3.5	<i>Overall project achievements Vs State of the Art and envisaged goals..</i> 35	
	Serious game for mental health and Serious game for pain rehabilitation .....	38
	Game design for mental health patients.....	38
	Game design for pain rehabilitation patients .....	39
	PlayMancer Serious Games assets.....	40
	Bio-feedback-based emotion recognition.....	40
	Speech-based emotion recognition .....	40
	Visual facial expressions-based emotion recognition.....	41
	Emotion recognition fusion.....	42
	PlayMancer emotion recognition database .....	42
	Low-cost Motion capture system.....	43
	Multi-sensor signal fusion.....	43
	Unity 3D emotion recognition input .....	44
	Unity 3D human player motion input.....	44
	Game Automatic Speech Recognition .....	44
	Field trial results on the use of the PlayMancer serious game for mental health patients and for chronic pain rehabilitation .....	45
1.4	PROJECT POTENTIAL IMPACT ON ITS INDUSTRY/RESEARCH SECTOR .....	45
1.4.1	<i>Visibility and exposure of results</i> .....	48
1.4.2	<i>Project achievements and IP protection</i> .....	52
1.4.3	<i>Project exploitation</i> .....	56
	Individual Objects .....	56
	Composite Objects.....	57
1.5	PROJECT WEB SITE AND PROJECT CONTACT DETAILS .....	60
2	USE AND DISSEMINATION OF FOREGROUND .....	62

<b>2.1 SECTION A</b> .....	<b>62</b>
2.1.1 <i>Publications</i> .....	62
2.1.2 <i>Demonstrations, Exhibitions and Conferences</i> .....	66
<b>2.2 SECTION B</b> .....	<b>71</b>
<b>3 REFERENCES</b> .....	<b>74</b>

## Table of Figures

Figure 1: High level architecture of the PlayMancer gaming platform .....	30
Figure 1: Capture from the first project video .....	48
Figure 2: Capture from the second project video .....	49
Figure 3: Capture from the third project video, a game prototype .....	49
Figure 4: Capture from the fourth project video, a TV channel report .....	50
Figure 5: Capture from Euronews TV report .....	50
Figure 6: Capture from a Spanish TV channel report on the project .....	51
Figure 7: Capture from PRI The World story on the project .....	51

## Terms and Abbreviations

ED	Eating Disorders
PG	Pathological Gambling
ASR	Automatic Speech Recognition
UCM	User-Centric Media
Unity3D	A commercial game engine and game development platform
ROM	Range of Motion (for body parts/muscles)

# 1 Final Summary Report

## 1.1 Executive Summary

PlayMancer implemented a new Serious Game environment, by augmenting an existing 3D gaming engine (Unity) with new multimodal possibilities.

The reached objectives are:

1. Evaluation of the specified by user requirements multimodal framework and gaming infrastructure by developing and testing serious mini-games applied to 2 application domains: physical rehabilitation, and therapeutic support and lifestyle management programs for behavioural and addictive disorders.
2. Construction of a next generation networked gaming environment, mainly augmenting the gaming experience with innovative ICT modes of interaction (i.e. motion, biofeedback, speech) between the player and the game world,

Playmancer made significant contribution to ICT research areas in the light of the Health Care sector combining multimodal interfaces and serious games.

Especially in the thematic areas of games for patients with chronic pain rehabilitation and patients with addictive mental disorders, Playmancer has offered a set of evaluated prototype setups, both featuring a serious computer game at their core.

Prominent research results include emotional data in context with health care assistance. This has been addressed by transcending traditional methods for eliciting emotions prior to collecting speech data, transposable to the clinical contexts on levels from the physical setting to the clinical/ethical aspects.

Similarly, other research efforts tackle issues in pain rehabilitation by using precise motion capture technology in addition with electromyography sensors integrated in a serious game.

Moreover attempts have been made to utilise speech understanding, and that revealed difficulties in adapted parsing to the forms of expression appropriate to the context.

Playmancer experimented with the connection between emotional models and clinical aspects. The project reached a consistent and integrated picture that relates interface technologies and affective processing to the health care protocols. Emotional models utilised reference workable and health care pertinent emotional categories. These categories consequently drew Playmancer technology to tune up accordingly. The project within its resources and time limitations, identified from the users (clinical partners) viewpoint, the type of emotions that need be detected and monitored. Affective interfaces were tuned towards the recognition of *these* relevant emotions.

Project developments proved that some emotional categories were difficult to elicit, yet they could still be accessible to dimensional models (e.g. bio-feedback can take

place with no explicit reference to affective models). An elaborated integration activity was met to address the above issues.

A similar refinement cycle has been demonstrated for the pain rehabilitation domain. Rehabilitation exercises have been transformed into game play equals, according to rehabilitation protocols and best practices. Health personnel iteratively helped in tailoring the PlayMancer motion capture and sensor fusion calibration to their needs and in tuning up the game setup during sessions so as to best addressing to the individual needs of the patients. Ultimately, the pain rehabilitation PlayMancer game serves as a promising complement to conventional therapy, while a number of improvements have been identified from the field trials with real patients.

Observations of clinical sessions, mock-ups and prototypes of the Playmancer system drew light on the forms of interaction that the end-users (patients) manifested during sessions. This has been applied both to CBT and physical rehabilitation with a clear justification of 3D rendering as an option providing a better route to incorporate affective and/or motion sensing.

## 1.2 Project Concept and Objectives

Computer games are a hit among children and youngsters but not very surprisingly the same enthusiasm can be hard to find when it comes to teaching or training. The potential of games for entertainment, and learning has been demonstrated thoroughly from research and clearly in the market place. Unfortunately, the investments committed to entertainment dwarfs that which is committed for more serious purposes. Furthermore, games development has become more complex, expensive, and burdened with a long development cycle. This creates barriers to independent games developer, and inhibits the introduction of innovative games, or new game genres, i.e. serious games, or games accessible to communities with special needs.

Serious games (SGs) or persuasive games are computer and video games used as educational technology or as a vehicle for presenting or promoting a point of view. They can be similar to educational games, but are often intended for an audience outside of primary or secondary education. Serious games can be of any genre and many of them can be considered as a kind of edutainment. The serious games are intended to provide an engaging, self-reinforcing context in which to motivate and educate the players towards non-game events or processes, including business operations, training, marketing, well-being and advertisement. Serious games can be compelling, educative, provocative, disruptive and inspirational.

The aim of PlayMancer is to implement a framework for serious games by augmenting existing 3D gaming engines. More specifically, the objectives of PlayMancer are:

1. to construct a fit-to-purpose gaming environment, mainly augmenting the gaming experience with innovative ICT modes of interaction between the player and the game world;
2. to apply the principles of Universally Accessible Games into 3D-based games through the specification of I/O configuration;

3. to evaluate the proposed environment and gaming infrastructure by developing and testing a series of serious games modules as applied to two application domains: physical rehabilitation, and therapeutic support / lifestyle management programs for behavioural and addictive disorders.

User requirements leading to results that can be generalised to other serious games applications will inform development of the framework. Specifically, the focus on physical –pain- rehabilitation drives platform requirements for supporting the development of rich and natural interaction games and the integration of low cost player motion tracking and gesture recognition devices. Games scenarios from the lifestyle related disorder implicate platform requirements for multi-modal measurements for emotion states such as boredom, depression, anxiety and associated cognitive responses.


Specifically, PlayMancer designs and develops an alternate computer gaming platform enabling new interaction experiences between the game and the player. The two PlayMancer games, one targeting mental health patients and one targeting pain rehabilitation patients, include game modules (mini-games) that are developed on top of this platform, all having a serious games orientation:

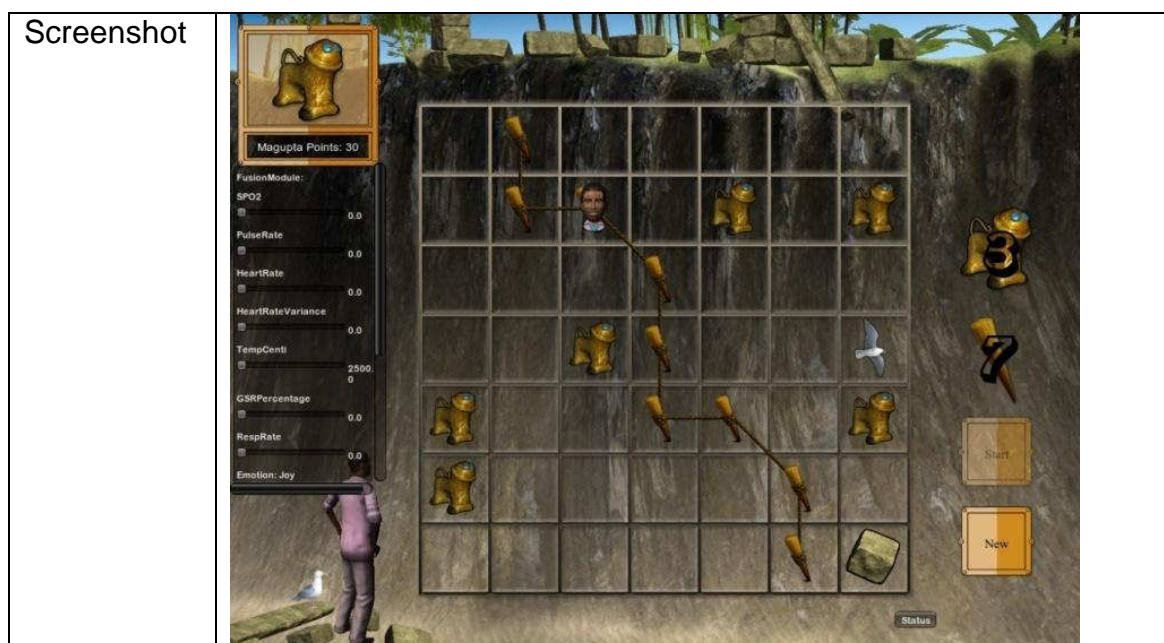
- A game module dealing with difficulties in motivation, self worth, or other maintenance factors in behavioural disorders
- A game module targeting impulsiveness tendencies in addictive behaviours as in gambling addiction
- A game module promoting pain rehabilitation activities

Based on the needs of the two main test cases, presented above, we have designed a game scenario that allows, from one side, to implement treatment games that are needed, and from the other side, is generic enough to be able to be used with other treatment cases in the future. The games are described in more details in D2.1c Game Scenarios and D2.4 Refined User Requirements, and here we give a very brief overview.

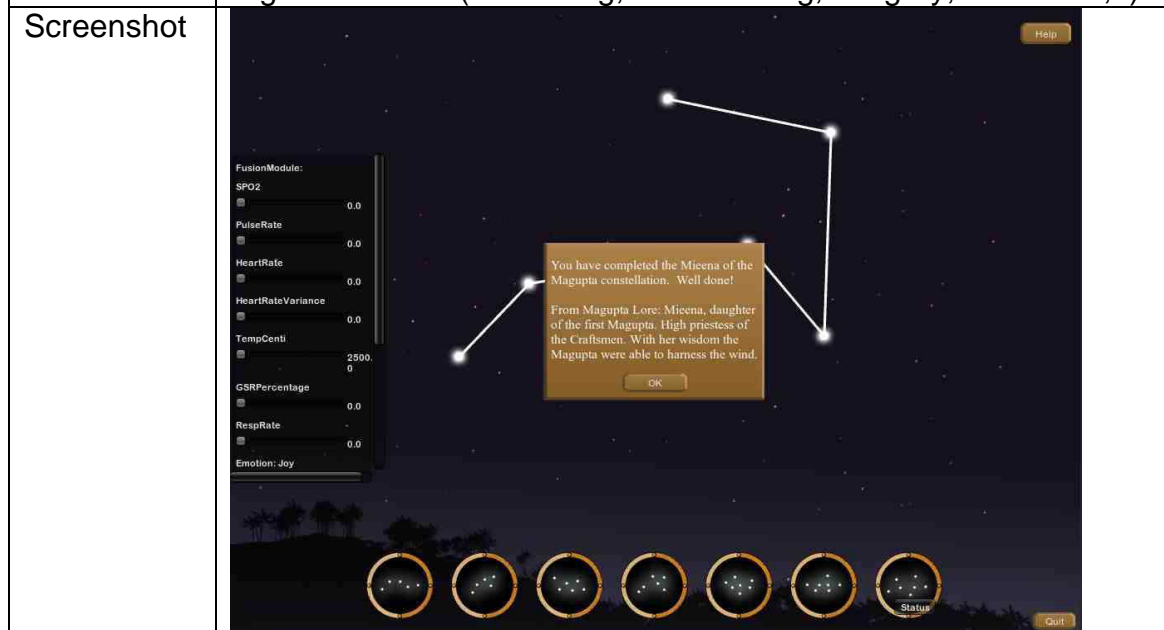
The scenario which we call “Islands”, is based on the idea that the patient is represented by an explorer found in an island, once inhabited by a lost civilisation. Different activities are available, like fishing, climbing, temple exploration, night sky star gazing, etc. The activities are linked to varying difficulty levels of game tasks, and they have been implemented in the form of mini-games, integrated with the island exploration. In the following paragraphs, we describe the 6 mini-games that have been developed for the 2 different PlayMancer serious games, three for mental health patients (suffering from ED and PG) and three for pain rehabilitation patients.

**Table 1: Mental health mini-games description**

Mini game 1	Treasures of the Sea
Game description	The player dives under water, gathering artifacts and balloon fishes. The oxygen level need to be maintain in order to keep continue playing.
Clinical goal	Increasing relaxation-breathing skills, emotional regulation and awareness, learning coping strategies to deal with frustration and impulsiveness, learning planning skills and stress management.
Screenshot	 <p>The screenshot shows an underwater scene from the game 'Treasures of the Sea'. A diver is visible in the center, surrounded by colorful fish and a glowing yellow dog. The interface includes a 'Magupia Points: 0' display, a 'FusionModule' panel with various physiological and emotional metrics (SPO2, PulseRate, HeartRate, HeartRateVariance, TempCenti, GSRPercentage, RespRate, Emotion: Joy), and a 'Status' bar at the bottom.</p>
Mini game 2	The face of Cronos
Game description	The player plans a climbing path up a cliff, while administering their resources and avoiding obstacles, generated by dysfunctional emotions or physiological reactions
Clinical goal	Increasing planning skills, emotional self-regulation and awareness, learning coping strategies to deal with frustration and impulsiveness, learning relaxation and stress management.

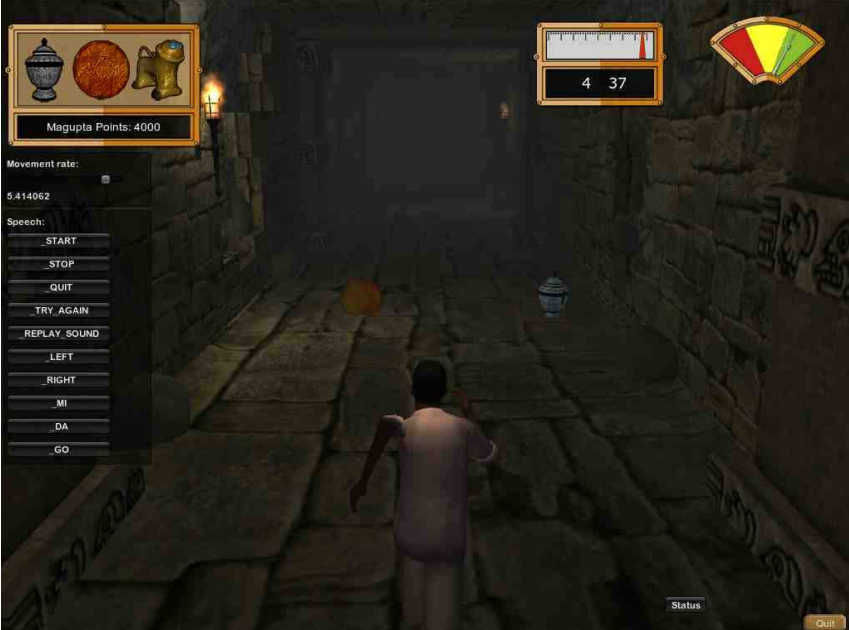




Mini game 3	Sign of the Magupta
Game description	A relaxation game in which the player draws constellations by deep breathing and staying calm.
Clinical goal	Learning relaxation-breathing skills and both stress management and self-control strategies. Learning self-soothing and self-regulation skills (distracting, self-soothing, imagery, relaxation,..)



**Table 2: Pain rehabilitation mini-games description**

Mini game 1	The Temple of Magupta
Game description	This mini-game is about exploring the ancient temple located on the island, in which the player runs through a secret corridor, trying to pick up as many of the lying artifacts in his way while at the same time trying to avoid the traps and falling debris by changing lanes.
Clinical goal	The patient walks on a treadmill and has to maintain a stable

	walking speed. Variations of his walking speed are reflected in the behaviour of his avatar in-game.
Screenshot	
Mini game 2	The three Wind Gods
Game description	The player has to worship the temple of the Three Gods lying at the island beach. This is done if the player activates the sound of the three wind pipes in the correct order.
Clinical goal	The patient has to perform a different cervical movement for each of the wind pipe sounds. This corresponds to exercising the ROM and quality of motion and to the relaxation of the neck shoulder muscle.
Screenshot	
Mini game 3	The face of Cronos (pain rehabilitation version)
Game description	This is a climbing game, where the player has to climb his way to the top in a limited number of attempts. At each climbing step, the climbing height is computed dependent on the player's effort.

Clinical goal	The chronic pain rehabilitation configuration of this mini-game is for the reaching exercise taking into account the shoulder stress/relaxation.
Screenshot	

## 1.3 Project Execution, Scientific and Technical Results and Foregrounds

### 1.3.1 First year

#### Project Management

PlayMancer became a member of the User-Centric Media cluster of projects, organised by the Networked Media unit of EC. Dr. Elias Kalapanidas, appointed by the lead partner as Playmancer's Project Manager, has taken part in three (3) concertation meetings that aimed to promote the work done under User-Centric media and to identify the future research directions in that particular domain.

In particular, ST represented PlayMancer in the following meetings:

- 13/11/2007, Brussels, Belgium, 9<sup>th</sup> Networked Media concertation meeting (PlayMancer presentation and discussion)
- 29-30/1/2008, Brussels, Belgium, 1<sup>st</sup> FP7 Networked Media concertation meeting on future R&D challenges to be addressed at EU level
- 16-17/4/2008, Algarve, Portugal, 2<sup>nd</sup> FP7 concertation meeting (PlayMancer short presentation, presentation of contribution to WG3 activities (reponses to Bled document questions))

Other activities in the project management work package for the first project year include:

- the organization of periodical audio conferences for the coordination of project tasks (making use of partner's UNIGE offer of an electronic conference platform),

- monitoring the project progress through preparing and distributing special periodical GANTT charts,
- organising or preparing and coordinating 5 project meetings (4 plenary, 1 technical)
  - 17-18/12/2007: Athens, Greece, Kick off meeting
  - 12/2/2008: Geneva, Switzerland, technical meeting
  - 13-14/3/2008: Barcelona, Spain, plenary meeting
  - 29-30/4/2008: Vienna, Austria, plenary/technical meeting
  - 18-19/9/2008: Milan, Italy, plenary/technical meeting

## Requirements, Architecture and Specifications

<b>WP2:</b>	<b>User requirements, platform specification and end-user evaluation</b>	
Task id.	Summary of progress	Results achieved
<b>T2.1</b>	<ul style="list-style-type: none"> <li>▶ Employment of project personnel by Research Institutions and introduction into the project.</li> <li>▶ Split D2.1 in 4 parts: a. user requirements; b. state of the art; c. game scenarios; d. system specification and architecture.</li> <li>▶ Deliverable D2.1 (a, b, c, d) completed. Peer review conducted by UOP (part A), UNIGE (part B) and ST (parts C and D).</li> <li>▶ Started to develop game pattern ideas to be developed as throwaway prototypes.</li> <li>▶ Coordination between NU, IDIBELL, TUW and UNIGE on scenario specifications in UML.</li> <li>▶ Coordination between NU and IDIBELL on state of the art, user requirements and game scenarios.</li> <li>▶ Extensive state of the art on serious games.</li> <li>▶ Contribution to the definition of user requirements and games scenarios, focusing in particular on the relationship between the scenario and its possible exploitations, as well as the PlayMancer business model for serious games.</li> <li>▶ Started gathering general stakeholder requirements for behavioural disorders for D2.1 User Requirements, Game Scenario, System Specification and Architecture.</li> <li>▶ Started state of the art on serious games to prepare for D2.1 and for first technical meeting in Geneva (planned on Feb 12<sup>th</sup> 2008).</li> <li>▶ Developed mini game patterns to be developed as potential throwaway prototypes. Detailed specifications of guess and match pattern for emotion recognition to prepare collaboration with UOP on throwaway prototype of emotion recognition mini-game. Discussions with UOP to be continued during the next period.</li> <li>▶ Additional state of the art on emotion recognition and emotional text-to-speech to prepare work with UOP on emotion recognition mini-game based on game patterns presented in D2.1c.</li> <li>▶ Elaboration of multiplayer component for the Islands scenario.</li> <li>▶ Started preliminary discussions on multiplayer aspect of Islands scenario to complete D2.1c. Detailed specifications of Islands scenario and mini-game patterns in collaboration with IDIBELL and ST.               <ul style="list-style-type: none"> <li>▪ Specific meeting with IDIBELL before plenary project meeting</li> </ul> </li> </ul>	<p><i>User needs &amp; requirements set</i></p> <p><i>Game scenarios alpha version</i></p>

	<ul style="list-style-type: none"> <li>▪ Coordination through audio conferences and e-mail to refine user requirements through UML modelling of the scenario</li> <li>▶ Overview of the user needs (psychologists) and relation to available technologies.</li> </ul>	
<b>T2.2</b>	<ul style="list-style-type: none"> <li>▶ Started brainstorming on game scenarios supporting existing developments for eating disorders and pathological gambling.</li> <li>▶ Initiated cooperation with the subcontractor Irschitz Medical.</li> <li>▶ Initiated cooperation with the Neurological Rehabilitation Center NRZ Rosenhügl <a href="http://www.nrz-rosenhuegel.at/de/index.asp">http://www.nrz-rosenhuegel.at/de/index.asp</a></li> <li>▶ Development of the game concept "Around the World" together with our subcontractor and the NRZ.</li> </ul>	<i>UA Games standards adaptation</i>
<b>T2.3</b>	<ul style="list-style-type: none"> <li>▶ Contribution to Deliverable D2.1 with an extended review of state of the art speech technologies in games and dialog management systems, and review of part (a) of this deliverable (User Requirements).</li> <li>▶ Have identified a number of game engines and spoken dialogue interaction platforms and proposed the most appropriate solution (OGRE+Olympus/RavenClaw) for the PlayMancer project.</li> <li>▶ Integration requirements and an Olympus interface for a TTS engine, FLite, was implemented.</li> </ul>	<i>Game engine architecture alpha version</i>
<b>T2.4</b>	<ul style="list-style-type: none"> <li>▶ Experts form IDIBELL conducted pilot studies to determine user acceptance</li> </ul>	<i>Evaluation methodology</i>

## Implementation

<b>WP3:</b>	<b>Implementation of the Playmancer 3D dialogue-enabled game engine</b>	
Task id.	Summary of progress	Results achieved
<b>T3.1</b>	<ul style="list-style-type: none"> <li>▶ Follow up of the 3D game engine properties and functionality selected by UOP.</li> <li>▶ Actively participation in the identification and initial assessment of an open source 3D rendering game engine, for its integration/enhancement in the framework of PlayMancer.</li> </ul>	<i>Identified multimodal requirements</i>
<b>T3.2</b>	<ul style="list-style-type: none"> <li>▶ Initial architecture and components description were prepared for the Emotion Recognition module.</li> <li>▶ Speaker and language dependency were tested for the Emotion Recognition module for English and German using acted speech databases.</li> <li>▶ A corpus for modern Greek based on real-world recordings was prepared for the Emotion Recognition module.</li> </ul>	<i>Emotion recognition module specification</i>
<b>T3.3</b>	<ul style="list-style-type: none"> <li>▶ Participated in the identification and initial assessment of a speech dialog management framework (Olympus) to be enhanced and used in PlayMancer.</li> <li>▶ The 3D rendering engine, OGRE), and its compatibility with an engine for game scripts execution, Yake, were tested.</li> <li>▶ Implementation of an interface between the dialog management engine (Olympus) and the game execution engine, Yake, has been started.</li> </ul>	<i>Speech dialog management specification</i>
<b>T3.4</b>	<ul style="list-style-type: none"> <li>▶ Description of the QoS monitoring component network architecture.</li> </ul>	<i>QoS monitoring specifications</i>

<b>T3.5</b>	<ul style="list-style-type: none"> <li>▶ Games scenario definition provided the 1<sup>st</sup> set of geometry elements to introduce the automatic generation concept.</li> </ul>	<i>Automatic generated content tool initial requirements</i>
<b>WP4:</b>	<b>Implementation of the PlayMancer multi-modal multi-player gaming platform</b>	
Task id.	Summary of progress	Results achieved
<b>T4.1</b>	<ul style="list-style-type: none"> <li>▶ Providing developer tools and supporting partners (e.g. setting up SVN repository).</li> <li>▶ Iotracker development.</li> <li>▶ Work on skeleton calibration.</li> <li>▶ Supporting partners with development tools, a sample project and information.</li> <li>▶ Implementation of the first Pong3D prototype.</li> <li>▶ Starting research on modelling and defining constraints of a human skeleton based on kinesiology.</li> <li>▶ Expert-based evaluation and demonstration of the prototype.</li> <li>▶ Adaptation of the first rehabilitation game prototype.</li> <li>▶ Buying necessary hardware and setting up a full VR setup with iotracker at the NRZ Rosenhügel clinic.</li> </ul>	<i>Optical tracking development</i>
<b>T4.2</b>	<ul style="list-style-type: none"> <li>▶ Purchase of the head-up display equipment and necessary interface.</li> </ul>	<i>Head-up display adaptation</i>
<b>T4.3</b>	<ul style="list-style-type: none"> <li>▶ Study of different Bio-feedback sensors platform integration, gTec and Exmocare.</li> <li>▶ Analysis of the restrictions posed by the bio-sensor devices</li> </ul>	<i>Biofeedback specifications</i>
<b>T4.4</b>	<ul style="list-style-type: none"> <li>▶ Initial requirements for the multi-modal configuration tool were identified.</li> <li>▶ First prototype architecture for the components to be implemented, for the multi-modal configuration tool, was defined, and performance evaluation for voice conversion systems was performed.</li> </ul>	<i>Multimodality set up and interactions</i>
<b>T4.5</b>	<ul style="list-style-type: none"> <li>▶ Assessment of user requirements with respect to the touch-screen interface was performed.</li> </ul>	<i>Touch interface requirements assessment</i>
<b>WP5:</b>	Game programming, main content design and Concept Validation	
<b>T5.1</b>	<ul style="list-style-type: none"> <li>▶ Preliminary design and modelling of basic scene objects of the island game.</li> </ul>	<i>Island game basic scenes</i>
<b>T5.2</b>	<ul style="list-style-type: none"> <li>▶ Development of first throwaway prototypes in free 3D gaming engine. Demoniak3D, suitable for rapid prototyping (ahead of time, before Milestone 1).</li> <li>▶ Setup and testing of game development platforms.</li> </ul>	<i>Game development platforms testing</i>
<b>WP6:</b>	Implementation of a Service Provider for games, 3D content distribution and project exploitation	
<b>T6.1</b>	<ul style="list-style-type: none"> <li>▶ We have started a survey of the major electronic content distribution models and distribution chains. TXT exploited its network of partners and customers to discuss possible models applicable to PlayMancer, conducting meetings with experts of media and marketing.</li> </ul>	<i>Market watch structure</i>

<b>T6.2</b>	<p>► We have started a the collection and formalisation of requirements for the electronic 3D content sharing service conducting surveys both internally, with the other partners of the consortium, and externally, discussing similar products and services with experts in media and telco domain.</p>	<p><i>Electronic content sharing services market studies</i></p>
-------------	---	--

### 1.3.2 Second year

#### Project Management

Based on the comments raised by the reviewers on both 1<sup>st</sup> annual review and 2<sup>nd</sup> year interim review the refined objectives of PlayMancer according to the new TA are the following:

1. Playmancer aims at integrating a development platform, based on an existing games engine, with tools and mechanisms that will allow for interoperable binding, inclusion and access of existing, emerging and new multi-modal I/O devices.
2. Playmancer evaluation objectives include recording of interaction data aiming at making them available on a readable and standardized manner, thus allowing therapists to evaluate and better understand the status and evolution of the patients.
3. The Playmancer evaluation system platform will be tailored for realizing serious games scenarios for health and consequently it will be tested and validated in the domain of two applications (on pain rehabilitation and mental health) involving the integration of innovative I/O devices.

In order to achieve the above objectives, a number of sub-objectives are identified. The latter are correlated to the general objectives in terms of proposing a methodology in order to achieve the project general objectives at the end of the project.

A non anticipated, at the project kick-off, overhead (extra effort) caused by drastic revisions/modifications on the focus and the objectives of the project has been appeared at the beginning of the second year. In order to meet all reviewers' comments, the coordinator proposed a project re-focusing plan that was agreed by partners at the project meeting PTP-06 in Athens. This plan consisted of the following actions:

- Define the refined objectives of the project
- Identification of the missing expertise and selection of new partners
- Negotiations with the new partners
- Refine the PlayMancer architecture
- Update, negotiate and consolidate the DoW
- Prepare a revised project implementation plan

The consortium has been changed and as of March 1st, 2009 the new partnership includes SGI and RRD. These two new partners have substituted former partner TXT who resigned from the consortium and project.

A/A	Sub-objective	Progress towards achieving objectives
1	Re-focusing the project according to review comments	1) Identify the missing knowledge 2) Selecting new partners 3) Recruiting new partners 4) Focus the project on the two selected user groups (mental health and pain rehabilitation)
2	Simplify the system architecture	1) Re-define technical requirements according to user needs 2) Definition of the new architecture
3	Bio-signal based emotion recognition system	1) Multimodal interaction: advancing the integration and development of the emotion recognition mechanisms based on bio-signals. 2) Evaluation of new technologies in bio-signal recognition. 3) Development and adaptation of first version of bio-signals measurement system
4	Video based emotion recognition system	Development of first version of video based emotion recognition
5	Speech based emotion recognition system	Development of first version of speech based emotion recognition system
6	Motion tracking	Development of first version of motion tracking system
7	First prototype PlayMancer game	Development of first game prototype completed
8	Identify all components and potential challenges of integration. Enable integration of components with Unity game engine	Components are identified but the integration procedure is still in progress
9	Evaluation of the first integrated game prototype by end users	In progress

## Requirements, Architecture and Specifications

WP2	User requirements, platform specification and end-user evaluation	
Task id.	Summary of progress	Milestone Results achieved
<b>T2.1</b>	<ul style="list-style-type: none"> <li>• Revised D2.1 deliverables (parts a, b, c) according to review feedback <ul style="list-style-type: none"> <li>○ Refinement of user requirements and Islands game scenario (NU, IDIBELL):</li> <li>○ Preparation of a driver scenario to test the different emotion recognition components before their integration in the platform</li> </ul> </li> <li>• Refinement of user requirements and Islands game scenario (NU, IDIBELL, UOP, UNIGE/MIRALab, ST, RRD). Contributions to D2.4: updated requirements and scenarios</li> <li>• Integration of the video based emotion recognition in the game scenarios as defined by the user requirements</li> <li>• RRD added information to D2.1a about pain rehabilitation, current pain rehabilitation treatment programs, innovative possibilities in</li> </ul>	<ul style="list-style-type: none"> <li>1) Clarified clinical background on CBT, clinical requirements and rationale for the Islands scenario</li> <li>2) Improved links between user requirements, state of the art, scenarios and architecture</li> <li>3) Established list of emotions to be recognised in the Islands scenario</li> <li>4) Improved rationale for recognising each different emotion in the scenario</li> <li>5) Based on clinical expertise and treatment goals commonly applied in pain rehabilitation, four game scenarios have been defined dealing with a) coordination and range of motion ('Sandboard Game'), b) (total) body relaxation ('Bounty Game'), c) Physical reconditioning ('Survival Game'), and d) psychological pain coping skills ('Tropical Supermarket'). Storylines, e.g.</li> </ul>

	<p>pain treatments, and some preliminary user requirements. These preliminary requirements served as a starting point for the organization of a user requirement workshop. From a participatory design perspective, end-users should be involved in the early stages of technology development since it is assumed to facilitate the (future) acceptance of the games to be developed. Therefore, a one and a half day requirement workshop together with experts has been conducted on March 23rd and 24th 2009 at Roessingh Research and Development. Experts who attended the meeting had various backgrounds and specific knowledge; experts on motion tracking (n=2), human movement scientists (n=3), biomedical engineer (n=1), physiotherapist (n=1), psychologist (n=1) and occupational health therapist (n=2). During the workshop the medical rationale for applying serious games in the treatment of musculoskeletal pain patients, i.e. due to low back pain or a whiplash associated disorder was discussed.</p>	<p>descriptives about the envisioned use of serious gaming in pain rehabilitation, and inputs and outputs of the devices/applications have been documented.</p>
<b>WP2</b>	<b>User requirements, platform specification and end-user evaluation</b>	
Task id.	Summary of progress	Milestone Results achieved
<b>T2.3</b>	<ul style="list-style-type: none"> <li>• Specification of evaluation criteria and evaluation tests performance for selection of 3D rendering engine, multimodal dialog manager, application manager, and speech-based interface.</li> <li>• Contribution to translation of user requirements into technical requirements.</li> <li>• Contribution to design and specification of the multi-modal PlayMancer high level architectural model with the integration of the Unity engine and video based emotion recognition</li> <li>• Specifications of the Architecture Component Interfaces (Definition of the XML based APIs and interfaces.)</li> <li>• Analysis of game scenarios and implications to the architecture</li> <li>• SGI has assisted in identifying game design issues and time scheduling bringing in industry expertise on the subject.</li> <li>• SGI has provided technical information to partners regarding the Unity game development tool and assisted in designing the architecture of integrating the input modalities in Unity.</li> </ul>	<ol style="list-style-type: none"> <li>1) Refined PlayMancer Architecture and integration of UNITY 3D game engine</li> <li>2) Specification of components' interfaces</li> </ol>

<b>T2.4</b>	<ul style="list-style-type: none"> <li>Revised D2.2 according to review feedback</li> <li>Refinement of the clinical evaluation methodology for the behavioural pilot (NU, IDIBELL)</li> <li>Developed new section on evaluation methodology for the technical assessment of project components at different levels (NU, UOP, UNIGE, TUW, ST)</li> <li>Specification of technical assessment methodology of the speech-based emotion recognition component.</li> <li>Specification of the qualitative and quantitative technical assessment methodology of the PlayMancer platform.</li> </ul>	Platform technical assessment Component technical assessment (driver scenario testing) Game prototype verification and validation framework Expert focus group testing
-------------	--	---

### Implementation

<b>WP3</b>	<b>Implementation of the Playmancer 3D affective game engine</b>	
Task id.	Summary of progress	Milestone Results achieved
<b>T3.1</b>	<ul style="list-style-type: none"> <li>Implementation of an Olympus agent for the integration of the speech-based emotion recognition components into the PlayMancer platform.</li> <li>Design and specification of a WOZ recording session to collect data for the adaptation of the speech recognition component to the application domain for Spanish language</li> <li>Processing of pilot trial recording session RS001 data and training of a domain specific language model for Spanish.</li> <li>In lab tests with Spanish recognition models.</li> <li>Implementation of an initial prototype for the NLG component.</li> <li>Identification of the emotions required by the game scenarios and the reactions that need to be taken into account by the services.</li> <li>Definition and design of the fusion component</li> <li>First version of the fusion component</li> </ul>	1) Implementation of a first demo version of the Olympus agent interface for communication with the game management component. 2) Implementation of an Unity interface for FLite TTS.
<b>T3.2</b>	<ul style="list-style-type: none"> <li>Coordination and planning for the use of the different emotion recognition components in the driver scenario (NU, UOP, UNIGE)</li> <li>Additional state of the art on biofeedback and multimodal emotion recognition</li> <li>UOP and NU clarified requirements, and specification for speech emotion recognition and prototype integration</li> <li>Defined specifications and XML data exchange format for the emotion recognition components (Technical meeting between UNIGE/MIRALab and NetUnion, March 30, 2009 – Geneva)</li> <li>Specification of XML data exchange format between emotion recognition modalities and fusion</li> </ul>	1) Processing of pilot trial recording session RS002 data, and training of application specific emotion detection models. 2) Implementation and delivery of the 1st prototype of the Emotion Recognition Component.

	<p>component; and between fusion component and game</p> <ul style="list-style-type: none"> <li>• Preparation of the Deliverables D3.1 and D3.2</li> <li>• Evaluation of different existing facial feature tracking software and Comparison.</li> <li>• Adaption of the bio-signals hardware and software to the project needs</li> <li>• Development of the second version of the bio-signal system based on the mobiHealth platform (adaptation of the mobiHealth platform for a non-network operation)</li> <li>• Integration of Mobi8 sensor system.</li> <li>• Implementation of a first demo version of the speech-based emotion recognition component: only two emotion states were considered (angry and neutral), and speaker independent English models were trained.</li> <li>• Design and specification of a WOZ recording session to collect data for training and adaptation of the emotion recognition component to the application domain and Spanish Language.</li> </ul>	
<b>WP3</b>	<b>Implementation of the Playmancer 3D affective game engine</b>	
Task id.	Summary of progress	Milestone Results achieved
<b>T3.2</b>	<ul style="list-style-type: none"> <li>• In lab tests with emotion models trained from session RS002 using the 1st prototype.</li> <li>• Processing of RS003 audio data.</li> </ul>	
<b>T3.3</b>	<ul style="list-style-type: none"> <li>• Implementation of a first demo version of a Yake interface for communication with the Olympus framework, and a simple demo application using speech recognition as input modality (for English language), and speech-based emotion recognition as context parameter.</li> </ul>	
<b>T3.4</b>	<ul style="list-style-type: none"> <li>• Continuation of the Study of technologies available for QoS monitoring. Follow up of Future internet activities.</li> </ul>	Integration and major contribution to deliverable D3.1, which provides detailed architecture specification and description of the dialogue-enabled PlayMancer game engine.
<b>WP4</b>	<b>Implementation of the PlayMancer multi-modal multi-player gaming platform</b>	
Task id.	Summary of progress	Milestone Results achieved
<b>T4.1</b>	<ul style="list-style-type: none"> <li>• Iotracker development</li> <li>• Full body motion capture development</li> <li>• Further work on skeleton calibration (performance etc.)</li> <li>• Evaluation of a general geometric constraint manager as element of the skeleton calibration and tracking modules</li> </ul>	

<b>T4.3</b>	<ul style="list-style-type: none"> <li>• Definition of the technological requirements and first design of bio-sensing modules, Based on the user requirements and game scenarios.</li> <li>• Analysis and evaluation of bio-sensors available in the market fitting the project needs</li> <li>• Continuing development of the bio-signal, video and facial recognition components.</li> <li>• Working on the adaptation of the MobiHealth platform to the project needs.</li> <li>• Development of a rule based emotion recognition subsystem.</li> <li>• Integration of a biosignal acquisition device (gMOBIIlab).</li> <li>• Development and integration of a pressure sensitive input device.</li> </ul>	<p>1) Installation of the bio-signal system for emotion recognition at the user site in Barcelona.</p> <p>2) Installation of the bio-signal system for emotion recognition at the user site in Barcelona.</p>
<b>T4.4</b>	Implementation was started by UOP and ST for the intermediate prototype of the multi-modal configuration tool.	
<b>T4.5</b>	Implementation of the intermediate prototype of the Touch-screen interface for the medical experts.	Implementation and delivery of the 1 <sup>st</sup> prototype of the GUI for therapists. In lab tests of the GUI for therapists.
<b>T4.6</b>	Implementation of interfaces to provide MoCap and biosignal input into Unity	
<b>WP5</b>	<b>Game programming, main content design and Concept Validation</b>	
Task id.	Summary of progress	Milestone Results achieved
<b>T5.1</b>	<ul style="list-style-type: none"> <li>• Requirements definition of the design and modeling of the game entities</li> <li>• Artistic production of the game assets (WP5)</li> <li>• Implementation of the game design documentation</li> <li>• SGI has supplied partners with assets for use in the game and provided information about Unity game creation process in general.</li> </ul>	Design and modeling of the game entities
<b>WP5</b>	<b>Game programming, main content design and Concept Validation</b>	
Task id.	Summary of progress	Milestone Results achieved
<b>T5.2</b>	<ul style="list-style-type: none"> <li>• Analysis of user requirements for the Islands game with respect to (a) emotion states to be recognized by the speech based emotion recognition component, and (b) speech-based interaction interface was performed</li> <li>• Implementation (scripting) of the PlayMancer game modules and first prototype in Unity <ul style="list-style-type: none"> <li>○ Implementation of the main island</li> <li>○ Diving quest: retrieve items from shipwreck</li> <li>○ Building a hut quest: retrieve items from inland and combine to make a protective hut</li> <li>○ Bridge building: put bridge blocks in place to cross the bridge to the relaxation island</li> </ul> </li> </ul>	<p>1) Development of driver/test application for the technical evaluation of the speech emotion recognition component</p> <p>2) Alpha testing of Island prototype (bridge building)</p> <p>3) Demo of controlling an in-game character in Unity using different input modalities such as Motion Capture</p> <p>4) First PlayMancer Integrated game prototype</p>

	<ul style="list-style-type: none"> <li>○ Starting scene: waking up in the island's beach</li> <li>• Integration of input modalities to the game prototype and production of the First PlayMancer Integrated game prototype. (Deliverable 5.5)</li> <li>• Demo of controlling an in-game character in Unity using different input modalities such as Motion Capture</li> </ul>	
<b>WP6</b>	<b>Implementation of a Service Provider for games, 3D content distribution and project exploitation</b>	
Task id.	Summary of progress	Milestone Results achieved
<b>T6.1</b>	Market study on revenue models and content distribution – definition of target users of the games (Deliverable 6.1)	

## Evaluation

<b>WP8:</b>	<b>PlayMancer games end-user evaluations</b>	
<b>T8.1</b>	<ul style="list-style-type: none"> <li>• Technical evaluation of emotion fusion component</li> <li>• Technical evaluation of speech emotion recognition component</li> <li>• Technical Evaluation of the Bio-signal monitoring component</li> <li>• Technical evaluation of game prototype</li> <li>• Technical evaluation of motion tracking system</li> <li>• Production of technical evaluation report (D8.1)</li> </ul>	First technical evaluation report (D8.1)
<b>T8.2</b>	<ul style="list-style-type: none"> <li>• Updated end-user evaluations</li> <li>• Preparation for data gathering trial in Barcelona (focusing on training data for the speech emotion recognition)</li> </ul>	
<b>T8.4</b>	<ul style="list-style-type: none"> <li>• RRD contributed to D2.2 by describing the evaluation methodology to be applied in the evaluation of the serious game developed within the Playmancer project. the methodology applied during the trial will be in line with the Staged Approached Evaluation of DeChant. This methodology states that the first stage in health care technology assessment is proving the efficacy and capabilities of the system. Medical Ethical Approval will be obtained before the onset of the trial.</li> </ul>	

### 1.3.3 Third year and project extension

#### Project Management

At the second year project review the independent reviewers made a series of recommendations for improving the implementation of the work plan:

1. focus the objectives of the third year, focusing on the bottlenecks that are critical, including
  - the emotion recognition (for CBT) and
  - motion tracking (for both),
2. remove all tasks that are replicating existing work, not improving state of the art
3. focus on improving performance and accuracy of framework elements, rather than investing in a specific implementation

4. the translation from user to technical requirements lacks in certain areas
5. the specification of the games seems to be superficial and disconnected from user requirements.
6. The project has not published sufficient number of jointly authored papers

Based on these comments, a number of changes to the Description of Work and to the related work plan were designed and applied (with a contract amendment which was accepted by EC on 8<sup>th</sup> of April, 2010, effected by 5<sup>th</sup> of February, 2010):

- **Project duration** was set to 42 months, including an extension of 6 months at no cost
- **Several deliverables** initially planned to be delivered at the end of the project, have been moved to M42 (D1.2, D7.4, D7.6, D8.2)
- **D4.3** is to provide prototype at M29, **D3.3** at M32. After evaluation iterations, WP3 and WP4 end at M36.
- Similarly, the game(s) were planned to provide a beta version at M33, **D5.4 and D5.6 be delivered to EC at M33.**
- **D5.5**, which was rejected, was planned to be re-submitted and it was planned to contain the revised game design documents and mapping between requirements and specifications (answering review comment 4), though this should have been a part of D3.1 and D2.4 (these were accepted).
- D7.3 was shifted to M36.
- **Tasks 8.3 and 8.4 were prolonged to M40.**
- All emotion recognition components were merged into one task. This task augmented old T3.2.
- Discontinuation of T3.1, T3.3, T3.5 (**answering review comments 1 and 2**)
- Discontinuation of T4.2, T4.4, T4.5 (**answering review comments 1 and 2**)
- Discontinuation of T7.4, T7.6 (**answering review comments 1 and 2**)
- Discontinuation of T8.1 (**answering review comments 1 and 2**)
- Effort was shifted from discontinued tasks to running ones, and from WP to WP for affected partners.
- SGI now takes the lead of WP5 from ST (**answering review comments 4 and 5**)
- ST takes the lead of WP7 from SGI (**answering review comment 6**)

At the last days of April 2011, which was the last project month, we met a challenge: arrange for the final project review within a certain period (of one and a half month) after the contractual end of the project, and participate at the Open Day event taking place at early May (after the project end). Since it was not feasible to find a mutually available date (the consortium, the project officer and the independent reviewers included), the project consortium asked for one-month extension of the project at no additional cost, which was granted. The Technical Annex has been amended again, in order to reflect this extension to 43 months of project duration from 42 (signed on 13<sup>th</sup> of May 2011, effected by 4<sup>th</sup> of April, 2011).

### Requirements, Architecture and Specifications

WP2	User requirements, platform specification and end-user evaluation	
-----	---	--

Task id.	Summary of progress	Milestone Results achieved
<b>T2.1</b>	<ul style="list-style-type: none"> <li>Game design re-visited (design document 2.0), after consulting again new D3.1 from specifications to requirements</li> <li>Emotion classes changed for more direct impact and easier assessment of games for mental health</li> </ul>	First version of re-designed design document for the 2 PlayMancer games
<b>T2.4</b>	<ul style="list-style-type: none"> <li>Architectural refinements</li> <li>Update of deliverable D2.1d (architecture)</li> <li>Refinement of user requirements and specifications, to find their way into re-submitted deliverable D2.4</li> </ul>	<i>Resubmission of D2.4 (updated with changes)</i>

## Implementation

<b>WP3</b>	<b>Implementation of the Playmancer 3D affective game engine</b>	
Task id.	Summary of progress	Milestone Results achieved
<b>T3.2</b>	<ul style="list-style-type: none"> <li>Player emotion data acquisition and annotation with MobiHealth bio-feedback device (new sensor sets) from 22 patients (11 pathological gamblers and 11 eating disorders) and healthy controls (12)</li> <li>Speech interface vocabulary collected and formulated with ASR tools (for syntax, grammar, etc.) for English, Spanish, Dutch</li> <li>Adaptation of emotion recognition fusion, so as to allow direct sensor readings access to the game (e.g. heart rate, respiration rate)</li> <li>Re-written D3.2 which was rejected at the second year project review</li> <li>Facial expressions emotion recognition module finalised</li> <li>Voice-based emotion recognition module finalised</li> <li>Fusion emotion recognition module finalised</li> </ul>	<p>1) <i>Delivery of updated D3.1 Transition from functional to technical requirements and optimised architecture specification of an affective game platform (with changes)</i></p> <p>2) <i>Re-submission of D3.2 Intermediate Playmancer 3D dialogue-enabled game engine prototype</i></p> <p>3) <i>Delivery of D3.3 Final Playmancer 3D dialogue-enabled game engine prototype</i></p>
<b>WP4</b>	<b>Implementation of the PlayMancer multi-modal multi-player gaming platform</b>	
Task id.	Summary of progress	Milestone Results achieved
<b>T4.1</b>	<ul style="list-style-type: none"> <li>Skeleton calibration and skeleton motion tracking finalised after improvements</li> <li>Evaluation of tracking accuracy</li> </ul>	
<b>T4.3</b>	<ul style="list-style-type: none"> <li>Bio-feedback emotion recognition module finalised</li> </ul>	
<b>T4.6</b>	<ul style="list-style-type: none"> <li>Integration with 3<sup>rd</sup> party character animation and motion analysis software</li> <li>OpenTracker multi-modal data-flow component delivered</li> <li>Integration with Unity3D game engine</li> </ul>	D4.3 was delivered
<b>WP5</b>	<b>Game programming, main content design and Concept Validation</b>	
Task id.	Summary of progress	Milestone Results achieved
<b>T5.1</b>	<ul style="list-style-type: none"> <li>Extension of the initial graphical assets with new</li> </ul>	

	<ul style="list-style-type: none"> <li>ones for the mini-games of the new game design document</li> <li>New avatar, animations</li> <li>New animals, props: fishes, artefacts</li> </ul>	
<b>T5.2</b>	<ul style="list-style-type: none"> <li>3 new mini-game modules for each of the 2 PlayMancer games (each targeting a different application domain)</li> </ul>	
<b>T5.3</b>	<ul style="list-style-type: none"> <li>Iterative validation with domain experts IDIBELL and RRD and NetUnion</li> </ul>	
<b>T5.4</b>	<ul style="list-style-type: none"> <li>Iterative verification of the 2 game prototypes by all partners</li> </ul>	
<b>T5.5</b>	<ul style="list-style-type: none"> <li>D5.5 re-write, which was rejected at the second year project review</li> <li>Drafting D5.6 and D5.4</li> <li>Updating D5.4 and D5.6 before and after field trials in WP8</li> </ul>	<p>1) <i>Re-submission of D5.5 Intermediate PlayMancer Games for behavioural and addictive disorders and motor-rehabilitation</i></p> <p>2) <i>Delivery of D5.4</i></p> <p>3) <i>Delivery of D5.6</i></p>

## Evaluation

<b>WP8:</b>	<b>PlayMancer games end-user evaluations</b>	
<b>T8.2</b>	<ul style="list-style-type: none"> <li>D8.1 was re-written after it was rejected at the second year project review</li> </ul>	D8.1 re-submission
<b>T8.3</b>	<ul style="list-style-type: none"> <li>Field trial setup and execution in IDIBELL, 16 patients testing the mental health game (and input technologies), 7 gambling addicts and 9 binge eating patients.</li> </ul>	
<b>T8.4</b>	<ul style="list-style-type: none"> <li>Field trial setup and execution in RRD, 9 patients testing the rehabilitation game (and input technologies)</li> </ul>	
<b>T8.5</b>	<ul style="list-style-type: none"> <li>Pre-processing of results taken from T8.3, T8.4</li> <li>Assessment of user questionnaires from T8.3 and T8.4, usability and user experience report</li> <li>(Statistical) Analysis of results acquired from T8.3, T8.4 and report on project games as a therapy supplement</li> </ul>	D8.2 Part A and Part B submitted, pre-requisites for last project Milestone 5: "PlayMancer games evaluation results"

Evaluation was carried out in two parallel strands, for each of the project's application domains:

- mental health (study configuration, details, and results are contained in deliverable D8.2 Part B)
- pain rehabilitation (study configuration, details, and results are contained in deliverable D8.2 Part A)

A summary of the main results and findings is given in the following paragraphs, for more information readers are asked to refer to the related deliverables:

The mental health study aimed: a) to examine the short-term effectiveness of a 6-sessions of videogame as a complementary tool during a traditional CBT therapy in a population of BN (bulimia nervosa) and PG (pathological gambling) patients; b) to analyze the treatment results of videogame and CBT treatment combined on symptomatology, psychopathology, and personality.

The study results were processed by a statistical analysis solution. First, the differences (changes) between pre-treatment and post-treatment mean scores in usability (SUS, UTAUT, CEGEC), general psychopathology and impulsiveness (I7, SCL-90-R) and anxiety-anger (STAI, STAXI) were valued for ED and PG patients through Wilcoxon pairs-test. Differences across diagnosis for the sociodemographic and clinical variables were compared separately for the total sample, through t-test procedures for quantitative measures and chi-square analyses for categorical variables. A level of significance of  $p < .05$  was used.

After considering the UTAUT scale for assessing the satisfaction with the Islands game, all the subscales have shown improved satisfaction when compared the scores at the beginning (after a first time playing) and at the end of the therapy using Playmancer game. After the first gaming session, the mental disorder patients rated the Usability of the Playmancer game "Good" (mean score 82.1, SD 16.4). Along the six weeks of gaming with the Playmancer game subject became more positive (measured by means of SUS), rating the game at the end of the gaming period as "Excellent" (mean score 94.6, SD 7.0). An improvement of SUS score of 12,5% was found. The change experienced between pre and post SUS scores was found statistically significant ( $p < .043$ ). Subjects enjoyed to play the Playmancer game and rated the enjoyment level (after the first time playing and after six weeks of playing) with a sum score of 18.48 points on a maximum 21 points. Between pre and post scores, a positive change of 6.7% was observed (17.9 mean pre scores vs. 19.1 mean post scores). Both the components Environment and Game Play scored 42 points. Between pre and post scores, a positive change of 10.1% was observed on Environment (32.8 mean pre scores vs. 36.1 mean post scores) and 13.6 % in Game Play (32.9 mean pre scores vs. 37.4 mean post scores). The differences on Game Play were statistically significant when compared pre and post scores ( $p < .034$ ).

Regarding General Psychopathology and Impulsiveness, here statistically significant reductions were observed between pre and post scores in several measures, such as Anxiety Trait (measured by STAI) and hostility (measured by means of SCL90R). Although there were improvements after the use of Islands video game on the other anger expression measures (by means of STAXI), the differences were not statistically significant. In terms of clinical symptomatology, the clinical features of our sample showed similar values than other described ED and PG populations. Indicating higher eating psychopathological scores, a mean weekly binge-purging frequency of 2.5 (SD 2.6) and 1.0 (SD 1.8), respectively, and a mean Body Mass Index (BMI: weight/ height<sup>2</sup>) of 22.8 (SD 5.8). In the case of PG, a mean score of 11.7 (SD 4.4) on pathological gambling severity was observed, by means of SOGS.

Another study has been conducted for the pain rehabilitation game prototype (and accompanied input devices). In total three pain subjects and seven healthy participants volunteered to participate in the current study.

Overall the participants were modest regarding the enjoyment they perceived while interacting with the games. The overall median level of enjoyment for the three mini-games was between a score of 5.7 and 6.05 on a 10 point VAS scale. In addition, the score of the participants for the attractiveness of the game environment of the mini-games was acceptable (5.3-1.3) but there is still room for improvement. According to the patients, for the final games the attractiveness can be improved by incorporating different levels of difficulty adding rewarding feedback about the results to the patients. In general, the games were not rated to be too exertive (1.1-2.0). According to the therapists, the exertiveness of the games can be increased by adding different levels of difficulty.

The mini-game "Temple of Magupta" was rated as the most enjoyable mini-game by 50% of the participants. The participants were most positive of this game because it was most active and dynamic out of the three mini-games. However, the game was a little dark (especially when projected with a beamer on a screen as was done at RRD) and the obstacles could be applied more randomly. Players saw items of the floor relatively late and therefore missed objects to be picked. For the final game, it is recommended to plan for reaction-time (for the actual speech reaction the system will require about half-a-second after the word is finished). In addition, some patients got confused by the fact that they were walking on the treadmill whereas the representative avatar was running in the game. It is recommended to also show a walking avatar in the game. According to the therapists, provoking a certain walking velocity will stimulate the attractiveness of the game as well. When the patient approaches the walking velocity imposed in the game, artefacts/objects will emerge which the patient can pick thereby collecting points and increase his score. When the walking velocity imposed is not approached these artefacts/objects will disappear. Although we got 4 out of 7 points for speech-input in the results of the questionnaire we have to reconsider to use body movements (for example arm movements) instead of speech recognition for left and right.

In our view, for the final game the attractiveness of the 'Face of Cronos' can be improved by making baseline (or when over it) better visible (hearable). By doing so, we can increase the success perceived by the patient during the game. Increased perception of success is hypothesized to boost the attractiveness of the game. In addition, patients should be challenged to climb faster for instance by preceding rising water while climbing.

Interestingly, patients rated the Three Wind Gods to take the most effort and to be most exertive out of the three mini-games. In other words, this game was labeled to be difficult to play (they had to remember the correct sequence of head movements) and mostly exertive (they had to approach their maximum range of motion which could (of course) be painful especially for the patients (score of 7.1 on effort expectancy and 6.3 on perceived exertion). According to the therapists, this might be explained by the fact that the game puts (perhaps too?) much emphasis on the painful movement (i.e. range of motion). In the Three Wind Gods game, subjects have to imitate a series of movements executed by the Three Wind Gods. Compared

to the other two games, the game does not really 'provoke' a spontaneous movement but 'provokes' an imitation. Therefore, it is hypothesized that subjects are less 'distracted' by the game from the pain. In the final version of the Playmancer game it would be better to provoke more spontaneous (range of motion) movements of the cervical area by letting the subject 'correct' the falling Wind God, which is blown from his statue by the wind, by making a movement in the opposite direction of the Wind.

The therapeutic relevance of the mini-games of the Temple of Magupta and Face of Cronos was rated acceptable (average score between 4-5 on a 7-point scale) on an overall level. This finding is encouraging, especially given the fact that subjects have only been interacting with a prototype version of the game. Less positive were the participants about the mini-game "Three wind god", which they rated it as the one of lowest therapeutic relevance. One explanation for this is the fact that one of the three wind gods was hardly visible on a projection screen, causing subjects to make mistakes more easily. In addition, patients stated that they had difficulty with remembering the correct sequence of head movements resulting in less emotional engagement with the game element. Therefore, we suggest incorporating a kind of easy to understand 'reminder' system in the game which reflects the sequence of movements to be executed. For the final game maybe some form of visual/audio guidance for the patient would be helpful. As researchers we got the impression that this game has been beaten under value. The reason for this, according to our view, is that it was too hard to get over the baseline for the ROM-moves. Therefore, participants (patients in particular) often had to try multiple times to achieve one movement, which could be frustrating. We suggest to lower the baseline by a (configurable) percentage from what the patient is capable of doing the baseline-calibration. Also the sporadic misrecognition of the movements by the system can be improved. For the final game maybe the visual/audio guidance for the patient should also state how close a patient is to the required values.

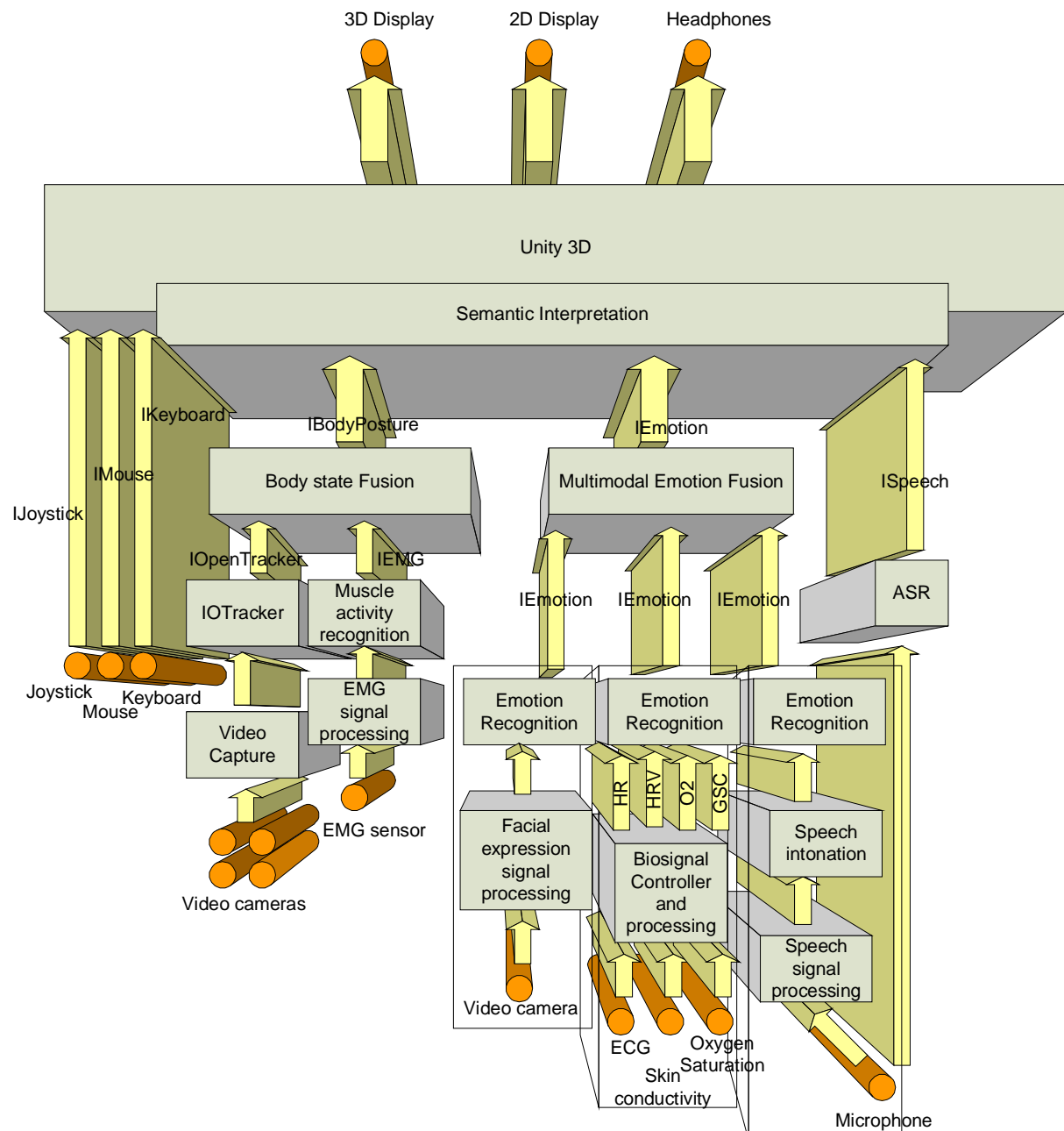
Very promising is the fact that the majority of participants (90%) would recommend this "serious gaming modality" to be added to their current rehabilitation treatment. Participant stated that a "serious gaming modality" would motivate them to increase their training intensity. About half of the patients would recommend a "serious gaming modality" to a friend (66.7%) or to another patient (50%). Most participant believed it is very valuable to see movement (which they execute) to be reflected in the game.

#### **1.3.4 Major project achievements**

PlayMancer has implemented an integrated system that provides rich user information to a computer game, and allows for almost natural game playing experience. The purpose of the project has been to build computer games to be used by 2 main agents:

- The players, who are mental health or pain rehabilitation patients
- Their therapists, supervising the patients' playing sessions from a close distance

The project has designed and implemented a number of collaborating components, that comply with the following architecture:



**Figure 1: High level architecture of the PlayMancer gaming platform**

The project specifications describe the programming interfaces between any pair of information exchanging components in the architecture diagram, in the updated project deliverable D2.4.

We have delivered a platform of components complying to the abovementioned architecture, and we have designed and developed two prototype serious games exploiting this platform in the course of the PlayMancer project. We have tested these serious games with real patients, for evaluating satisfaction and usability during the playing experience, and for medical value as a complement to conventional therapy.

We present in the following paragraphs some guidelines and rules of thumb that we followed during the design process, which might be useful for others, for games for health or related endeavours.

### **Coached games**

Playmancer games are played as part of the clinical session. The therapist is there, for now, for guidance and debriefing. Typical games are not played in this setting.

Our chosen setting is computer games for patients under the presence and supervision of a therapist, who is sitting next or nearby the patient, in the same room with the patient, and is supervising the game playing session through his own monitor and session interface. In this interface, he can either have a view of the player's screen (as in the pain rehabilitation game), or a special interface where sensitive measurements about the game are being displayed (e.g. sensor readings, as in the mental health game).

### **Main game story context**

Unlike virtual reality, or therapeutic support for phobias or anxiety, where the therapeutic setting might be progressive exposure to heights, open spaces, or spiders (or other phobias), the therapeutic setting for complex behavioural disorders should target underlying behaviour, and not a stereotypical setting.

Islands were chosen as setting because they are easily associated with adventure, vacation, fun and relaxation. For the more adventurous, there are associations with getting lost, finding hidden treasures. For the hedonist, it is all about vacation and relaxation. Having a setting that is removed from the daily problems of potential users is also important. The island setting also lends itself to expansion to many islands, which, in fact was the first idea for the game setting.

A tropical island is a pleasant, tranquil setting, and it is a place you want to visit (warm and sunny, nature, peaceful). The main location was also chosen and designed graphically in order to be visually pleasing and calming. Patients may not be gamers in which case they will not be as reluctant to enter the game world if it appears pleasing and welcoming. And since it is the player's choice (as related in the introduction narrative) to sail to the island, the feeling of exploration and it being your island greatly overshadows any feelings of solitude (alone on the island) - you are not a marooned victim, but an empowered explorer.

### **Main game story line**

The storyline and narrative framing (the Magupta empire, island that resurfaces, mythological story) was inspired by the Bermuda / Atlantis stories/myths, and the Aztec / Mayan cultures, in order to give room for imagination and exploration, but also a degree of recognition for the patient/player. A realistic setting with fantasy/mythological elements draws on a huge narrative corpus (Indiana Jones, Harry Potter, fairy tales, Brothers Grimm, Hans Christian Andersen, Lord of the Rings) and has thus always had a great appeal to a broad target audience. Making a game for such a versatile group, as was the case with the RRD and Idibell patients (versatile even within each patient group), would require a setting and a narrative that would appeal broadly.

A single story line for both applications was chosen to reduce the development time. This provided an overall structure, while the mini games focused on addressing the specific therapeutic requirements.

### **Decoupling strict linking between game scoring and measured therapeutic progress**

The main scoring and player advancement mechanism in the 2 PlayMancer games is through gaining points from gathered artifacts that progressively unlock the game tablets. When a tablet is unlocked, an unknown part of the island's lore is revealed to the player. The first tablet is unlocked when 10 points worth of artifacts have been gained, the next needs 100 points, then 500, and for the remaining six tablets 1000 points are needed for each. There are a total of nine tablets, comprising the entire history of the empire.

Since the unlocking of tablets is based solely on the player's score, the actual therapeutic achievements, that the patient might have accomplished, have no effect on neither the amount of points a player gets or the unlocking of the narrative (apart from a player getting more points when being more accomplished in the game, either due to therapeutic improvements or game play experience). Hence, a patient that didn't improve much during sessions would not be penalized if s/he at least still tried to reach the goals of his/her rehabilitation.

This mechanism succeeds to reward success and not penalise effort.

### **On balancing player satisfaction and patient therapeutic progress**

Player satisfaction is manifested by the immersion of the player in the game, and their willingness to advance the game storyline, gain more points, artifacts and unlocking tablets. Achieving the therapeutic goals is on the other hand based on careful calibration of the game parameters by the therapist and on guaranteeing repetitions of the game and its mini-games by the patient.

In PlayMancer games the emphasis is towards the game repetitions and not so much to the player's progress through the game. This might seem reasonable due to the nature of the PlayMancer games (serious games, games for health) but also because the average age of targeted population of patients is over 35 years old, underlining that the players will not be so inclined in progressing through the game as much as following their therapists guidance. That is why the rewards are narrative rewards rather than points, or more time underwater (in the case of the "Treasures of the Sea" mini-game) rather than more points. This is a general guideline governing the game design of both games.

Particularly, in the case of the mental health PlayMancer game, the players are mostly motivated to keep on playing by their enthusiasm based on self-perceived clinical improvement over the sessions and not by the simple game rewarding system. Considering the personality traits of our patients, and after clarifying the rational and purpose of the Islands game explained to them before starting the videogame therapy, the main goal with behavioural and mental disorders is to get self-control. For the patients, being able to increase these lacking skills was acting as crucial motivating factor itself. Afterwards, this consideration was supported by the feedback of patients who successfully used the videogame, who expressed that one of the most relevant motivating factors for encouraging the continuation of the

therapy were some external game factors (their own improvements while reacting more calmed down in front of new life events and the positive reinforcement of the family) and internal game factors (the expectation to be able to have higher self-control and relax faster than in the previous game session).

### **Measuring patient progress through the gaming sessions**

One of the PlayMancer results that contributes to further scientific research is the ability of the PlayMancer platform to log descriptive and detailed game play data during the game sessions of the patients. This structured information includes specified game information as well as information registered by the game input modules. There are different levels of logging:

- the emotion recognition fusion component, used in the mental health game, logs emotion recognition inputs from the 3 available emotion recognition components and its emotion recognition output decision,
- the multi-sensor signal fusion component, used in the pain rehabilitation game, logs motion capture and EMG data,
- both games, as an inherent scripted behaviour, save selected game events and information pertinent to the game play performance of the patient, such as time being underwater in the Treasures of the Sea mini-game, or average walking speed in the Temple of Cronos game, in the patient's profile.

The logging feature facilitates the analysis of game sessions with patients and the correlation with other findings of the clinical change, and allowed us to evaluate the progress of the patients session by session, and also to post-process this wealth of information after the end of the trials. While this feature is not promoted as adequate patient progress monitoring tool, it can be used as such complementary with the therapist or carer's conventional patient assessment.

The accuracy of the logged data guarantees a valid statistical analysis and quantitative results out of the evaluation phase, in antithesis with several other serious games for health where the patient progress is solely measured with methods outside the game scope. The use of such an accurate system for motion capture in PlayMancer allows the therapist to know the level of progress of patients, session by session and overall, while they perform the prescribed physical exercises that are also embedded in the logic of the PlayMancer computer game for pain rehabilitation. This knowledge allows the therapist to focus on specific issues of the problem by modifying the baseline calibration, order, or duration of the mini-games that are included in each of the game-playing sessions.

The PlayMancer platform allowed us to discover interesting patterns considering the change of the progress per session and per patient, correlated with game play elements. These findings are documented in project deliverable D8.2 (Part A and Part B).

### **On affective feedback and how to avoid the “Death Spiral” effect**

In the PlayMancer game for mental health (focusing on eating disorders and pathological gambling), the mini-games that have been implemented incorporate elements that react to the emotions of the patient. By carefully designing the reaction

of these game elements, and after certain player emotions are manifested, the patients are learning to recognise them and handle them.

The PlayMancer emotion recognition components recognise emotions by means of facial expressions, speech features or physiological signals. The classes of emotions that can be recognised have been set by the domain experts (partner IDIBELL) and correspond to:

- Joy
- Anger
- Sadness
- Surprise
- Neutral (calm)
- Boredom

Examples of affective feedback elements used in the PlayMancer game, are:

- In the mini-game “Treasures of the Sea”, the player is diving into a sea basin in order to search for lost treasures. In order to replenish his oxygen which is slowly depleting, they have to catch a special kind of fish, a balloon fish. The balloon fish moves away from the player when the player gets emotional. So they have to learn to staying calm to catch the balloon fish, and this is part of the exercise. It is not possible to catch balloon fish while angry or bored, so the player will have to regain a calm state before proceeding.
- In the “Face of Cronos” mini-game, the player is climbing a wall. This is a 2 stage game: During this first stage, the player plays his moves, but their emotions affect the presence (or not) and quantity of opponents, such as falling rocks or seagulls flying in their way. Then at the second stage, they see the result of these moves in a resolution of the moves of both the player and their opponents. The interactive appearance of the opponents during the first stage is working as an indirect visualisation of the player’s current emotional state, which can be helpful for the player in order to “get in touch” with their own emotions and better understand the potential danger signals.

However there are pitfalls in blindly applying affective feedback in a game: The player may be trapped in a spiral, by developing negative emotions (such as frustration or anger) that, according to the game mechanics will lead to failure, and this in turn might also develop more frustration which will eventually lead the player to quit the game. There are several steps that will help avoid this issue, which the PlayMancer game for mental health followed:

- First, the games should be designed NOT to be too difficult to prevent users from advancing,
- The fine tuning between the level of difficulty and frustration versus planning skills required to get the maximum benefits is an ongoing process and requires many careful iterations. It is recommended that a game should define one (or just a few) overall difficulty parameter, simple and meaningful to the therapist, that can be easily adjusted during iterations.
- Finally, it should not be forgotten that the game is played inside a therapeutic environment. The player is not alone. When the patients are experiencing frustration, it is recommended that the therapist discuss and explore the issue with the patient during the sessions. One of the main reasons for having the therapist in the experimental room is to avoid the hypothetical vicious circle of

frustration. In our trials with patients, from the beginning, the patients were advised to use the relaxation section of the island (Sign of Magupta mini-game) in the hypothetical case that they would not find a way to reduce frustration and to stay calm down. None of the patients explored had the need to abruptly interrupt the game session due to excessive feelings of frustration. The presence of the therapist and the hospital scenario may have a double positive effect, by giving them an additional feeling of security.

### 1.3.5 Overall project achievements Vs State of the Art and envisaged goals

PlayMancer is a multidisciplinary project: it employs technologies and scientific disciplines from computer science (multimodal interaction, HCI, medical ICT), clinical psychology, physical rehabilitation and physiotherapy.

Individual project results have been innovative and beyond what has been already researched in the abovementioned disciplines. The broad and wide initial goals of the project though was not able to be successfully completed within the timeframe and the resources allocated. This is why, by following the recommendations of the independent reviewers during the annual and intermediary project reviews, the project work plan has been restructured and the project goals re-focused on the critical objectives of the project. These objectives have successfully met by the end of the project timeframe and the re-organised work plan was able to lead to the following results:

**Table 3: Project achievements Vs State of the Art**

Project Achievement	Brief description	Innovation/ Progress	Further reference
1. Serious game for mental health	A game that is designed and built as a supplement to CBT therapy for binge eating sufferers and pathological gambling addicts	Unique use of emotion recognition technologies, in closed loop with player	D5.4, D5.6
2. Serious game for pain rehabilitation	A game that is designed and built as a supplement to rehabilitation of chronic pain sufferers	Unique use of precise optical-based motion tracking and ASR for a game (not VR) application	D5.4, D5.6
3. Game design for mental health patients	Design document that is structured after the user requirements of clinical psychologists, targeting personality traits that are difficult to be tackled in regular therapy	Mini-games at the core of the design, each targeting a different aspect of the requirements	D2.1c, D5.5

4. Game design for pain rehabilitation patients	Design document that is structured after the user requirements of pain rehabilitation experts, targeting the vicious circle of maladaptive pain-related cognitions (i.e. fear of movement)	Mini-games at the core of the design, each targeting a different aspect of the requirements	D2.1c, D5.5
5. PlayMancer Serious Games assets	Content that is used in the game development process, including multi-media files, images, drawings, 2-D and 3D models, sounds, programming scripts designed and developed after the user requirements of PlayMancer domain experts.	Mini-games at the core of the design, each targeting a different aspect of the requirements	D5.4
6. Bio-feedback-based emotion recognition	Multi sensor-based emotion recognition component from different physiological signals such: <ul style="list-style-type: none"> <li>• SpO<sub>2</sub></li> <li>• Pulse Rate</li> <li>• Heart Rate</li> <li>• Heart Rate Variability</li> <li>• Body Temperature</li> <li>• GSR</li> <li>• Respiration Rate</li> </ul>	In contrast with many studies on emotion recognition and bio-feedback, PlayMancer used medically-approved equipment for physiological reading acquisition and processing.	D3.2, D3.3, D4.3
7. Speech-based emotion recognition	Feature extraction from speech signal, and recognition of a set of pre-defined emotions for the problem at hand (ED and PG)	Improvement of emotion recognition accuracy (documented in D3.1, D3.2)	D3.1, D3.2
8. Visual facial expressions-based emotion recognition			D3.1, D3.2
9. Emotion recognition fusion	A fusion component that is combining available inputs from the 3 emotion recognition components: speech-		D3.1, D3.2

		based, face expression-based, bio-feedback-based		
10	PlayMancer emotion recognition database	Time-stamped emotion game play sessions	user annotated	Available for research purposes through the LREC organisation
11	Low-cost Motion capture system	Optical infrared camera marker-based skeleton tracking, optimised for run-time applications		Features adequate precision for rehabilitation applications for a fraction of the cost of competing systems D4.2, D4.3
12	Multi-sensor signal fusion	Generic network layer. Input integration of the pain rehabilitation game is implemented on top of it.	data-flow abstraction device	Improved IOTracker software. Integrated with Unity3D game engine for the 2 project games D4.2, D4.3
13	Unity 3D emotion recognition input	Unity 3D scripts implementing the integration with the emotion recognition modules and with the emotion recognition fusion module.		D2.1d, D3.3
14	Unity 3D human player motion input	Unity 3D scripts implementing the player motion, interfacing with the Multi-sensor signal fusion (result No 12)		D2.1d, D4.3
15	Game Automatic Speech Recognition	Limited vocabulary. This is a light component that recognizes and understands a limited set of spoken commands uttered by the game players (patients) in the Spanish or Dutch language.		Open Source speech engine used, API based on open standards (windows sockets). D4.3, D3.3
16	Field trial results on the use of the PlayMancer serious game for mental health patients	A report on studying the impact of introducing the PlayMancer game to mental health therapeutic program		Innovative introduction of computer game play mechanics for the targeted use cases D8.2 Part B

		(eating disorders and pathological gambling)	
17	Field trial results on the use of the PlayMancer serious game for chronic pain rehabilitation	A report on studying the impact of introducing the PlayMancer game to rehabilitation therapy	Extends previous VR prototypes by introducing computer game play mechanics

We discuss in the paragraphs below in more detail features and knowledge gained about each individual result, how they can be re-used and what is their assessment by the project members that contributed to their implementation, tested them and trialled them.

### **Serious game for mental health and Serious game for pain rehabilitation**

These two results are comprised of an executable run-time package of files, and a game design project for the Unity3D game development environment.

The former includes run-time parts and external asset files, placed in folders. This is a build of each of the two games for Windows O/S, and contains configuration and setup steps in order to properly interface the external peripheral devices, such as the motion tracking solution, the ASR with microphone support and the EMG sensors support for pain rehabilitation, and the 3 emotion recognition components (interfacing with a web camera, a microphone and a multi-sensor processing unit) plus the fusion software module for mental health. This part of the results cannot be modified and serve needs other than the ones that it has been designed and built for. This is a limitation that restricts its reusability:

- for areas other than pain rehabilitation and specifically focused on the upper body-back pain and cervical area pain
- for areas other than BE and PG, and specifically on clinical psychology targeting emotional stability, personality traits

The latter includes the design files and scripts and assets needed in order to build the former through the Unity3D platform. This result can be modified in order to respond to motions by other body parts of the patient-user. Also, by maintaining some of the critical scripts that implement the interface to the external peripheral devices, one could alter the artistic assets and game logic, and develop a totally different serious game, or even add another mini-game to the island concept. Prerequisites for this is owning a valid Unity3D license, and knowledge in Unity3D game development.

Judging from the results of the evaluation phase when trials with real patients have taken place at partner RRD and IDIBELL premises, the 2 serious games are very promising in terms of their medical value, and it are successful in terms of user satisfaction and playing experience. A set of recommendations for improvement of the game design have been gathered (documented in deliverable D8.1 Part A and Part B), that are pending implementation before exploiting this game and putting it in use out of the research context of the PlayMancer project.

### **Game design for mental health patients**

The design of the serious game for the mental health patients (suffering from BE or from PG) is based upon the requirements set by the domain experts IDIBELL in deliverables D2.1a, D2.1c, D2.4 and updated D3.1. The game design has been considerably changed through the project iterations and this can also be witnessed through reading the abovementioned deliverables. The final game design represents an evolutionary refined version, where game modules in the form of mini-games, are focused on dealing with individual user requirements in terms of impulse control and personality traits that are difficult to tackle with sessions of the conventional treatment. This flexible structure and modular fashion facilitates future expansion of the game design, or even modification, as well as evaluation of each independent module. Of course, all such mini-games are seamlessly integrated in one game-playing experience of the main 3D game world, and can be triggered by the player anytime during the playing session.

Although, several naturalistic studies have shown the usefulness of serious videogames for enhancing: positive attitudes, problem solving strategies, and modifying abnormal behaviors, there is a lack in the literature of specially designed serious-games or treating mental disorders and of controlled studies.

The final game design used in PlayMancer game for mental health presents our approach and judging from the promising results of evaluation during filed trial with real patients, there are parts in the game design that can be adopted by other serious games as best practice towards designing serious games for health (such as the structural architecture of game modules, linked together by a 3D world that the player explores). The produced game design documents (D5.6 and D5.4) are not specific to any game engine or game development tools and can be implemented with any such tools available.

On the other side, we have learnt that a level-based design around an open 3D world takes too much effort to be implemented on time, in terms of the artistic assets needed at each of the levels and level programming.

### **Game design for pain rehabilitation patients**

The game design for the pain rehabilitation game is, as with the case of the previous result, based upon the requirements set by the project domain experts (RRD) in deliverables D2.1a, D2.1c, D2.1 and updated D3.1. The game design of the pain rehabilitation patients is documented and included in project deliverables D5.6 and D5.4. As with the game design for mental health, this one evolved from the initial versions of an open 3D world of an archipelago comprised of a number of different islands, based on missions and levels, to one island world encompassing 3 different mini-games, each tackling a different rehabilitation exercise. This natural mapping from physical exercise to mini-game design provided an easier control of the patients during game-playing sessions by their therapists. Therapists are monitoring the game from a close distance, as in the case of mental health PlayMancer game.

Game design is modular in this case as well, and the mini-games can be triggered by the players through the 3D island world that encompasses them. The final game design used in PlayMancer game for pain rehabilitation presents our approach and judging from the promising results of evaluation during filed trial with real patients, there are parts in the game design that can be adopted by other serious games as best practice (such as the structural architecture of game modules, linked together by a 3D world that the player explores) and parts that could be further improved, as it is mentioned in D8.2 Part A.

The game design is limited by the requirements that were set up at the first project stages, and relate to tackling chronic pain in the back and cervical areas, and improving overall physical condition. Extensions of the included mini-games might be necessary for tackling lower-body originating pain.

### **PlayMancer Serious Games assets**

For the implementation of the island world and individual mini-games, some artistic assets were re-used and others were produced specifically for the PlayMancer project. All game assets are re-usable components that might be re-used for other serious or conventional entertainment-oriented computer games. Some of these assets are ready to be imported to any game development pipeline (e.g. 3D models, textures, sounds), other are specific to the Unity3D game development environment (e.g. shaders, JavaScript/ C# scripts, terrains). Among the several project-specific asset objects are animals (seagulls, balloon fishes, other fishes), artifacts (urns, tablets, sculptures), textures, shaders (e.g. sea, sea-shore splashing waves).

### **Bio-feedback-based emotion recognition**

This is an implementation based on the MobiHealth sensor system suit (using TMS International Mobi 8-channel device) for physiological measurements acquisition and processing. An emotion recognition algorithm has been developed to recognise between the emotional state classes that the project requires. For this purpose, a set of databases have been built, from a data acquisition process on healthy subjects. This process is documented in D3.1 (section 4.4.3, 4.6).

This result can be re-used as is by third party applications and games. The implementation resides as a set of devices, files and an exposed API, which will have to be used in order for an external application to start registering the emotional states that this result will produce. The API for Bio-feedback based emotion recognition includes IEmotion, IGalvanic and IHeartRate interfaces. The former is interfacing the emotion fusion component, while the latter two are directly interfacing the game engine.

The limitation of this result is the specific set of emotion classes that supports, that have been tailored to the mental health game of the project. Other mental health disorders –psycho addictions such as for example game addiction or anorexia nervosa, are similar in nature, and may re-use this component as is. Another future adaptation relates to the accuracy of this component, that might be further improved with more training and testing data, that might be more fitting to the requirements of other target groups, other than the patients and healthy subjects that participated in this project.

### **Speech-based emotion recognition**

This result is a software component that provides an API in order to interface external systems. The main input of this component is the speech utterance of the game player. The functionality of this component is based on the processing of the acoustic features of speech audio signals, and classification of emotions-affective states according to the predefined models. The target emotions-affective states are defined by the user requirements, and are described in D2.4, section 2. This result is using a VAD (voice activation detection) component, which acts as a trigger for the speech-based emotion recognition component.

In PlayMancer it is interfacing the emotion fusion component, which in turn interfaces the game engine, furnishing in periodic data about the user's/player's emotional state. This component recognises the same set of emotion classes as the bio-

feedback –based emotion recognition, and exposes the same interface (IEmotion) to the emotion recognition fusion component. This interface will send to the emotion recognition fusion interface (IEmotion) the results of its emotion recognition in an XML packet following the schema described in the updated D3.1, section 3.1.7. This XML packet will contain all emotions the component can recognise with an intensity of 0 if the emotion was not recognised.

This result can be used in third-party applications or other computer games as is, provided that the API has been correctly used. As with the other modal emotion recognition components, this result can directly interface another application or directly a game engine instead of the emotion recognition fusion component of the PlayMancer architecture.

Similarly to the other emotion recognition components, this result faces the limitation of the specific set of emotion classes that supports, that have been tailored to the mental health game of the project. Other mental health disorders –psycho addictions such as for example game addiction or anorexia nervosa, are similar in nature, and may re-use this component as is. Another future adaptation relates to the accuracy of this component, that might be further improved with more training and testing data, that might be more fitting to the requirements of other target groups, other than the patients and healthy subjects that participated in this project (documentation on the data acquisition process for developing and using the corpus used for this result's training can be found in D3.1, section 4.4.3). As it can be seen in technical deliverables D3.1 and D3.2, the accuracy of this component reaches and even surpasses the accuracy of other related implementations in the state-of-the-art area for speech-based emotion recognition, still it is low for systems to rely solely on the acoustic mode. It is recommended to fuse this component with emotion recognition components that are based on other modes, in order to optimise and maximise the final accuracy of the emotion recognition process.

### **Visual facial expressions-based emotion recognition**

The Facial (expressions-based) Emotion Recognition component that constitutes this result, provides feedback to PlayMancer platform through the Multimodal Emotion Fusion component with respect to the affective state of the game player. This component functions by analysing the facial expression of the game player who is recorded by camera, and classifies emotions according to a training model.

As in the emotion recognition through speech, the targeting emotions-affective states are defined by the user requirements, as described in D2.4, section 2. The output of the emotion recognition component is sent to the multimodal emotion fusion component by using the IEmotion interface, common to all three emotion recognition components.

The limitations of this result, common to the other 2 emotion recognition components of the project, lies in the specific set of emotion classes that supports, that have been tailored to the mental health game of the project. Other mental health disorders – psycho addictions such as for example game addiction or anorexia nervosa, are similar in nature, and may re-use this component as is. Another future adaptation relates to the accuracy of this component, that might be further improved with more training and testing data, that might be more fitting to the requirements of other target groups, other than the patients and healthy subjects that participated in this project (documentation on the data acquisition process for developing and using the corpus used for this result's training can be found in D3.1, section 4.6).

### **Emotion recognition fusion**

The Multimodal Emotion Fusion component, fuses emotion output retrieved from various emotion recognition components through the IEmotion XML-based programming interface and provides feedback to the PlayMancer platform with respect to the affective state of the game player. This component fuses the affective information retrieved from individual emotion recognition components at the decision level, according to a training model. The same as with the emotion recognition components, the targeting emotions-affective states are defined by the user requirements, as described in D2.4, section 2. This also constitutes the result's main limitation to future re-use, because its inherent model has been trained and tested for the specific set of emotion classes. A potential adaptation to another set of classes would require the re-iteration of the model learning process.

This result comes with 4 different fusion methods implemented:

- Weighted Sum Rule Based
- Temporal Weighted Sum Rule Based
- Bayes Belief Based
- Dynamic Bayesian Network Based

### **PlayMancer emotion recognition database**

This is a developed resource, a unique multimodal affect database that has served the training and testing phases of the emotion recognition components. This database was created in support of the research and development activities, taking place within the PlayMancer project, which aims at the development of a serious game environment in support of treatment of patients with behavioural and addictive disorders, such as eating disorders and gambling addictions. Specifically, for the purpose of data collection, we designed and implemented a pilot trial with healthy test subjects. Speech, video and bio-signals (including pulse-rate, SpO2) were captured synchronously, during the interaction of healthy people with a number of video games. The collected data were annotated by the test subjects (self-annotation), targeting proper interpretation of the underlying affective states. The broad-shouldered design of the PlayMancer database allows its use for the needs of research on multimodal affect-emotion recognition and multimodal human-computer interaction in serious games environment.

Again the limitations are set by the boundary conditions governing the configuration of the data acquisition process. These include the set of emotion classes according to which the acquired data are annotated, and the annotation process of self-annotation. Detailed documentation of this result can be found in "The PlayMancer Database: A Multimodal Affect Database in Support of Research and Development Activities in Serious Game Environment" publication by T. Kostoulas, O. Kocsis, T. Ganchev et al. presented at LREC 2010 conference. This publication can be found in the project site ([www.playmancer.eu](http://www.playmancer.eu)) under "Documents", "Research Articles".

Soon this result will be available through ELDA (Evaluations and Language resources Distribution Agency), whose mission is to promote language resources for the Human Language Technology (HLT) sector, and to evaluate language engineering technologies. This move is expected to build a considerable added value by third parties who would like to test their algorithms and models and compare with the ones that the project members have acquired for emotion recognition.

### **Low-cost Motion capture system**

The motion tracking prototype mainly consists of extensions to the *iotracker* software. These include an application, which generates an approximated skeleton model and a module/plug-in to fit the model to the tracking data.

All required input modalities have been implemented, integrated and tested within the first game-prototypes. Test results of the integrated system with healthy subjects and patients can be found in deliverable 8.1. Supported measurements include MoCap-data of rigid-bodies and full-body MoCap data using a generic skeleton model. In addition, the MoCap data is processed to retrieve measurements like range-of-motion of the neck, walking speed and certain parameters for arm-movements. For a detailed description of the full-body motion tracking prototype and the extensions implemented for the Opentracker data flow network please refer to deliverable 4.3.

Three years past the project's start Microsoft released the Kinect (for Xbox 360) based on Primesense's system on a chip. In April 2011 ASUS released the Xtion Pro, a PC version of the Kinect, which also uses the Primesense chip. A comparison of the Kinect to our iotracker system can be found in our [1]. In summary, Kinect may be usable for some serious games where tracking accuracy and smoothness of motion are not of primary concern. For Kinect, jitter in positional data is clearly visible in the extreme positions. Jitter also strongly disturbs the velocity, which we calculated on a frame by frame basis. Since velocity is being used to determine smoothness of motion this is considered problematic for our purpose. Due to the low quality of motion data captured by a device based on the current Primesense sensor, such data cannot be used for a medical evaluation of human motion. Therefore, low cost motion capture devices such as the Kinect or ASUS Xtion Pro cannot be considered competitors to our iotracker high quality mocap system.

Compared to competitive motion capture systems of equal measurement accuracy and capturing quality (such as those that are used for rehabilitation purposes), this result is one of the most affordable systems for precise and robust motion capture. It is marker-based and successfully tackles the issue of occlusion of body parts and provides the level of accuracy that is needed according to the project requirements as set by domain experts (partner RRD) in deliverables D2.1, D2.4. Its cost lies in the range of 10-20 K Euros, which is lower than competing systems providing equal or better robustness and precision. The use of such an accurate system for motion capture in PlayMancer allows the therapist to know the level of progress of patients, session by session and overall, while they perform the prescribed physical exercises that are also embedded in the logic of the PlayMancer computer game for pain rehabilitation. This knowledge allows the therapist to focus on specific issues of the problem by modifying the baseline calibration, order, or duration of the mini-games that are included in each of the game-playing sessions.

### **Multi-sensor signal fusion**

This result consists of providing Opentracker extensions and adaptations in order to support iotracker, TMSI Mobi device and supported sensors, various gMOBIIlab sensors, the SqueezeOrb and the Wii BalanceBoard. Furthermore, various bio-signals like EMG, ECG, heart rate and GSR are incorporated and are post-processed (e.g. filtered) within Opentracker. Finally, hand pressure strength can be measured as well as the centre of balance. This has been achieved by implementing and adding modules to the framework. In the Opentracker data-flow-network,

information relevant for the games is extracted and processed. From OpenTracker a connection to Unity3D is established making it possible to use the motion-data within the games.

### **Unity 3D emotion recognition input**

This result relates to the implementation of the IEmotion, IGalvanic and IHeartRate interfaces at the side of the Unity 3D game development platform. This result allows a game developer to effortlessly interface any of the PlayMancer emotion recognition modules, either directly the speech-based or the facial expressions-based or the bio-feedback-based emotion recognition component, or the emotion recognition fusion component.

The related scripts can be easily re-used, because they are treated as Unity assets, and as those they are uniformly managed by the asset manager of Unity within or across different game projects. Of course, this result is useless without any of the external components with which it is communicating (emotion recognition or fusion components) and for this reason, it should be combined with one or multiple of these.

### **Unity 3D human player motion input**

This result relates to the implementation of the IOpenTracker, IEMG, IGalvanic and IHeartRate interfaces at the side of the Unity 3D game development platform. This result allows a game developer to effortlessly interface the multi-sensor signal fusion (IOTracker) component or the motion tracking system.

The related scripts can be easily re-used, because they are treated as Unity assets, and as those they are uniformly managed by the asset manager of Unity within or across different game projects. Of course, this result is useless without any of the external components with which it is communicating (emotion recognition or fusion components) and for this reason, it should be combined with one or multiple of these.

### **Game Automatic Speech Recognition**

This result is comprised of a set of software modules, most of which are part of a dedicated spoken dialog system. The speech input processing module is a flexible mini speech environment which consists of several individual processes. Executable binaries (processes) communicate each-other by using socket technology based on the tcp / ip network protocol. More particularly all processes communicate each-other because they are based on the Galaxy Communicator architecture, which establishes a distributed, message-based, hub-and-spoke Galaxy Communicator software infrastructure. Due to its socket-based architecture, speech input processing module is flexible enough to be enhanced with other components-processes, such as the speech-based emotion recognition component.

This result comes with Unity support. In order to load a Unity-based game that supports speech-related modalities (such as automatic speech recognition modality and/or speech-based emotion recognition modality), Unity has to pre-load Speech input processing module at start-up and before the game is loaded, which is succeeded by the execution of a Unity script.

This result is re-usable and re-configurable in terms of the vocabulary that it can understand, though this adaptation process can be performed by a researcher or technician that has a good understanding of spoken-dialog systems, and in particular with the specific platform that has been exploited, which is CMU's

Olympus/RavenClaw, even if only a fraction of the whole platform has been used in this result.

### **Field trial results on the use of the PlayMancer serious game for mental health patients and for chronic pain rehabilitation**

Each of these two results comprises of two reports on studying the impact of introducing the PlayMancer game to:

- mental health therapeutic program
- pain rehabilitation therapy

The use of innovative computer game play mechanics for the targeted use cases (eating disorder and pathological gambling addicts for the former, and pain suffering patients for the latter) is assessed and guidelines for future research in this area are also given.

These two results are freely available in the form of the following project documents:

- Deliverable D8.1 Intermediate Playmancer evaluation Results: The two parts of this report (Part A for pain rehabilitation and Part B for mental health) discuss the methodology for the technical evaluation of the PlayMancer platform components, as well as a preliminary assessment of the components by internal and external users, and recommendations for future improvements.
- Deliverable D8.2 Final Playmancer evaluation Results: The two parts of this report (Part A for pain rehabilitation and Part B for mental health) describe the state of the art in evaluation of relevant applications or systems for the project's two application domains, the methodology and results of the evaluation of the PlayMancer games as developed in the Playmancer project in trials with real patients, and finally drawing conclusions and future directions.

These results constitute a valuable foreground knowledge that has been acquired after the completion of the PlayMancer project. While every attention has been invested in completing the number of sessions with real patients as described in the evaluation methodologies in the timeframe planned for the project (after consecutive amendments and changes of its contract), the resources (both human and effort-related) left during the end of the project allowed us to complete a part of the sessions required to draw definitive conclusions. For this reason, the positive results that have been observed by the end of the evaluation phase cannot be published, and the evaluation process is continuing past the end of the project, in order to complete the full cycle of the evaluation plan. It is expected that the project consortium will be able to publish the final evaluation results before December 2011.

## **1.4 Project potential impact on its industry/research sector**

The project has produced considerable impact on the related industry and research disciplines, in events where members of the PlayMancer consortium participated and presented the project objectives and results.

During its lifetime the project received several emails from interested parties, as a result of the project dissemination activities and of the successful exploitation of the

available dissemination channels. This raw feedback from the public can be distinguished in the following categories:

- Research: people asking for information on the project in order to complete research papers, dissertations, or to be better informed about the project innovations and objectives
- End-users: people asking for information as potential end-users, healthcare organizations, or even potential patients wanting to try out the project results
- Working/collaborations: people asking for job opportunities, or declaring interest for collaborating in new initiatives on the Games for Health area

This feedback is summarized in the following table. In the list of research event invitations we consider only those that are communicated through the official project contact :

Correspondent	Affiliation	Type of request	Request
Ben Sawyer	Organising committee of 2010 Games for Health conference, Boston	Research	Conference invitation
Wolfgang Huerst	FOCUS 3D coordinator	Research	Project collaboration
Julian Alvarez	IDATE	Research	Participation in market survey about Serious Games
Matthew Smith	PhD candidate, Kingston University, UK	Research	Inclusion of the project in a research study
Cristina Costa	CREATE-NET, Organising Committee of 2010 User Centric Media Conference	Research	Invitation to the conference
Thanasis Michalopoulos	Organiser of Greek Obesity Conference	Research	Invitation to the event
Bernd Carsten Stahl	De Montfort University, Centre for Computing and Social Responsibility, Leicester, UK FP7 ETICA project coordinator	Research	Project collaboration, answering questionnaire on networked media technologies
Tasos Tsitsanis	PhD candidate, NTUA, Greece	Research	Deliverable request for research on serious games
Cilia Robert	M.Sc. student, University of Malta	Research	Collaboration on idea about a social serious

				game
Gianfranco Binazzi	Professor Christian Archaeology, University of Perugia, Italy	of Working/ collaborations		Internship of their son with a consortium organisation
Laurent Grumiaux	Fishing Cactus, Belgium	Working/ collaborations		Offering their expertise on MS Kinect for a new initiative
Christophe Rieder	Responsible of a psychosomatic program in a rehabilitation clinic in Switzerland	End-users		Information about the project
Madalena Lobo	Major Psychotherapy Clinic in Portugal	End-users		Information about the project, searching for possible complementary interventions
Francisco de Soure	Member of Oficina de Psicologia, Portugal	End-users		Information about the project, searching for possible complementary interventions
Shannon Mangum	Assistant Professor LSUHSC Department of Occupational Therapy, New Orleans, Louisiana, USA	End-users		Information about the project, project participation in USA
Paul Devine	Purchasing Manager at The Copyright Company, audio and video products supplier to all the Duty Free's in the Middle East	Collaborations		Looking for finished product to purchase and distribute

### 1.4.1 Visibility and exposure of results

The PLAYMANCER consortium promotes the production and distribution of audiovisual material, which is disseminated to a broader audience in the various events. Audiovisual material includes demos demonstrating the PLAYMANCER project prototypes (i.e. demos made while testing/ validating/ evaluating the PLAYMANCER prototypes), as well as the work being carried out on each partner site. Audiovisual material, is made available to all PLAYMANCER partners, and, once approved, made publicly available.

The project has been very active in producing and promoting video clips about the project implementation. It has proved that this material attracted the attention of the public, and maintained their interest in the project. It has also brought the attention of news agencies and news media, the reports of which created a positive and well-received impact, not to mention the viral side effects of the reproduction of these reports in the electronic press, news casts, blogs and other social media.

The first video comes from an open event by partner TUW, available to citizens of Vienna (Vienna Science Fair, October 11-12, 2008). There, hundreds of children played with an early prototype game based on the motion capture technology used in the PlayMancer rehabilitation game. There is no narration in the video footage, only introductory and closing screens in English.

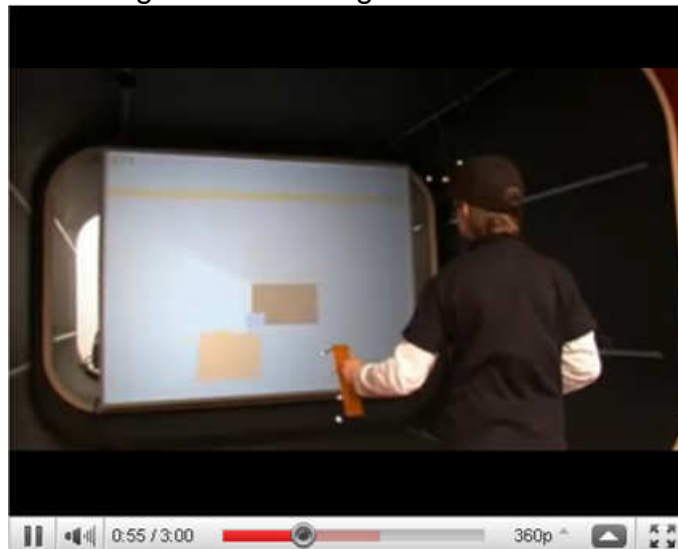


Figure 2: Capture from the first project video

The second video was released through the project site on 3<sup>rd</sup> of November, 2009. It focused on the new low-cost motion capture technology built for PlayMancer from partner TUW. Also no narration or spoken language exists, all the explanations provided in this material are in English.



Figure 3: Capture from the second project video

The third video was released the same day (3<sup>rd</sup> of November, 2009), and consisted of a sneak peak in the bridge building game prototype that has been demonstrated at the NEM summit of that year, by partner ST. No narration or spoken language exists, titles and explanations are in English.



Figure 4: Capture from the third project video, a game prototype

The fourth video was a report by Austrian TV channel ORF, interviewing our Austrian partner members (TUW), released through the site at 17 of September, 2010. The language of the report is German, but the project members have successfully produced subtitles in English.



Figure 5: Capture from the fourth project video, a TV channel report

The fifth video was a report by Euronews TV channel, interviewing several of the project members, with video footage at both of the field trial premises, in Barcelona, Spain (IDIBELL) and Enschede, Netherlands (RRD). The producers provided a license to the project to use the final cut video for all the project dissemination needs and through any channel. A YouTube version exists already with English narration, while the project members own the original DVD material, holding versions narrated and close-captioned in 10 EU languages, which will be edited in order to be used in other project dissemination activities.

The report is available on Euronews website, [www.euronews.net/sci-tech/futuris](http://www.euronews.net/sci-tech/futuris) and it is also accessible on YouTube and other smaller regional streaming online websites. The report is also broadcast in athenaweb.org, website specialised in Worldwide Research TV reports. All European public televisions and main private ones have received the report via an Eurovision exchange.

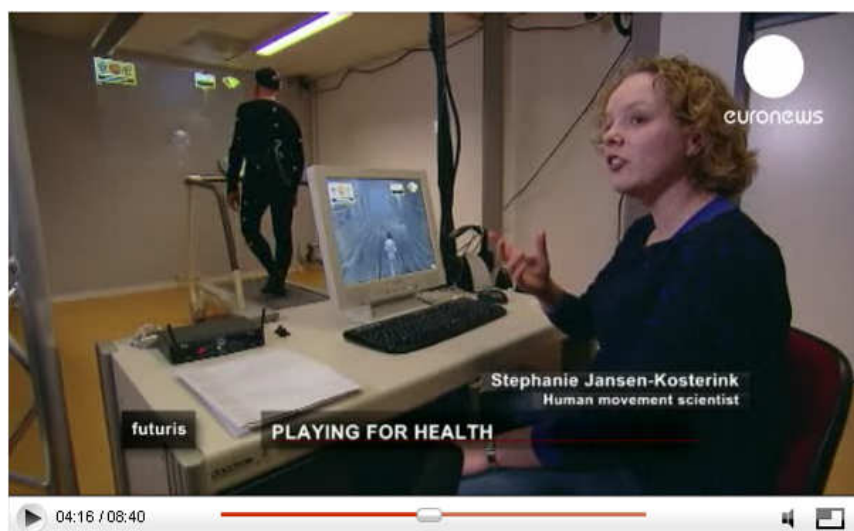


Figure 6: Capture from Euronews TV report

Then, a number of TV reports in Spanish were generated after a press conference organised by project partner IDIBELL. Spanish TV channels own the rights to the produced content, which is narrated in Spanish.



Figure 7: Capture from a Spanish TV channel report on the project

At last, in June 2011 a report has been published in the world wide web and aired by the public radio PRI about the project. The journalist covering this story has travelled to partner RRD premises and played with the pain rehabilitation prototype (he had to wear the body suit in order to be motion-tracked). His story can be found here: <http://www.theworld.org/2011/06/playmancer-rehab-netherlands/>



Figure 8: Capture from PRI The World story on the project

The project results have been disseminated through a variety of channels, including the internet (blogs, newscasts, articles, etc.), press, radio, television. A list of the video footages produced about the project, which had the major impact to the public, are displayed in the table below:

**Table 4: Activities that mostly contributed to the project visibility**

Type of activities	Title	Date	Place	Type of audience	Size of audience	Countries addressed
TV clip; interview	Euronews futuris TV report on PlayMancer: Games for Health	January 13-19, 2011	Spain, Netherlands	Public	Millions	Europe
TV clip; interview	French TF1 TV channel report	February 15, 2011	Spain	Public	Millions	France
TV clip; interview; press release	Spanish TV3 TV channel report	February 8, 2011	Spain	Public	Millions	Spain
TV clip; interview; press release	Spanish TV TVE channel report	February 7, 2011	Spain	Public	Millions	Spain
TV clip; interview; press release	Spanish TV Tele 5 channel report	February 7, 2011	Spain	Public	Millions	Spain
TV clip; interview; press release	Spanish TV Antena 3 channel report	February 7, 2011	Spain	Public	Millions	Spain
interview	The World -- BBC/WGBH/PRI; story about PlayMancer	February 8, 2011	Brussels, Belgium	Public		USA, Europe
Interview; press release	RAC 1 Radio Station project report	February 7, 2011	Spain	Public		Spain
Interview; press release	Catalunya Ràdio Station project report	February 7, 2011	Spain	Public		Spain
Interview; press release	COM Ràdio Station project report	February 7, 2011	Spain	Public		Spain
Interview; press release	EFE Televisió Station project report	February 7, 2011	Spain	Public		Spain
Interview; press release	Ràdio 4 Station project report	February 7, 2011	Spain	Public		Spain
Interview; press release	Cadena SER Station project report	February 7, 2011	Spain	Public		Spain
Interview; press release	El Hospital de Bellvitge desarrolla juegos de ordenador con fines terapéuticos, La Vanguardia newspaper	26 January, 2009	Spain	Public	Millions	Spain
Interview; press release	Videojuegos que sanan la mente, El País newspaper	February 7, 2011	Spain	Public	Millions	Spain
Interview;	PRI U.S. radio interview and web report	June 13, 2011	Brussels, Belgium	Public	Millions	U.S.A., Europe

#### 1.4.2 Project achievements and IP protection

The project achievements can be distinguished between:

1. foreground knowledge acquired during the execution of the project that will not be commercialised (only can contribute to a future capitalization)
2. and prototypes that have the potential to be commercially exploited.

In the former category fall all the results and publications that have been presented to scientific journals, conferences or fora and which are public and can be used not for profit by every one, especially by the research community:

- Game design for mental health patients: game design documents that target ED and PG patients, informed by the user requirements that have been set by domain experts
  - a. Included in D5.5, D5.6 (D5.6.1, the report), D5.4
- Game design for pain rehabilitation patients: game design documents that target pain rehabilitation patients, informed by the user requirements that have been set by domain experts
  - a. Included in D5.5, D5.6 (D5.6.1, the report), D5.4
- Bio-feedback-based emotion recognition:
  - a. Included in D3.1, D3.2, D3.3
- Speech-based emotion recognition
  - a. Included in D3.1, D3.2, D3.3
- Visual facial expressions-based emotion recognition
  - a. Included in D3.1, D3.2, D3.3
- Emotion recognition fusion
  - a. Included in D3.1, D3.2, D3.3
- PlayMancer emotion recognition database
  - a. Included in D3.1, D3.2
- Low-cost Motion capture system: Improvements on real-time response and precision and evolution of a background knowledge, the IOTracker system, for use according to the project end-user requirements.
  - a. Included in D4.1, D4.2, D4.3
  - b. A rigid-body target design methodology for optical pose-tracking systems
  - c. Full Body Interaction for Serious Games in Motor Rehabilitation

- Multi-sensor signal fusion: Adaptation of a background knowledge, the IOTracker system for multi-modal and multi-signal (input) processing
  - a. Included in D4.1, D4.2, D4.3
- Game Automatic Speech Recognition: adaptation of background knowledge (an open source ASR system, Olympus/RavenClaw and simplification in order to be integrated with a game engine (ie: Unity3D))
  - a. Included in D3.1, D3.2, D3.3
  - b. Performance Evaluation for Voice Conversion Systems
- Field trial results on the use of the PlayMancer serious game for mental health patients
  - a. Included in D8.1, D8.2 Part B
  - b. Internet-Based Cognitive-Behavioral Therapy for Bulimia Nervosa: A Controlled Study
  - c. PlayMancer: Games for Health with Accessibility in Mind
  - d. Meta-analysis on drugs in people with eating disorders
  - e. Comorbilidad del juego patológico: variables clínicas, personalidad y respuesta al tratamiento
  - f. Executive functioning among female pathological gambling and bulimia nervosa patients: Preliminary findings
  - g. Lifetime substance abuse, family history of alcohol abuse/dependence and novelty seeking in eating disorders: Comparison study of eating disorder subgroups
  - h. Subtyping eating disordered patients along drive for thinness and depression
  - i. Meta-analysis on drugs in people with eating disorders
  - j. Predictors of early change in bulimia nervosa after a brief psychoeducational therapy

- k. Male eating disorders and therapy: A controlled pilot study with one year follow-up
- l. Playmancer Project: A Serious Videogame as an Additional Therapy Tool for Eating and Impulse Control Disorders
- m. Age of Onset in Pathological Gambling: Clinical, Therapeutic and Personality Correlates
- n. Motivation to change and pathological gambling: Analysis of the relationship with clinical and psychopathological variables
- o. Social anxiety in the eating disorders: relationship with eating and personality features. Journal of Anxiety Disorders
- p. Subtyping Study of a Male Pathological Gambling Sample
- q. Serious Games as additional Psychological Support: A review of the literature
- Field trial results on the use of the PlayMancer serious game for chronic pain rehabilitation
  - a. Included in D81, D8.2 Part A
  - b. Chronic Pain Rehabilitation with a Serious Game using Multimodal Input

In the latter category all the tangible results that could be commercially exploitable:

- Serious game for mental health: the actual game executable software, including source code
- Serious game for pain rehabilitation: the actual game executable software, including source code
- PlayMancer Serious Games assets
- Bio-feedback-based emotion recognition
- Speech-based emotion recognition
- Visual facial expressions-based emotion recognition
- Emotion recognition fusion

- Low-cost Motion capture system
- Multi-sensor signal fusion
- Unity 3D emotion recognition input
- Unity 3D human player motion input

No applications for patents and generally for IP protection have been submitted yet, due to lack of project resources. However, the project partners are seriously considering doing so with own funds, in order to protect and establish the core concept idea, after the project termination.

### 1.4.3 Project exploitation

Analysing the work within PLAYMANCER, we are sorting out two major categories for the exploitable results:

- **individual exploitable results:** this class groups individual PLAYMANCER components sorted out by research and development activity;
- **composite exploitable results:** in this second category, we are identifying a list of exploitable results built using one or more of the individual exploitable results.

### Individual Objects

Based on the current status of the PLAYMANCER research stage, the individual exploitable objects - per PLAYMANCER subsystem - are the following:

1. Serious game for mental health
2. Serious game for pain rehabilitation
3. Game design for mental health patients
4. Game design for pain rehabilitation patients
5. PlayMancer Serious Games assets
6. Bio-feedback-based emotion recognition
7. Speech-based emotion recognition
8. Visual facial expressions-based emotion recognition
9. Emotion recognition fusion
10. PlayMancer emotion recognition database
11. Low-cost Motion capture system

12. Multi-sensor signal fusion
13. Unity 3D emotion recognition input
14. Unity 3D human player motion input
15. Game Automatic Speech Recognition
16. Field trial results on the use of the PlayMancer serious game for mental health patients
17. Field trial results on the use of the PlayMancer serious game for chronic pain rehabilitation

### Composite Objects

This category represents the PLAYMANCER exploitable results consisting of more than one of the individual exploitable results. We can divide them into in the following main classes:

- ***PLAYMANCER integrated prototypes:*** Two of the PLAYMANCER composite (exploitable) results are the integrated PLAYMANCER prototype games, consisting of all the individual exploitable results:

*PlayMancer serious game for mental health.* This integrated environment consists of:

- Serious game for mental health
- Unity 3D emotion recognition input
- PlayMancer Serious Games assets
- Bio-feedback-based emotion recognition
- Speech-based emotion recognition
- Visual facial expressions-based emotion recognition
- Emotion recognition fusion
- Field trial results on the use of the PlayMancer serious game for mental health patients

*PlayMancer serious game for pain rehabilitation.* This integrated environment consists of:

- Serious game for pain rehabilitation
- Unity 3D human player motion input

- Low-cost Motion capture system
  - Multi-sensor signal fusion
  - Game Automatic Speech Recognition
  - Field trial results on the use of the PlayMancer serious game for chronic pain rehabilitation
- **Re-packaged results:** The PLAYMANCER project results can be re-packaged and offered as composite system components that could be promoted as individual results for third-party systems or applications. These could be:
    1. User emotion recognition component. This is made up of the following individual components:
      - a. Bio-feedback-based emotion recognition
      - b. Speech-based emotion recognition
      - c. Visual facial expressions-based emotion recognition
      - d. Emotion recognition fusion
    2. Multi-sensor Motion capture component. This is made up of the following components:
      - a. Low-cost Motion capture system
      - b. Multi-sensor signal fusion
    3. Principles, theory and practice on using serious games for mental health patients. This comprise knowledge for building new games for the intended user group:
      - a. Game design for mental health patients (part of deliverables 5.4, 5.6)
      - b. Field trial results on the use of the PlayMancer serious game for mental health patients (part of deliverable D8.2)
      - c. Publications on PlayMancer serious game for mental health patients

4. Principles, theory and practice on using serious games for pain rehabilitation patients. This comprise knowledge for building new games for the intended user group
  - a. Game design for pain rehabilitation patients (part of deliverables 5.4, 5.6)
  - b. Field trial results on the use of the PlayMancer serious game for chronic pain rehabilitation (part of deliverable D8.2)
  - c. Publications on PlayMancer serious game for pain rehabilitation

Last but not least, the individual and collective know-how acquired by the project partners will serve as an additional Exploitation Object. Details about the project exploitation plan can be found in D7.3, where the following dimensions are described:

- Exploitation objects (already presented herein)
- Direction of exploitation: internal within consortium vs external, both will be sought
- Regional dimension: European-wide exploitation will be firstly sought, then international (mainly US-oriented) according to expressed interest
- Promoter(s): The project commercial entities will carry out this role, namely ST, SGI, NETUNION
- Market Sector (Analysis): An overview of the market sector is presented, for the following segments that are related to project results:
  - Games for Health, and for Psycho-education
  - ICT solutions for mental health CBT
    - a. Eating disorders
    - b. Gambling addiction
  - ICT solutions for pain rehabilitation CBT
  - Human-Computer Interaction
    - a. Motion Capture
    - b. Affective Interfaces
    - c. Speech Recognition

- SWOT analysis identifying the Strengths, Weaknesses, Opportunities and Threats relating to the integrated PlayMancer result and to the 4 PLAYMANCER composite exploitation results:
  - a. PlayMancer serious game for mental health
  - b. PlayMancer serious game for pain rehabilitation
  - c. User emotion recognition component
  - d. Multi-sensor Motion capture component (IOTracker system)

Individual exploitation plans for each of the project partners are also included in this deliverable and present the different strategies and goals of each of the partners that own part of whole of the respective results.

## 1.5 Project Web Site and project Contact Details

The project website is the main dissemination channel for the PLAYMANCER project. It serves three major purposes: i) Dissemination of the project results to the public ii) Collaborative working within the Consortium, and iii) Providing access to internal project information (for partners only).

A first version of a dynamic web site dedicated to the PLAYMANCER project has been produced in February 2010 (month 3 from the project start) and two unique domain names for the project have been registered ([www.playmancer.eu](http://www.playmancer.eu) and [www.playmancer.com](http://www.playmancer.com)). This version, after being tested and commented by all PLAYMANCER partners, has been modified and led to the current version of the PLAYMANCER Site (released at the end of March 2010).

The project site is divided into a “Public Area” and a “Members Area”, i.e. an area to which access is restricted to authorized users.

### Public Area

The public section features:

- General description of the project and its objectives
- Information about the consortium and links to partners' websites
- Public documents, such as public deliverables (reports) produced during the project, published research articles concerning the project's technological and scientific achievements, project presentations, brochure and press releases.
- Contact information
- Calendar information about past and upcoming events (organized by PLAYMANCER or other)
- Regularly updated news feeds
- Information about research projects related to PLAYMANCER
- Polls

The PLAYMANCER site interface and content is being provided in English.

The project consortium is paying particular attention to the impact of our website, as it is a direct window on the PLAYMANCER activities and outcomes. Google Analytics service, a tool for providing information about traffic tracking of web sites, is

being used to track / analyse the PLAYMANCER site traffic data, e.g. information about the origins of the connections, the main destination pages, the time spent on each page, the top referring sites and the links that have been most used and so on. In this way the consortium is in position to better adapt the website content to the interests of the visitors.

The project members can be contacted through the following emails: [elias.kalapanidas@systema.gr](mailto:elias.kalapanidas@systema.gr); [maria.vassiou@systema.gr](mailto:maria.vassiou@systema.gr) .

## 2 Use and Dissemination of Foreground

### 2.1 Section A

#### 2.1.1 Publications

PLAYMANCER publications can be either scientific publications or documents that abstractly cover topics addressed by the project. Prior to achieving mature technological and scientific results, only publications of the second category are made.

Scientific publications, i.e. research articles at well referred conferences, workshops and journals in disciplines related to PLAYMANCER, are announced to the PLAYMANCER consortium prior to their submission.

Where a publication result is not directly available through the permanent identifier provided in the table below (doi number or URL address), then readers are encouraged to search in the public area of the project site, where most of the publications cited in the table are publically available. Digital Object Identifier (doi) number references can be resolved to valid URL addresses through the doi service at: <http://dx.doi.org/>.

**Table 5: Template A2- List Of Scientific (Peer Reviewed) Publications****TEMPLATE A1: LIST OF SCIENTIFIC (PEER REVIEWED) PUBLICATIONS**

NO.	Title	Main author	Title of the periodical or the series	Number, date or frequency	Publisher	Place of publication	Year of publication	Relevant pages	Permanent identifiers <sup>1</sup> (if available)	Is/Will open access <sup>2</sup> provided to this publication?
1	<i>Performance Evaluation for Voice Conversion Systems</i>	<i>Ganchev T.</i>	<i>Text, Speech And Dialogue</i>	<i>Volume 5246/2008</i>	<i>Springer</i>		<i>2008</i>	<i>317-324</i>	<i>doi:10.1007/978-3-540-87391-4_41</i>	<i>Yes</i>
2	<i>Internet-Based Cognitive-Behavioral Therapy for Bulimia Nervosa: A Controlled Study</i>	<i>Fernando Fernández-Aranda</i>	<i>CyberPsychology &amp; Behavior</i>	<i>Volume: 12 Issue 1: February 10, 2009</i>	<i>Mary Ann Liebert, Inc.</i>		<i>2009</i>	<i>37-41</i>	<i>doi:10.1089/cpb.2008.0123</i>	<i>Yes</i>
3	<i>A rigid-body target design methodology for optical pose-tracking systems</i>	<i>Thomas Pintaric</i>	<i>VRST '08 Proceedings of the 2008 ACM symposium on Virtual reality software and technology</i>		<i>ACM</i>		<i>2008</i>	<i>73-76</i>	<i>doi:10.1145/1450579.1450594</i>	<i>Yes</i>
4	<i>PlayMancer: A Serious Gaming 3D Environment</i>	<i>Conconi, A.</i>	<i>Automated solutions for Cross Media Content and Multi-channel Distribution, 2008. AXMEDIS</i>	<i>17-19 Nov. 2008</i>	<i>IEEE Xplore</i>	<i>Florence</i>	<i>2008</i>	<i>111 - 117</i>	<i>doi: 10.1109/AXMEDIS.2008.29</i>	<i>Yes</i>

<sup>1</sup> A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).

<sup>2</sup> Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

			'0							
5	<i>PlayMancer: Games for Health with Accessibility in Mind</i>	Kalapanidas E.	<i>Communications &amp; Strategies</i>	<i>Vol. 73, Special Issue: New challenges for the video game industry, 31-3-2009</i>	IDATE		2009	105-120	<a href="http://www.idate.org/en/Digiworld-store/Collection/Communications-Strategies_18/No-73-New-challenges-for-the-Video-Game-Industry_379.html">http://www.idate.org/en/Digiworld-store/Collection/Communications-Strategies_18/No-73-New-challenges-for-the-Video-Game-Industry_379.html</a>	Yes
6	<i>Serious Games as additional Psychological Support: A review of the literature</i>	Juanjo Santamaria	<i>Journal of Cybertherapy and rehabilitation</i>	<i>Submitted for publication</i>						
7	<i>Full Body Interaction for Serious Games in Motor Rehabilitation</i>	Christian Schönauer	<i>AH '11 Proceedings of the 2nd Augmented Human International Conference</i>	<i>to be published</i>	ACM		2011		<i>doi:10.1145/1959826.1959830</i>	No
8	<i>Playmancer Project: A Serious Videogame as an Additional Therapy Tool for Eating and Impulse Control Disorders</i>	Susana Jiménez-Murcia	<i>Annual Review of Cybertherapy and Telemedicine - Advanced Technologies in the Behavioral, Social and Neurosciences Edited by Brenda K. Wiederhold, Giuseppe Riva</i>	<i>Volume 144, 2009</i>	IOS Press	Netherlands	2009	163-166	<i>doi:10.3233/978-1-60750-017-9-163</i>	Yes
9	<i>Meta-analysis on drugs in people with eating disorders</i>	Ana Calero-Elvira	<i>European Eating Disorders Review</i>	<i>Volume 17, Issue 4, July/August 2009</i>	Wiley		2009	243-259	<i>doi: 10.1002/erv.936</i>	No
10	<i>Comorbilidad del juego patológico: variables clínicas, personalidad y respuesta al tratamiento</i>	S. Jiménez-Murcia	<i>Revista de Psiquiatría y Salud Mental</i>	<i>2 (4), December 2009</i>	<i>psiquiatria.com</i>	<i>Barcelona, Spain</i>	2009	178-189	<a href="http://www.psiquiatria.com/articulos/tr_personalidad_y_habitos/impulsos_trastorno_control/ludopatias/45669/">http://www.psiquiatria.com/articulos/tr_personalidad_y_habitos/impulsos_trastorno_control/ludopatias/45669/</a>	Yes

11	<i>Executive functioning among female pathological gambling and bulimia nervosa patients: Preliminary findings</i>	E.M. Álvarez-Moya	<i>Journal of the International Neuropsychological Society</i>	15, 10 Feb 2009	Cambridge Journals		2009	302-306	doi:10.1017/S1355617709090377	Yes
12	<i>Lifetime substance abuse, family history of alcohol abuse/dependence and novelty seeking in eating disorders: Comparison study of eating disorder subgroups</i>	Isabel Krug	<i>Psychiatry and Clinical Neurosciences</i>	Volume 63, Issue 1, pages, February 2009	Wiley		2009	82-87	doi:10.1111/j.1440-1819.2008.01908.x	No
13	<i>Subtyping eating disordered patients along drive for thinness and depression</i>	E. Peñas-Lledó	<i>Behaviour Research and Therapy</i>	Volume 47, Issue 6, June 2009	Elsevier		2009	513-519	doi:10.1016/j.brat.2009.03.003	Yes
14	<i>Meta-analysis on drugs in people with eating disorders</i>	A. Calero	<i>European Psychiatry</i>	Volume 23, Supplement 2, April 2008, 16th AEP Congress - Abstract book, 16th AEP Congress	Elsevier		2008	S184		Yes
15	<i>Predictors of early change in bulimia nervosa after a brief psychoeducational therapy</i>	Fernando Fernández-Aranda	<i>Appetite</i>	Volume 52, Issue 3, June 2009	Elsevier		2009	805-808	doi:10.1016/j.appet.2009.03.013	Yes
16	<i>Male eating disorders and therapy: A controlled pilot study with one year follow-up</i>	Fernando Fernández-Aranda	<i>Journal of Behavior Therapy and Experimental Psychiatry</i>	Volume 40, Issue 3, September 2009	Elsevier		2009	479-486	doi:10.1016/j.jbtep.2009.06.004	Yes
17	<i>Age of Onset in Pathological Gambling: Clinical, Therapeutic and Personality Correlates</i>	Susana Jiménez-Murcia	<i>Journal Of Gambling Studies</i>	Volume 26, Number 2, January 2010	Springer		2010	235-248	doi:10.1007/s10899-009-9175-3	Yes
18	<i>Motivation to change and pathological gambling: Analysis of the relationship with clinical and psychopathological variables</i>	Mónica Gómez-Peña	<i>British Journal of Clinical Psychology</i>	Article first published online: 2 MAR 2011	Wiley		2011		doi:10.1348/014466510X511006	No
19	<i>Social anxiety in the eating disorders: relationship with</i>	Peñas-Lledó, E.	<i>Journal of Anxiety</i>	24 (7), Epub 2010 May 26	Elsevier		2011	767-773		

	<i>eating and personality features. Journal of Anxiety Disorders</i>		<i>Disorders</i>						
20	<i>Subtyping Study of a Male Pathological Gambling Sample</i>	<i>Eva M Alvarez-Moya</i>	<i>Canadian Journal of Psychiatry</i>	<i>55(8), August 2010</i>	<i>CPA</i>	<i>Canada</i>		<i>498-506</i>	

## 2.1.2 Demonstrations, Exhibitions and Conferences

**Table 6: Template A2- List Of Dissemination Activities**

TEMPLATE A2: LIST OF DISSEMINATION ACTIVITIES								
NO.	Type of activities <sup>7</sup>	Main leader	Title	Date	Place	Type of audience <sup>8</sup>	Size of audience	Countries addressed
1	Conference	<i>T. Kostoulas</i>	<i>A Real-World Emotional Speech Corpus for Modern Greek</i>	<i>May 28-30, 2008</i>	<i>Morocco</i>	<i>Scientific Community</i>		<i>International</i>
2	Conference	<i>Susana Jiménez-Murcia</i>	<i>Playmancer project: a serious videogame as additional therapy tool for eating and impulse</i>	<i>Jun 21 - 23, 2009</i>	<i>Villa Caramora,</i>	<i>Scientific Community</i>	<i>Annual CyberTherapy and</i>	<i>International</i>

<sup>3</sup> A permanent identifier should be a persistent link to the published version full text if open access or abstract if article is pay per view) or to the final manuscript accepted for publication (link to article in repository).

<sup>4</sup> Open Access is defined as free of charge access for anyone via Internet. Please answer "yes" if the open access to the publication is already established and also if the embargo period for open access is not yet over but you intend to establish open access afterwards.

<sup>7</sup> A drop down list allows choosing the dissemination activity: publications, conferences, workshops, web, press releases, flyers, articles published in the popular press, videos, media briefings, presentations, exhibitions, thesis, interviews, films, TV clips, posters, Other.

<sup>8</sup> A drop down list allows choosing the type of public: Scientific Community (higher education, Research), Industry, Civil Society, Policy makers, Medias ('multiple choices' is possible).

			<i>control disorders</i>		<i>Italy</i>		<i>CyberPsychology 2009 conference</i>	
3	Conference		<i>Serious videogames as therapeutical tool for mental disorders: enhanced human computer interaction in PlayMancer</i>	<i>July 15-17, 2009</i>	<i>Barcelona, Spain</i>	<i>Scientific Community</i>	<i>13th International Conference of on Information Visualisation (VIZ09)</i>	<i>International</i>
4	Conference	<i>Soto A.</i>	<i>A Review of Serious Games as Psychological Support in Health</i>	<i>July 15-17, 2009</i>	<i>Barcelona, Spain</i>	<i>Scientific Community</i>	<i>13th International Conference of on Information Visualisation (VIZ09)</i>	<i>International</i>
5	Conference	<i>F. Fernández-Aranda</i>	<i>Playmancer project: A serious videogame as additional therapy tool for eating disorders</i>	<i>September 11-13, 2009</i>	<i>London, UK</i>	<i>Scientific Community</i>	<i>In symposium (Chair U. Schmidt) New Technologies in the treatment of eating disorders. European Council on Eating Disorders</i>	<i>International</i>
6	Conference	<i>Kostoulas T.</i>	<i>The PlayMancer Database: A Multimodal Affect Database in Support of Research and Development Activities in Serious Game Environment</i>	<i>May 19-21, 2010</i>	<i>Valletta, Malta</i>	<i>Scientific Community</i>	<i>Seventh conference on International Language Resources and Evaluation (LREC'10)</i>	<i>International</i>
7	Conference	<i>Kalapanidas E.</i>	<i>Ωφέλιμα παιχνίδια ως εργαλείο αντιμετώπισης της επεισοδιακής υπερφαγίας: Το ερευνητικό έργο PlayMancer (in Greek)</i>	<i>October 29-30, 2010</i>	<i>Corfu, Greece</i>	<i>Scientific Community</i>	<i>10th Corfu International Obesity Congress 2010</i>	<i>Greece</i>
8	Conference	<i>F. Fernández-Aranda</i>	<i>A Serious videogame as additional therapy tool for pathological gambling: Playmancer Multicenter European Project</i>	<i>October 2010</i>		<i>Scientific Community</i>	<i>2010 11TH ANNUAL NCRG CONFERENCE ON GAMBLING AND ADDICTION</i>	<i>International</i>
9	Conference	<i>Fernando Fernández-Aranda</i>	<i>A Serious Videogame as additional therapy tool for Eating disorders: PlayMancer EU project</i>	<i>November 12-14, 2009</i>	<i>Universidade do Minho, Braga, Portugal</i>	<i>Scientific Community</i>	<i>INTACT International Symposium- The Dynamics of Eating Disorders: Towards a better understanding of the processes of falling ill, getting well and staying well</i>	<i>International</i>
10	Conference	<i>Fernando Fernández-Aranda</i>	<i>Playmancer project: A serious videogame as additional therapy tool for eating disorders</i>	<i>11-13 September, 2009</i>	<i>London, UK</i>	<i>Scientific Community</i>	<i>Symposium (Chair U. Schmidt) New Technologies in the treatment of eating disorders. European Council on Eating Disorders</i>	<i>International</i>
11	Conference	<i>Juan J. Santamaria</i>	<i>A serious videogame as additional therapy tool for bulimia nervosa and binge eating disorders: PLAYMANCER EU Project</i>	<i>November 25 – 27, 2009</i>	<i>Isla de la Toja, Santiago de Compostela, Spain</i>	<i>Scientific Community</i>	<i>III Simposium Internacional del CIBER Fisisopatología de la Obesidad y Nutrición</i>	<i>International</i>
12	Workshop; Poster	<i>Fernando Fernandez</i>	<i>Utilización de videojuegos como herramienta terapéutica en salud mental: Proyecto Playmancer</i>	<i>December 2009</i>	<i>Sant Boi, Barcelona, Spain</i>	<i>Scientific Community</i>	<i>Roundtable discussion: Las TICs en diagnóstico, terapia y seguimiento en salud mental (II): aplicaciones de realidad virtual y Videojuegos</i>	<i>Spain</i>

13	Workshop	Jiménez-Murcia, S	Tratamiento de la Adicción a la Nuevas Tecnologías	November 25-26, 2010	Sevilla, Spain	Scientific Community	Panel de Experiencias, Consejería de Igualdad y Bienestar Social	Spain
14	Conference	Fernando Fernández-Aranda	PlayMancer project: A Serious Videogame as additional therapy tool for Eating disorders	June 12, 2010	Salzburg, Austria	Scientific Community	Academy for Eating Disorders	International
15	Conference	Susana Jiménez-Murcia	A serious videogame as additional therapy tool for obesity and binge eating disorders: PlayMancer multicenter European project	July 11-15, 2010	Stockholm, Sweden	Scientific Community	International Congress of Obesity	International
16	Workshop	Fernando Fernandez-Aranda	Videojuegos como herramienta terapéutica en Trastornos de la alimentación: Proyecto europeo Playmancer	July 21, 2010	Alicante, Spain	Scientific Community	Cursos de Verano	Spain
17	Conference		Playmancer project: A Serious Videogame as additional therapy tool for Eating and Impulse control disorders	June 21-23, 2010	Verbania-Intra, Italy	Scientific Community	14th. Annual Cybertherapy & Cyberpsychology	International
18	Conference	Kocsis, O.	Serious videogames as therapeutical tool for mental disorders: enhanced human computer interaction in PlayMancer	July 15-17, 2010	Barcelona, Spain	Scientific Community	13th International Conference of on Information Visualisation (VIZ09)	International
19	Conference	Antonio Soto	A Review of Serious Games as Psychological Support in Health	July 15-17, 2010	Barcelona, Spain	Scientific Community	13th International Conference of on Information Visualisation (VIZ09)	International
20	Conference	Fernando Fernández-Aranda	A serious videogame as additional therapy tool for bulimia nervosa and binge eating disorders: Playmancer multicenter European Project	October 7-9, 2010	Boston, USA	Scientific Community	Eating Disorders Research Society 16th Annual Meeting	International
21	Conference	Fernando Fernández-Aranda	A Serious Videogame as Additional Therapy Tool for Pathological Gambling: Playmancer Multicenter European Project	November 14-15, 2010	Las Vegas, USA	Scientific Community	Annual NCRG Conference on Gambling and Addiction: Redefining Diagnosis, Treatment, Research and Responsible Gaming for the 21st Century.	International
22	Conference	C. Schönauer	Chronic Pain Rehabilitation with a Serious Game using Multimodal Input	2011 (submitted)		Scientific Community	Submitted to International Conference on Virtual Rehabilitation (ICVR)	International
23	Conference	C. Schönauer	Full Body Interaction for Serious Games in Motor Rehabilitation	March 12-14, 2011	Tokyo, Japan	Scientific Community	Augmented Human Conference	International
24	Workshop	Fernando Fernández-Aranda	Playmancer European Project: A New-generation Videogame for Treating Eating disorders and Impulse control disorders	8-10 March, 2011	Barcelona, Spain	Scientific Community	HICT 2011: International Forum on Health Care and Information Communication Technology	International
25	TV clip; interview	Project members	Euronews futuris TV report on PlayMancer: Games for Health	January 13-19, 2011	Spain, Netherlands	Public	Millions	Europe
26	TV clip; interview	Fernando Fernández-	French TF1 TV channel report	February 15, 2011	Spain	Public	Millions	France

		<i>Aranda</i>						
27	<i>TV clip; interview; press release</i>	<i>Fernando Fernández- Aranda</i>	<i>Spanish TV3 TV channel report</i>	<i>February 8, 2011</i>	<i>Spain</i>	<i>Public</i>	<i>Millions</i>	<i>Spain</i>
28	<i>TV clip; interview; press release</i>	<i>Fernando Fernández- Aranda</i>	<i>Spanish TV TVE channel report</i>	<i>February 7, 2011</i>	<i>Spain</i>	<i>Public</i>	<i>Millions</i>	<i>Spain</i>
29	<i>TV clip; interview; press release</i>	<i>Fernando Fernández- Aranda</i>	<i>Spanish TV Tele 5 channel report</i>	<i>February 7, 2011</i>	<i>Spain</i>	<i>Public</i>	<i>Millions</i>	<i>Spain</i>
30	<i>TV clip; interview; press release</i>	<i>Fernando Fernández- Aranda</i>	<i>Spanish TV Antena 3 channel report</i>	<i>February 7, 2011</i>	<i>Spain</i>	<i>Public</i>	<i>Millions</i>	<i>Spain</i>
31	<i>interview</i>	<i>Elias Kalapanidas</i>	<i>The World -- BBC/WGBH/PRI; story about PlayMancer</i>	<i>February 8, 2011</i>	<i>Brussels, Belgium</i>	<i>Public</i>		<i>USA, Europe</i>
32	<i>Interview; press release</i>	<i>Fernando Fernández- Aranda</i>	<i>RAC 1 Radio Station project report</i>	<i>February 7, 2011</i>	<i>Spain</i>	<i>Public</i>		<i>Spain</i>
33	<i>Interview; press release</i>	<i>Fernando Fernández- Aranda</i>	<i>Catalunya Ràdio Station project report</i>	<i>February 7, 2011</i>	<i>Spain</i>	<i>Public</i>		<i>Spain</i>
34	<i>Interview; press release</i>	<i>Fernando Fernández- Aranda</i>	<i>COM Ràdio Station project report</i>	<i>February 7, 2011</i>	<i>Spain</i>	<i>Public</i>		<i>Spain</i>
35	<i>Interview; press release</i>	<i>Fernando Fernández- Aranda</i>	<i>EFE Televisió Station project report</i>	<i>February 7, 2011</i>	<i>Spain</i>	<i>Public</i>		<i>Spain</i>
36	<i>Interview; press release</i>	<i>Fernando Fernández- Aranda</i>	<i>Ràdio 4 Station project report</i>	<i>February 7, 2011</i>	<i>Spain</i>	<i>Public</i>		<i>Spain</i>
37	<i>Interview; press release</i>	<i>Fernando Fernández- Aranda</i>	<i>Cadena SER Station project report</i>	<i>February 7, 2011</i>	<i>Spain</i>	<i>Public</i>		<i>Spain</i>
38	<i>Interview; press release</i>	<i>Fernando Fernández- Aranda</i>	<i>El Hospital de Bellvitge desarrolla juegos de ordenador con fines terapéuticos, La Vanguardia newspaper</i>	<i>26 January, 2009</i>	<i>Spain</i>	<i>Public</i>	<i>Millions</i>	<i>Spain</i>
39	<i>Interview;</i>	<i>Fernando</i>	<i>Videojuegos que sanan la mente, El País</i>	<i>February 7, 2011</i>	<i>Spain</i>	<i>Public</i>	<i>Millions</i>	<i>Spain</i>

	<i>press release</i>	<i>Fernández-Aranda</i>	<i>newspaper</i>					
40	<i>Exhibition</i>	<i>Elias Kalapanidas</i>	<i>ICT 2010 exhibition area</i>	<i>27-29 September, 2010</i>	<i>Brussels, Belgium</i>	<i>Registered; Public</i>	<i>Thousands</i>	<i>PanEuropean; Europe</i>
41	<i>Workshop</i>	<i>K. Karpouzis</i>	<i>"R&amp;D in Serious Games", Networked Session in ICT 2010</i>	<i>29 September 2010</i>	<i>Brussels, Belgium</i>	<i>Registered; Public</i>	<i>Thousands</i>	<i>PanEuropean; Europe</i>
42	<i>Press release</i>	<i>Elias Kalapanidas</i>	<i>ICT Results</i>	<i>6 March, 2009</i>		<i>Public</i>	<i>Millions</i>	<i>PanEuropean; Europe</i>
43	<i>Conference</i>	<i>M. Vollenbroek - Hutten</i>	<i>Technology supported training for rehabilitation</i>	<i>23 march 2011</i>	<i>The Hague, The Netherlands</i>	<i>Scientific Community</i>	<i>Symposium Br@ins &amp; G@mes</i>	<i>Dutch</i>

## 2.2 Section B

**Table 7: Template B2 - List Of Exploitable Foreground**

Type of Exploitable Foreground <sup>9</sup>	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application <sup>10</sup>	Timetable, commercial or any other use	Patents or other exploitation (licences)	Owner & Other Beneficiary(s) involved
<i>Commercial exploitation</i>	Serious game for mental health	YES						Project consortium
<i>Commercial exploitation</i>	Serious game for pain rehabilitation	YES						Project consortium
<i>General advancement of Knowledge</i>	Game design for mental health patients	NO						SGI, IDIBELL, ST
<i>General advancement of Knowledge</i>	Game design for pain rehabilitation patients	NO						SGI, RRD, ST
<i>Commercial exploitation</i>	PlayMancer Serious Games assets	YES						SGI, ST
<i>General advancement of Knowledge</i>	Bio-feedback-based emotion recognition	NO						UNIGE

<sup>9</sup> A drop down list allows choosing the type of foreground: General advancement of knowledge, Commercial exploitation of R&D results, Exploitation of R&D results via standards, exploitation of results through EU policies, exploitation of results through (social) innovation.

<sup>10</sup> A drop down list allows choosing the type sector (NACE nomenclature) : [http://ec.europa.eu/competition/mergers/cases/index/nace\\_all.html](http://ec.europa.eu/competition/mergers/cases/index/nace_all.html)

Type of Exploitable Foreground <sup>9</sup>	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application <sup>10</sup>	Timetable, commercial or any other use	Patents or other exploitation (licences)	Owner & Other Beneficiary(s) involved
General advancement of Knowledge	Speech-based emotion recognition	NO					RESULTS PUBLISHED	UoP
General advancement of Knowledge	Visual facial expressions-based emotion recognition	NO					RESULTS PUBLISHED	UNIGE
General advancement of Knowledge	Emotion recognition fusion	NO						UNIGE
General advancement of Knowledge	PlayMancer emotion recognition database	NO					RESULTS PUBLISHED	UoP, IDIBELL, LREC
Commercial exploitation	Low-cost Motion capture system	YES						TUW
Commercial exploitation	Multi-sensor signal fusion	YES						TUW
Commercial exploitation	Unity 3D emotion recognition input	YES						SGI
Commercial exploitation	Unity 3D human player motion input	YES						SGI
General advancement of Knowledge	Game Automatic Speech Recognition	NO						UoP

Type of Exploitable Foreground <sup>9</sup>	Description of exploitable foreground	Confidential Click on YES/NO	Foreseen embargo date dd/mm/yyyy	Exploitable product(s) or measure(s)	Sector(s) of application <sup>10</sup>	Timetable, commercial or any other use	Patents or other exploitation (licences) or IPR	Owner & Other Beneficiary(s) involved
<i>General advancement of Knowledge</i>	Field trial results on the use of the PlayMancer serious game for mental health patients	<b>NO</b>					<b>PUBLICLY AVAILABLE</b>	<b>IDIBELL</b>
<i>General advancement of Knowledge</i>	Field trial results on the use of the PlayMancer serious game for chronic pain rehabilitation	<b>NO</b>					<b>PUBLICLY AVAILABLE</b>	<b>RRD</b>

*In addition to the table, please provide a text to explain the exploitable foreground, in particular:*

- *Its purpose*
- *How the foreground might be exploited, when and by whom*
- *IPR exploitable measures taken or intended*
- *Further research necessary, if any*
- *Potential/expected impact (quantify where possible)*

### 3 REFERENCES

- 1 Schönauer C., Jansen – Kosterink S., Pintaric T., Vollenbroek Hutten M., and Kaufmann H. (2011). Chronic Pain Rehabilitation with a Serious Game using Multimodal Input. In Proceedings of *International Conference on Virtual Rehabilitation*, Zurich, Switzerland.

Del. no.	Deliverable name	Availability	Available from
D7.1	PlayMancer Web site deployment	Public	Project Site, Public Area
D7.2	Dissemination and communication plan report	Restricted	Project Site, Members' Area, please contact maria.vassiou@systema.gr
D1.1	Serious game development Standards and Policies	Public	Project Site, Public Area
D2.1	User requirements, game scenarios, system specification and architecture	Public	Project Site, Public Area
D2.2	Evaluation methodology for technical assessment and pilot trials	Public	Project Site, Public Area
D4.1	Report of PlayMancer gaming platform development	Public	Project Site, Public Area
D6.1	Report on the development of 3D content sharing and game distribution services	Restricted	Project Site, Members' Area, please contact maria.vassiou@systema.gr
D2.4	Refined requirements and specifications	Public	Project Site, Public Area
D3.1	Transition from functional to technical requirements and optimised architecture specification of an affective game platform	Public	Project Site, Public Area

D3.2	Intermediate Playmancer 3D dialogue-enabled game engine prototype	Restricted	Project Site, Members' Area, please contact maria.vassiou@systema.gr
D4.2	Intermediate PlayMancer gaming platform prototype	Restricted	Project Site, Members' Area, please contact maria.vassiou@systema.gr
D8.1	Intermediate PlayMancer evaluation results	Public	Project Site, Public Area
D5.5	Intermediate PlayMancer Games for behavioural and addictive disorders and motor-rehabilitation	Restricted	Project Site, Members' Area, please contact maria.vassiou@systema.gr
D4.3	Final PlayMancer gaming platform prototype	Public	Project Site, Public Area
D3.3	Final Playmancer 3D dialogue-enabled game engine prototype	Public	Project Site, Public Area
D5.4	PlayMancer Games development report and manual	Public	Project Site, Public Area
D5.6	Final PlayMancer Games for behavioural and addictive disorders and motor-rehabilitation	Restricted	Project Site, Members' Area, please contact maria.vassiou@systema.gr
D5.6.1	Final PlayMancer Games for behavioural and addictive disorders and motor-rehabilitation	Public	Project Site, Public Area
D7.3	Final Plan for using and disseminating knowledge	Restricted	Project Site, Members' Area, please contact maria.vassiou@systema.gr
D7.3.1	Final Plan for using and disseminating knowledge	Public	Project Site, Public Area
D7.4	Awareness and wider societal implications	Public	Project Site, Public Area
D8.2	Final PlayMancer evaluation results	Public	Project Site, Public Area
D1.2	Final report	Public	Project Site, Public Area
D7.6	PlayMancer achievements, workshop proceedings and showcase web site	Public	Project Site, Public Area