Integrated Project on Interaction and Presence in Urban Environments

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Second Prototype of TimeWarp Application

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Table of Content

Abstract

This document describes the third year of research within the *TimeWarp* subproject of IPCity. *TimeWarp* concentrates on mixed reality game experience in an urban context. The aim of the project is to develop a game that makes use of state-of-the-art AR technology and implements variious presence concepts such as the use of sound or virtual characters.

The specific objectives for TimeWarp are:

- To advance the infrastructure and gameplay by:
  - Providing a more convenient, intuitive and reliable interface
  - Improving the gaming experience to get a more joyful and exciting adventure to reach a stronger identification with the situation and environment and thus enhance the cross-reality presence

- To develop and evaluate concepts and tools to gain a stronger presence experience by:
  - Evaluating different display techniques regarding the influence of the presence experience
  - Supporting and using spatial sound
  - Exploring and applying techniques for advanced visualization

Intended Audience

This document is intended to all partners of the project, the EC, and to the reviewers for the third project's phase.

1 Workpackage Objectives

Objectives Phase III	During phase II we have redesigned *TimeWarp* according to the findings of Phase II. The objectives of the redesign was to advance the infrastructure and gameplay by improving the interface and the gaming experience.
Results Phase III	The results of the redesign phase III comprised of improvements and modifications regarding the following parts: • AR system and devices • Realization and implementation • Game Design and Game Play • Interface Elements • Level Design and Challenges • Narrative Structures • Sound Desing Certain tests were conducted to explore aspects related to presence (see WP3). We extended the existing measurement techniques to include aspects relevant to the new design.
Evaluation Results Phase III	• Further developed our testing approaches to include collaborative aspects ad other themes from WP3. The semi-structured interview approach was also modified. • Completed a study of the *TimeWarp* systems, resulting in some guidelines how to shape city MR games.
Objectives Phase IV	During phase IV we will: ▪ Redesigned TimeWarp according to the findings of Phase III

2 Related Work on Game Design

While computer games have been around for several decades it is only recently that game studies has developed into an academic research area. In addition to research areas such as social science and technological fields there is also an interest in the abstract elements that when combined with each other constitute a game.

The terminology in the field of computer game studies is still evolving. There are a number of game designers and authors who have different understandings of what constitutes a game. Salen and Zimmermann (Salen, K., et al., Rules of Play – Game Design Fundamentals. The MIT Press, Cambridge, 2004) explored the most prominent definitions and summarized them, describing games as “a system in which players engage in an artificial conflict, defined by rules, that results in a quantifiable outcome”. The term “game design” in that context is defined as “the process by which a game designer creates a game, to be encountered by a player, from which meaningful play emerges”.

Several people have stated that game design still lacks its own discipline. This often results in other areas such as theatre and drama playing a part in shaping the discussion. As one of the early people in the field Costikyan (Costikyan, G., I Have No Words & I Must Design. http://www.costik.com/nowords.html (August 2008) stated that game designers need a way to analyze games and try to understand how they are working and what makes them interesting. His claim that games are in need of a critical language is a fundamental step towards the development of a discipline for games and the creation of unique game design methods.

The views of Costikyan are expanded on by Church (Church, D., Formal Abstract Design Tools. In: Game Developer, Volume3, Issue 28, August 1999), who said that a proper design vocabulary would enable one “to talk about the underlying components of a game”. Churchs’ so called Formal Abstract Design Tools (FADTs) are the first serious attempt to collect knowledge of abstracted game components for creating and analyzing games. He stated that “FADTs are not bricks to build a game out of”, but they should be regarded as tools that can be used to shape a game with. Although FADTs got quite some recognition in academia, only 25 with varying quality have been publicly collected until 2002. FADTs however served as a basis for LeBlanc’s framework of Mechanics, Dynamics and Aesthetics (LeBlanc, M., Tools for Creating Dramatic Game Dynamics. In: Salen K. & Zimmermann, E. (eds.), The Game Design Reader: A Rules of Play Anthology. MIT Press, Cambridge MA, 2006) that allows viewing at a game from different perspectives.

A related approach that is indeed to support game design is from the 400 Project of Falstein and Barwood (THE 400 PROJECT, http://www.theinspiracy.com/400_project.htm (September 2008)). The project was initiated in 2001 with the objective of collecting 400 rules for game design. Each rule is an imperative statement, that a game designer can follow or not and can build hierarchical structures to related rules. As a by product of this approach it names a large number of game components. However the lack of a proper framework combined with the fact that it is a record of knowledge makes it static and perhaps even inappropriate when applied to mobile and pervasive games The current list consists of 112 rules, but has not been updated since March 2006.

Kreimeier (Kreimeier, B., Game Design Methods: A 2003 Survey. http://www.cs.columbia.edu/~dsturman/cs6998-8/kreimeier_pfv.htm (August 2008) takes a similar approach to Church and states that game developers do not lack only of a proper vocabulary to name the objects created during game development, but also a framework that might express how these objects relate to each other. To meet these requirements Kreimeier suggests using a format based on the Architectural Design Patterns of Alexander, where each pattern names a problem, solution to that problem and describes its consequences. Kreimeier provided only seven of his so-called Game Design Patterns.

Another approach of the same name has been initiated by Björk and Holopainen (Björk, S., Holopainen, J., Games and Design Patterns. In: Salen, K. & Zimmermann, E. (eds), The Game Design Reader: A Rules of Play Anthology. MIT Press, Cambridge MA, 2006). Their

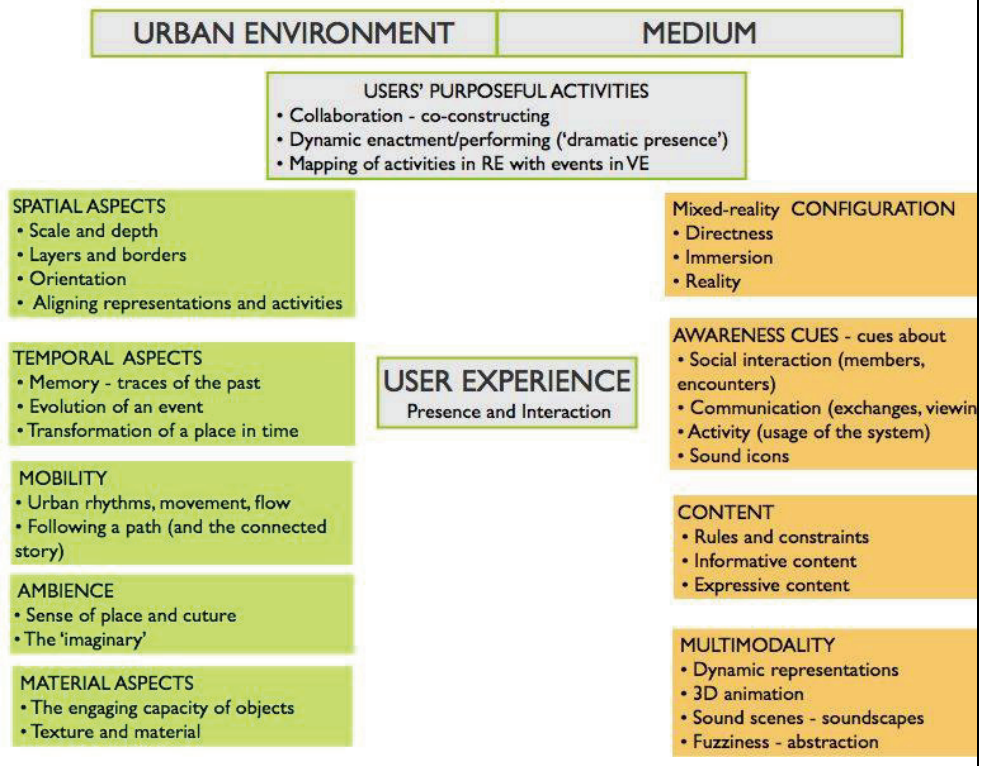
effort is to provide a unified approach that would enable communication, analysis and design within an interdisciplinary environment. They claim that the focus of game research should be on “gameplay”, as this term does not only describe functional but also experiential aspects of a game. Gameplay is rather abstractly defined “as the structures of the player interaction with the game system and with other players in the game”. Björk and Holopainens ’model contains two parts. The first is a gameplay-centric component framework that names the basic buildings blocks of games with respect to gameplay. The framework makes it possible to look at different layers of a game’s structure like play times, physical object representations or rules. The second are game design patterns (more recently described as gameplay design patterns) that, partially based on former work about game mechanics, describe the relations between the components of the component framework. The pattern format shares some similarities with Alexander’s and Kreimeier’s patterns, but has some fundamental differences. Gameplay design patterns are “semiformalized interdependent descriptions of commonly reoccuring parts of the design of a game that concern gameplay” and do not focus the problem-solving-pairs of other pattern-formats anymore. Instead the interaction-structure is named and linked to related structures. During the last years the approach of Björk and Holopainen found excessive use in various branches of game studies. Following the initial collection of gameplay design patterns for all kinds of games, additional pattern collections have been created, that amongst others formulate the characteristics of mobile and pervasive games. The current amount of available gameplay design patterns exceeds 400. Gameplay design patterns have already been used in several studies concerning game analysis and game design.

Overview and Concept Map

Within year 3 of the project our primary intention of testing the technologies was to explore further the complex relationships which exist between the real and virtual elements of the experience. This was further extended into exploring how the new TimeWarp design (using UMPC's rather than HMD's) and the more collaborative nature of the game would alter the users behaviour. While a more thorough description of the study and results can be found in D3.4, a short summary is provided within the table in section 3.1 and also a description of how this relates to the concept map. We used a similar range of evaluation techniques as were adopted in the previous study, however they were extended to include aspects specifically relating to the new design of TimeWarp

2.1 Relationship to IPCity's Conceptual Map

The intention is to evaluate TimeWarp from a range of perspectives as outlined in the presence concept map in WP3. The underlying interest is to explore how the mixed-reality aspects of TimeWarp influence user perception and behaviour within the environment – an initial set of research questions for the first prototype are outlined and answered below.

WP3 Presence Concept Map	Based on the concept map outlined in WP3 *TimeWarp* focuses on the following presence research:  In addition to this issues, *TimeWarp* will analyse following topics based on the game play experience: Fantasy (~ Urban Environment): theme, characters, exploration Challenges (~ Activities): controlling, solving, winning Audio-visual (~ Medium): graphics, sound, music (= multi-modal content)

Relationship To concept map	**Collaboration** • Two players each with differing roles take part in the game and must ***collaborate*** in order to complete the game. Their roles are shaped by the equipment they are given at the start of the game, however they are free to swap over as the game continues. This gives rise to them assuming various problem solving strategies and thus how they understand the experience through which they ***align the real and virtual*** aspects. **Spatial Aspects** • Players ***orientate*** themselves simultaneously in a blended reality, as they walk around they need to orientate in physical, virtual and temporal space. Thus experience new realities which are blended, or experience ***layers and borders*** between them as they move between time periods and locations. As activities take place in multiple dimensions they are required to ***align their behaviour*** with the mixed reality space they now find themselves in. these layers and borders are implemented through graphical and auditory aspects such as building objects or narratives. **Temporal Aspects** • Augmented objects, buildings and characters provide clues as to what a given location was like in the past present or future. Thus providing links to ***traces of the past*** or how a location will or has ***change over time***. One intersting aspect relates to the framing of such experiences (in particular how past experiences improves believablily and presence), for example it is impossible to know what the future will look like, hence as noted in the study people were starkly divided on their experience of the future time period. **Mobility** • TimeWarp takes places in a preset area consisting of many locations, between which the players must walk. Therefore path structures (by this we mean in the blended or real spaces) becomes important – as they can be used to provide a ***connected story*** between locations. The use of path structures within the game to improve narratives elements was only considered on a basic level in this prototype, but this will be expanded in the final year prototype. **Ambience** • Various lcoations were selected to provide a strong ***sense of ambience***, for example Cologne Cathedral and the City Hall – where weddings often took place during the studies. The nature of the ***places*** and the blends created through the mixed reality elements formed an important part of the game. For example players were willing to undertake tasks only when their actions were deemed suitable within the given place, for example not undertaking certain acts when weddings took place. **Awareness Cues** • Awareness cues relating to non-player characters, locations and objects are provide through ***sound and visual*** cues. Sounds become closers as users appoach the preset location, narratives are also used to alert users to game elements. **Content** • Beyond contracts on how to interact with the technology and battery life there are no hard and fast limits on game play. The primary content oriented ***constraints*** related to the size of the area in which the game takes place – however they can leave this if they desire. This constraint is reinforced through the use of the map and sound cues, all which try to make sure the user stays within the game location.

	Multimodality • Reality is altered through providing a lens into the new world, this takes the form of augmenting a video stream on a UMPC with augmented objects.
Concepts	
Activities:	The above aspects will be evaluated and tested using relevant techniques.

2.2 Evaluation plan

For *TimeWarp* a combinatory approach was developed, which would use post-experience analysis as well as data from the actual experiences. To achieve this, questionnaires, interviews, direct observation and video analysis were used. Several Presence questionnaires were combined and adapted by adding specific questions. While the majority of users were video recorded, some were also observed as they took part in the game. For this we adapted an observation technique developed within *IPerG* (Integrated Project on Pervasive Gaming), and used it to consider which notes were taken and also to act as a method of analysis for the videos. The study had a range of objectives to analyse the game play itself, explore presence aspects and uncover technical issues. There was also a desire to explore the measurement methods and how they reflect the view of presence espoused by IPCity, in particular how they explore themes such as collaboration and temporal presence.

Evaluation Preparatory Work:	**Selecting participants – diverse groups,** in total diverse of people took part in the study, ranging from students to professionals. **Evaluate game scenario (including content) with test users** **Define observation techniques and criteria**. Our criteria was to explore similar aspects to the previous year but with addition to reflect the changes made during year 3.
Evaluation Methods:	**Video observation** Participants were recorded during their participation, we tried to be as non-instrusive as possible. **Direct Observation.** Where possible an additional evaluator took part and noted down any interesting observations. **Presence questionnaire.** We improved on the methods used in the previous year by altering the questionnaires to reflect issues specifically relating to the new game style. Of particular interest were the collaborative aspects. **Semi-structured interviews** Based on the data obtained from the questionnaires direct and video observation we will conduct semi-structured interviews with selected participants.

3 Review of year 2 results

The evaluation of the year 2 prototype yielded as result the definition of nine design guidelines. These guidelines are:

1. Understand Attention Allocation
2. Simplify the Interaction Scheme
3. User Safety
4. Design appropriate paths through the environment
5. Understand the Locale
6. Interaction with Others
7. Seamful Design
8. Use a combination of real and virtual objects
9. Provide a continuous experience

For redesigning the year 3 prototype the guidelines were applied or further developed to reflect aspects of the game. We focused on three aspects of the concept map namely enhancing social, temporal and spatial aspects. Spatial aspects were enhanced by additional audio clues and sound items. The introduction of these sound and audio objects fulfill also the requirements of guidelines 1, 3, 5 and 9. Guideline 9 will also be implemented by reducing the game area. A smaller area results in shorter distances and thus in a more continuous game experience. The experience of spatial presence will also be supported by a narrative structure in form of a speaker. A story-telling character was added to guide the players through the environment. This serves on the one hand guideline 4 which ask for appropriate paths through the environment and on the other hand guideline 5. The simplification of the interaction scheme (guideline 2) is achieved by reducing the interaction controls and by introducing shared user interaction via a cooperative two-player game. The introduction of a cooperative two-player game serves also guideline 6 which asks for interaction with others.

The temporal presence is supported by explanatory audio comments (1, 5) and underlying ambient sounds (8). Furthermore additional virtual 3D objects enhance the temporal presence experience (8, 9). An improved tracking enables also a better impression of temporal presence. The introduction of a multi-user mechanism and the usage of less obtrusive equipment makes the experience of social presence much better.

4 Year 3 Prototype

4.1 Overview

TimeWarp is an outdoor Mixed Reality game that allows for exploring the history of a city using AR and mobile devices. The background of TimeWarp is the tale of the Heinzelmännchen (HM) of Cologne. The tale is about these small elves, which helped (although they were actually never observed) the citizens of Cologne during the night, until they suddenly disappeared. Rumor has it that they disappeared because they were trapped by a nosy tailor's wife.

We extended this legend by spreading the rumor that the elves actually never left Cologne, but fell into time holes. Thus, they are still in the city, but they are captured in different time periods. The goal of the game for each player is to find the Heinzelmännchen within the individual epochs by the means of time travel and bring them back into the present. Therefore, each player is equipped with a "magic technical" system, which enables her to see the elves and to visit different time periods – roman, medieval, new age and even the future. To rescue the so much missed small helpers, the player has to solve challenges presented by the elves.

4.2 AR system and devices

4.2.1 Mobile AR system

The Mobile AR System augments the real world with graphics and sounds by incorporating a mobile device and open headphones.

For the year 3 prototype the mobile AR system used a handheld mobile device instead of a backpacked laptop. This decision came from the findings of the year 2 study. The obtrusiveness of the visor results in a disadvantage for social presence. Furthermore, the bad visibility with the see-through display was another reason for using a handheld mobile device. A usability and presence test comparing several devices will be described in section 5.2.3.

A *Sony Vaio VGN-UX280P* Ultra Mobile PC (UMPC) was used as mobile AR system (see Fig. 2). The device provide several buttons which were used for interaction (section 5.5)

Figure 1 An Ultra mobile PC was used as mobile AR system for the year 3 prototype.

Poor tracking had negative impacts on spatial and temporal presence, however this was improved by integrating a new device. A *xSens MTi-G* sensor (Fig. 3), which is a combined inertial and GPS sensor with an integrated Kalman filter replaced an InterSense IntertiaCube and a separated GPS sensor.

Figure 2 xSens MTi-G sensor

The combination of the inertial and GPS sensors together with the integrated Kalman filter improved the tracking results significantly. Figure 4 shows the results of the year 2 tracking realized with two separated sensors on the left, and the results with the xSens tracker on the right. It is obvious that the disturbances and the failures of the results is much more higher with the year 2 tracking on the left side, where two sensors were used. The Kalman filter enable smoothed tracking values and provide much more precise results.

We also conducted tests to improve the GPS-based positioning by correcting the results using the European Geostationary Navigation Overlay Service (EGNOS) which is a satellite-based differential global positioning system. We were able to improve the results with the year 2 tracking devices. But using the xSens tracker in combination with the Kalman filter, the resulted values were falsified by EGNOS. The best results were obtained the xSens device without EGNOS.

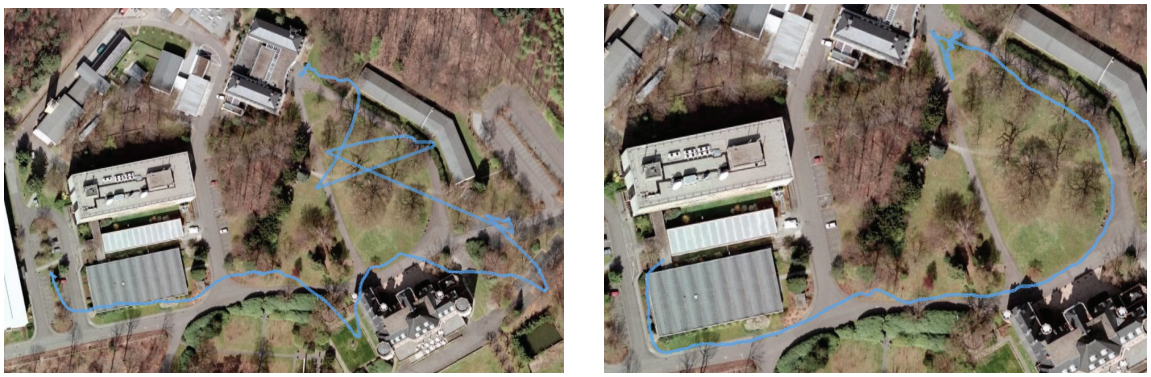


Figure 3 Comparison of tracking results of the year 2 prototype (left) and of the year 3 prototype (right)

Nevertheless, it was impossible to prevent all problems which may occur using GPS-based positioning in urban environments. We still had some problems with jittering when the GPS reception suffer from the lack of a clear line of sight, caused by streets cutting through dense blocks of buildings or a cloudy weather situation.

Since the jittering makes the interaction with virtual objects harder for the user, a workaround to fix the current GPS position was developed. By pressing button 2 (Fig. 2) the player was able to freeze his current position to facilitate clicking on a virtual object.

4.2.2 Information and Map Tool

The information and map tool inform the player about the current game state and include an interactive map for orientation and navigation, based on the AuthOr application. In the year 2 prototype, this functionality was provided by an application running on a PDA, which was handed out as second device to the player. Since this additional device for orientation and information was too much of interaction for one player, the second UMPC will be used by a second player leading to collaborative mutli-player game.

Figure 4 Year 2 prototype (left) and UMPC-based information tool (right)

The elements of the information and map tool comprise an interactive map, the player position, infos about game locations, time left and the current age.

Minimap

The Minimap is Player 2's primary view on the game area. It displays the game world (in this case the old part of the city of Cologne) from above. The following items are displayed on the Minimap:

Players' position
HM

The Minimap also includes items that are not yet visible to Player 1 as there are shape models in the way. Conclusively both players should work together to find the HMs faster. The Minimap offers a zoom function.

Info-screen

The info screen is shown right next to the Minimap and always visible. It lists up the following:

1. Current age with the exact date and time
3. The time left

Figure 5 Player with mobile devices

4.2.3 Device Tests

In a device comparison test, we evaluated different display techniques regarding the influence of the presence experience and the usability. We compared the following four display devices.

- A backpacked laptop with a monocular head-mounted optical see-through display and a mouse as interaction device. This system was used as AR system for the year 2 prototype.

- A backpacked laptop with a binocular head-mounted optical see-through display and a mouse as interaction device. Since there are no binocular see-through displays available, we developed our own.
- A tablet PC which will be used with a “Magic Lens” metaphor. Instead of an optical see-through display, a live video image will be displayed on the screen.
- A Ultra Mobile PC as described in section 5.2.1.

Figure 6 Compared devices: monocular and binocular see-through display (left) and Tablet PC and UMPC (right).

During the tests, a subset of the TimeWarp game was played. The player has to complete three tasks. First he has to solve the tutorial challenge (5.6.1). Afterwards they have to pass the time portal which appears after the first challenge was solved successfully. The third task is to solve the future challenge (5.6.5).

For evaluation we prepared two questionnaires. The first questionnaire focuses on the usability especially on the interface elements and the interaction with game elements. The second questionnaire asks for presence related issues.

Currently, the testing is still in progress and we are not able to provide first results. The final results of the study will be presented on the IPCity review on March 2nd 2009 in Barcelona.

4.3 Realization and implementation

While the year 2 prototype was realized by implementing a separate application coupled with parts of the Morgan framework and by describing the game logic using the Mixed Reality Interaction Markup Language (MRIML), the year 3 prototype is fully based on Morgan and the Morgan Interaction Prototyping. This replacement offers several advantages for the development of TimeWarp. First of all, the Interaction Prototyping facilitates the development and the maintenance of the game. It allows an easy access and control to the Morgan components like tracking sensors or media handlers.

The components provided by Morgan Interaction Prototyping allow for the development of the entire game logic. Using the *StateMachine* component it was possible to implement the game logic in one short and comprehensive file. Additionally, the Morgan Interaction Prototyping editor provides a graphical interface to develop TimeWarp.

```
Behavior GAMESTATE
{
  SIGNAL initialize HIDE_TIMEPORTAL_MENU_ACTION.execute

  Sensor
  {
    result Event
    {
      Char character ''
    }

    targets   "DEVICE:Key::"

    CONNECT result.character  GAME_STATE_MACHINE.character
    SIGNAL  fire GAME_STATE_MACHINE.execute

  }

  Trigger
  {
    input Event
    {
      String newstate ""
    }

    CONNECT input.newstate GAME_STATE_MACHINE.currentState

    SIGNAL fire GAME_STATE_MACHINE.execute
  }

  StateMachine GAME_STATE_MACHINE
  {
    currentState Start_game
          //  0           1        2        3        4        5        6                    7
    states [Start_game, Tutorial, Roman, Medieval, New_age, Future, Start_TimeMachine, Medieval_Timema

    Input Char character ''
    Input Bool pressedLeft FALSE
    Input Bool pressedRight FALSE

                         //    0        1       2         3       4             5                    6
    transitionsFrom     [Start_game, Roman, Medieval, New_age, Future, Start_TimeMachine,  Newage_Time
                         //        9               10              11                    12
```

Figure 7 Extract from TimeWarp game logic realized with the Morgan Interaction Prototyping

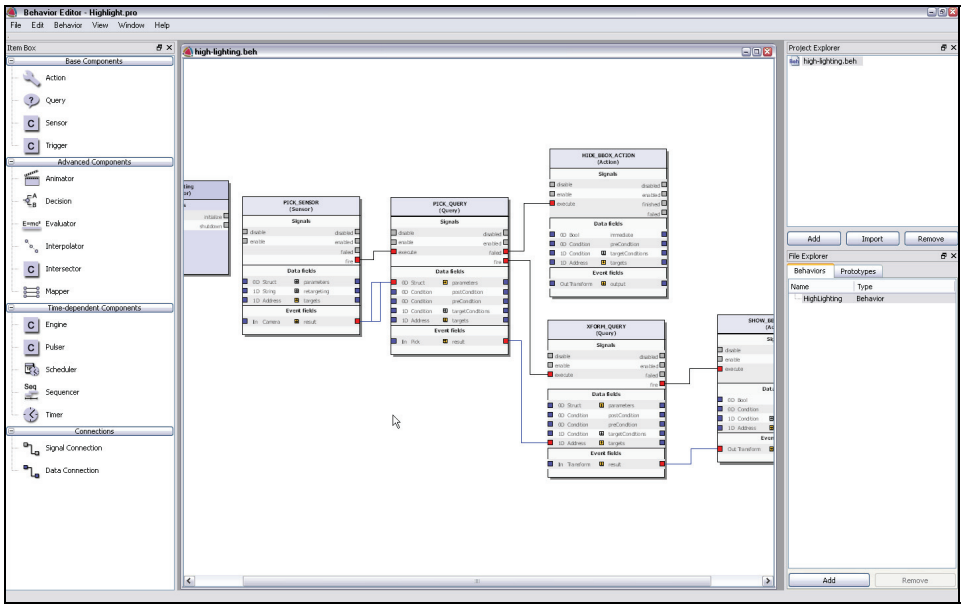


Figure 8 Behavior editing using the Morgan Interaction Prototyping Editor

4.4 Core Game Design and Game Play

TimeWarp is a mobile augmented-reality game played in an outdoor-environment. The goals of the game are to find and rescue a number of Heinzelmännchens which are scattered in different areas and time zones in Cologne. Each of the Heinzelmännchens is located at a certain spot where the players are asked to solve a puzzle. Therefore the important features of the game are exploring the city through physical navigation and interacting with virtual and augmented objects.

Based on the evaluation guidelines of the year 2 prototype the game design has been slightly changed to a cooperative two-player game. While both players are equipped with the same devices, they have different abilities in the game and therefore different tasks.

Player 1 is responsible for the direct interaction with virtual objects which are rendered into his UMPCs camera stream. Usually that interaction takes place in the vicinity of a Heinzelmännchen. Additionally she is also responsible for the time jumps the team has to make to switch to another time zone of cologne.

Player 2's UMPC shows a map of the game area, where all spatial positions of the Heinzelmännchens are marked. Therefore her task is to navigate through the city and lead the team to these locations. If the team finds a Heinzelmännchen there, Player 1 start interacting with the virtual objects to solve the puzzle. If not a time jump is usually necessary.

The game design enforces cooperation in multiple layers. First, from the view of interaction the abilities of both players are asymmetric. Each player on its own is virtually lost in the game area and unable to find or free all Heinzelmännchens in time. Second, the players have to stay close to each other so they can communicate about different aspects of the game like how to solve a puzzle or which route they should take. Further cooperation is provided by the option to switch player roles by just exchanging the UMPCs.

The game design has been done under the use of game design patterns. The following figure shows the structure of TimeWarp's basic game:

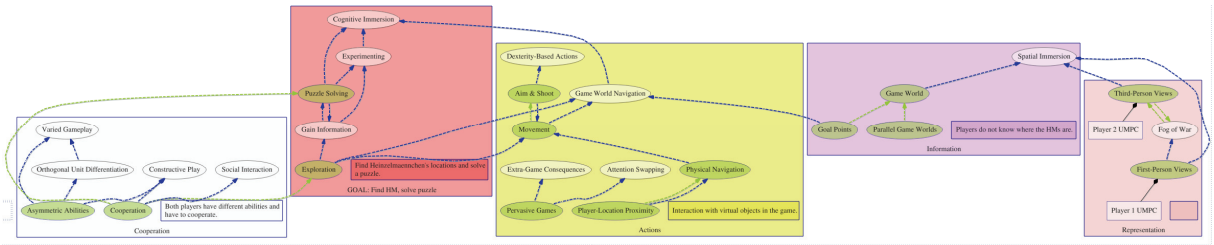


Figure 9 TimeWarp structure with Game Design Patterns

4.5 Interface elements and tools

4.5.1 Player 1 Interface

Simple Using or manual mode

Player 1's UMPC serves as a magic lens into the game world. In the middle of the augmented camera stream there is a crosshair. The crosshair is context sensitive and changes its color once the player points at an object that can be used. Player 1 may then press the primary interaction button. This kind of interaction is used for all simple interactions such as starting a dialogue with a NPC or picking up objects. Usually that works only within a certain range to the used object.

Starting the time machine

By pressing the time jump-button a menu pop ups in Player 1's field of view. With the mouse buttons the player can do a selection and confirm it with interaction button (see figure). The menu

will then disappear and a time portal opens 5 to 10 meters in front of the player(see figure 10). Once the player walks through the portal, the team is being switched to the corresponding time zone.

Figure 10 Time machine menu (left) and activated time portal (right)

4.5.2 Player 2 Interface

Player 2 primary view is a minimap of the game area. The map shows the player's current locations as well as the spatial locations of the Heinzelmännchens (see figure 4 (left))

4.6 Level Design and Challenges

The game area of *TimeWarp* is a part of Cologne in the south of the Cologne Cathedral. The area is fitting for gaming purposes as there is not too much car traffic and a number of historical locations. The following figures give an overview over the gaming area and challenge locations.

Figure 11 The city center of Cologne – the game area of TimeWarp

There are four different time zones in TimeWarp:
Roman Age (500 BC – 500 AC)
Medieval (500 – 1500)
New Age (1500 – Present)
Future (approximately 2200 to 2500)

The players are slowly introduced into the game. After completing a tutorial mission the players can use the time machine for the first time to Roman age. After completing the roman age, all other time zones are unlocked for free time travelling.

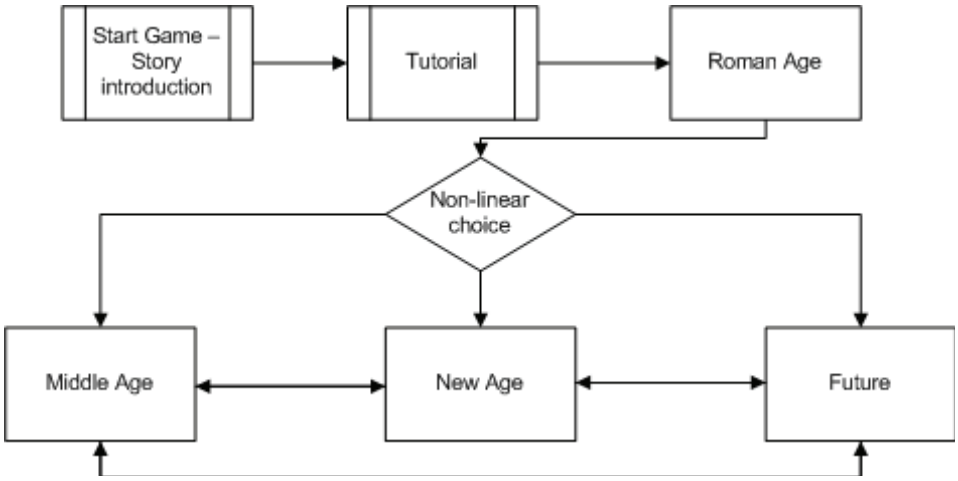
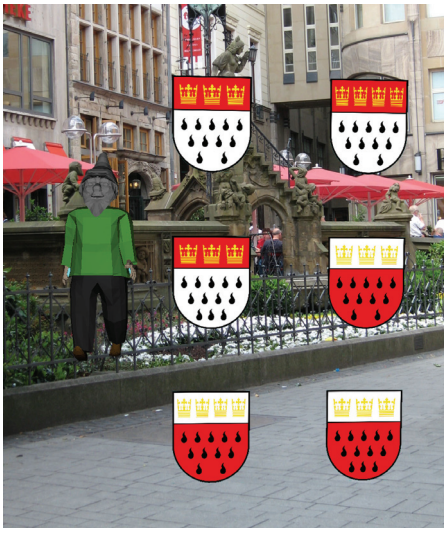


Figure 12 Time travelling options in the game

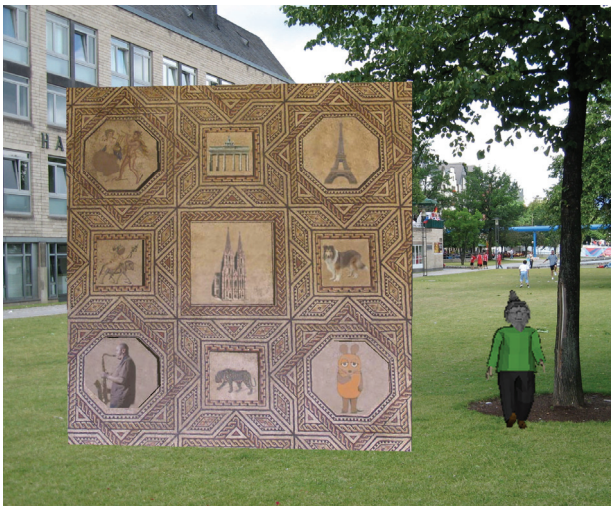
4.6.1 Tutorial

The first challenge is the tutorial, which is a challenge and is entitled “The coat of arms of Cologne”. It takes place at the Heinzelmännchenbrunnen. The players are first introduced into the game controls and the minimap. After that the players need to pick up the correct emblem of Cologne, by clicking on it with the mobile AR device. After the completion of the tutorial the players are allowed to make their first time jump to the Romanian Age.



4.6.2 Roman Age

The Roman Age is the first time zone the players visit after leaving the tutorial. The challenge location is next to the Roman Germanic museum (Roncalliplatz). The goal of the challenge is to help the Heinzelmännchen to complete the mosaic. The mosaic is a modified 3D version of the real roman Dionysus mosaic, which is visible through the window of the museum. The player has to turn around some pieces of the mosaic by clicking on it until the mosaic is complete.



4.6.3 Medieval

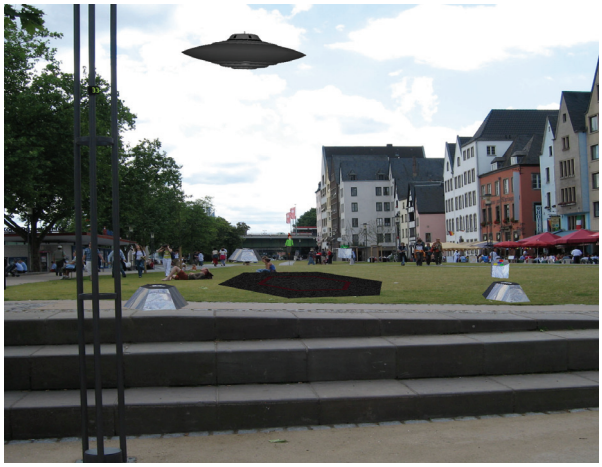
The challenge in the medieval is placed at the town hall. Several paper scrolls are lying around. The player has to collect them all by clicking on them.

4.6.4 New Age

"The Construction of the Cologne Cathedral" is the title of the new age challenge. People say that the cologne cathedral will never be completed. However there is a Heinzelmännchen who just continues building it. The player has to help to build it by collecting bricks by clicking on it.

4.6.5 Future

In the future challenge, there is a space station located at the Rheinufer. An incoming space ships is unable to land because of some broken traffic lights. The player shall help the Heinzelmännchen to repair the traffic lights. To solve this challenge the player has to put three relays to the central terminal by clicking on that. After completing the task, the lights turn on and the spaceship can land safe.



4.7 Narrative Structures

Since TimeWarp's game area is open and cannot be limited by any physical boundaries, narrative structures are necessary to lead the players through the game experience. For that purpose a number of non-player characters are used. The NPCs will talk to the players once they are within a certain range. For the year 3 prototype 156 messages have been recorded by different voice actors.

Agent Monroe

The supervising agent is a game character, which the players will hear throughout the game as a little man in one's ear. That character is the primary source of narrative structures in the game. Whenever the players approach a location important to the gameplay Agent Monroe will give instructions to the players. His main duties are:

- Leading the players through the game and tutorials

- Telling the player historical facts about certain locations
- Giving hints if the players are unable to succeed

Agent Brown

A second character similar to Agent Monroe. That NPC is usually used for messages concerning time travelling in TimeWarp. This is being done to help the players to distinguish between content and control related messages.

The Heinzelmännchens

Each Heinzelmännchen gives hints how to solve the challenge once the players are within a certain range.

4.8 Sound Design

The importance of sound in virtual and mixed reality settings has been expressed by many presence researchers (Holland et. Al, 2002, Jones et. Al, 2007, Larsson et al(2007), Turner (2007)). Participants of prior *TimeWarp* studies confirmed that view but still pointed out, that some sounds seem to be misplaced from a design point of view. To provide the game with a more sophisticated and adequate acoustic feedback, a complete sound design has been conducted. The process resulted in 60 new sounds which have been applied to the game in three different layers:

1) **GUI**

   Interface sounds are played when a player interacts with GUI elements like the Time Machine menu or the map. Additionally beeping sounds communicate the success or failure of an interaction or invisible changes in the game state to the player.

2) **Object**

   Object sounds are sounds that are spatially associated with virtual objects. They may be played due to player interaction with that object (e.g. the player picks a scroll up), as loops (e.g. the engines of a passing spaceship or the trotting of a carriage) or as company to triggered events. Each object has its own set of sound effects.

3) **Environment**

   A number of environment sounds is scattered over the game area to support spatial presence in certain areas. Environment sounds are usually not connected to virtual objects but real locations in their corresponding time zones (e.g. mumbling of people at the old marketplace in medieval age).

5 Evaluation Summary

Playing *TimeWarp* is a collaborative experience which requires players to co-operate on many aspects, this also provides a method of comparing differences between player, non-player characters and passers-by. There was a very strong sense of presence between the players, and many pointed to this being a positive aspect of the game – and one which had a substantial impact on creating the game world in which the user inhabited. Co-operation took many forms, ranging from navigational information, negotiating strategies, to sharing ideas concepts and discussing gaming elements. For example players would often stop and talk to discuss gaming elements before agreeing on common strategies. Furthermore they often took into account the level of engagement with the game and would swap devices, to ensure that the navigator could now become the first player thereby allowing them to experience more of the virtual gaming elements.

Figure 13 Players collaborating during the game experience

Non-player characters (e.g. the Heinzelmännchen) feature heavily within the game, and provide not only its underlying narrative but also form critical aspects of the challenges which players must complete. As would be expected the sense of presence experienced between players was higher than between users and NPC´s, in part due to the reality of such cartoon like characters and the interaction techniques involved. Interestingly people reported a moderate awareness of non-participants, but their degree of involvement in the game resulted in them paying little attention to them; this points to the game being the dominant factor rather than the real environment.

Place making is shaped by many elements including social interactions, physical, material and historical elements (Gustafson, 2001). Within *TimeWarp* sense of place was shaped through various methods including the negotiated understanding of the new aspects which people were experiencing in combination with content such as building facades, challenges and audio information. Such experiences also extended to being aware of when not to intervene in a space while playing, in particular see figure 13 when marriages were occurring at the town hall. The sense of being inside the game (presence) and where people felt located (place) was very heavily influenced by the connection between gaming elements (the virtual dimension) and reality (the actual city). Players also noted that imagination became a key element in helping to shape their sense of place.

Figure 14 The wider environment had a significant impact on participation in a game, here two players are deciding what to do as a wedding is taking place at the city hall.

The players liked the strong connections between gaming elements and the city of Cologne, for example the challenges reflecting aspects of the city´s history. This interplay between real and virtual elements resulted in interesting feedback with respect to place and sense of presence. Many of the challenges in particular within the past and current time periods appeared to map on to believable elements. For example some old buildings remain in Cologne thus the virtual objects appear at least to be within a valid contextual frame of reference. This contextual element played an important part in the player's perceptions and preferences within the game, indeed many reported how a break in this did one of two things. Firstly many people reported that they felt more present within the future time period, this was in part due to the available actions but also it does not require a suspension of disbelief – in essence the contextual link between the game and the real environment was significantly broken. Indeed it is from the outset unreal with features objects and activities feeling out of place. Therefore the surrounding environmental context is less relevant, and as such players do not expect reality either in terms of the actions available, graphics or sense of place. However such enthusiasm by many users for this location was counterbalanced by lack of a link between the real and virtual contexts by others. Thus the requirement for suspending disbelief would appear to be heavily dependent on user preferences (ranging from actions to gaming style) through to the relationship between real and virtual elements. This view was further reinforced by comments from some users who pointed out that the Heinzelmännchen felt unreal, however for many players it was this sense of unrealness which made the characters and hence the game engaging.

Moving between real, virtual and blended experiences was a common issue for the players. As noted in other literature sense of place is often shaped by the paths between locations as much as the actual locations themselves - and many players commented on the need for content between locations; the long walks between locations resulted in them feeling like they were constantly entering and leaving the game experience. By far the strongest indication of a change in experience would occur when players had to enter a time portal, with players often changing posture and stance and running through the portal. The time portal was regarded as one of the best elements of the game, and although no difference in feeling of temporal presence were noted it was clear that the level of engagement and involvement would increase dramatically when players either searched for a portal or entered one. Other switches would occur when the players left the gaming experience, however they reported not feeling any change in presence when they first entered the game world.

From the interviews it was apparent that many people felt the computer graphics were a layer on top of the real environment, rather than part of it. Thus there was no real blended experience, this can partially be explained by aspects such as concentration which many players noted was focused more on the virtual or gaming elements. Technical aspects such as the cartoon nature of the graphics also had an impact. However it was also due to the sudden changes people would experience while walking through the city, for example the fact that streets often contained little if any content resulted in a situation where players would actively seek out gaming elements. This again points to the need to consider integrating paths and streets more thoroughly within such experiences. Furthermore it was noted that players felt a disconnection from reality by indicating that it was easier to interact with virtual than real elements. Therefore although the game was clearly linked to physical and

historical aspects of the city this lack of integration with the real environment was considered a negative aspect.

5.1 Results

An extensive list of high level design guidelines relating to TimeWarp was published in Herbst et. al. 2008 (a list is at the end of this section). The items below relate to new elements from the study of the second prototype.

Provide support for shared and negotiated understanding: one core element of the prototype two experience was allowing people to discuss the gaming elements. This improved their feelings towards the game as well as participation in game elements, and their ability to navigate.

Understand spatial context: experiences by default take place in real world spaces, therefore there is a need to careful consider the impact a game will have on reality. As noted within the study weddings took place at one location, this frequently caused problems for the players as they did not wish to disrupt the wedding party.

Consider the frame of reference: as time travel is currently not possible, and seeing the future is also not possible it is important to consider when and how to employ realism. For example some users felt a stronger appreciation for elements which were clearly futuristic (both graphics and sound), than those which attempted to be realistic. This raises important questions about how and when to employ realism as any attempt to do so is heavily shaped by the gaming and location context.

From our earlier prototype the following guidelines were devised: Attention allocation, *simplify the interaction scheme*, *user safety*, *design appropriate, understand the locale, interaction with others, seamful design and provide a continuous experience.*

6 Dissemination

The main dissemination plans of phase 3 of TimeWarp were focused on scientific publications and appearances in public press.

6.1 Accepted Publications

British HCI 2008, Liverpool (Organizer)

Workshop Evaluating Player Experiences in Location-Aware Games

DIMEA 2008, Athens (Organizer)

Special Session on Mobile AR games

Jahrestagung GI 2008, Munich

Workshop Mobiles Spielen

Mobile HCI 2008, Amsterdam

TimeWarp Paper – Best Paper Award

Special Issue, P & U Journal (in progress)

6.2 Appearances in public press / television

- http://www.stern.de/computer-technik/technik/:Pervasive-Games-Die-Realit%E4t-Spielbrett/636171.html (21.09.2008, www.stern.de)

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ipcity.eu