



**Integrated Project on Interaction and Presence
in Urban Environments**

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Final Prototype of TimeWarp application
Deliverable D8.4



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Abstract

This document describes the fourth and final year of research within the *TimeWarp* workpackage of IPCity. *TimeWarp* concentrates on creating a 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 Augmented Reality (AR) technology and implements various presence concepts such as co-presence or the use of virtual characters.

The specific objectives for the final phase of TimeWarp were:

- 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 mixed-reality presence

- To develop and evaluate concepts and tools to gain a stronger presence experience by:
 - Engaging the players more with the virtual characters and objects
 - Strengthening collaboration between players
 - Providing a stronger narrative

Intended Audience

This document is intended for all partners of the project, the EC, and to the interested public.

1 Workpackage Objectives

| | |
|-----------------------------|---|
| Objectives Phase IV | During phase IV we have redesigned <i>TimeWarp</i> according to the findings of phase III. The objectives of the redesign was to advance the infrastructure and gameplay by improving the interface and the gaming experience as well as examining further presence aspects |
| Results Phase IV | The results of the redesign phase IV consists of improvements and modifications regarding the following parts: <ul style="list-style-type: none">• AR system and devices• Realization and implementation• Game Design and Game Play• Interface Elements• Level Design and Challenges• Narrative Structures |
| Evaluation Results Phase IV | The results are presented as a set of design guidelines for Mixed Reality games and applications in urban contexts, giving guidance on how to increase presence, sense of place and collaboration in such scenarios, as well as how to deal with issues from placing a game in the real world and technical and usability issues. |

2 Overview

TimeWarp is a mobile mixed reality game which is played by two players as a team in the old town of Cologne. The game runs on ultra-mobile PCs (UMPCs) and is narrative driven. In order to succeed the players have to solve certain tasks throughout the game. A game session usually lasts between 60 and 90 minutes. In order to finish the game, the players have to collaborate as both have different means of interaction at their disposal. The main topics TimeWarp investigates cover presence (temporal and social), sense of place, collaboration and game design.

2.1 Story

In the game, the players are so-called Chrononauts, time-travelling agents employed by the Chronoguard. They have to travel to different time periods in the history of Cologne to stabilize the time space continuum. This has been endangered by little robots that the players meet throughout the game. These so-called "Heinzelmännchen" have been created in the future to help people in their households, but they escaped via time portals under mysterious circumstances. Throughout the game the players are briefed by Agent Morgan, a character also working for the ChronoGuard and appearing via video feed to the players. He explains the problem, guides them through their time travels and also shares knowledge about the various things that players encounter throughout their journeys.

After their first time jump, the players find themselves in Roman Cologne and encounter the first of the robots. The robot explains that it considers itself to be a conscious being (a point of view which Agent Morgan strongly opposes to) and pleads to the players to send it somewhere safe instead of back to where it was coming from. The players now have to decide whether they follow their orders or have enough sympathy with the robot to set it (or him?) free.



Figure 1. Augmented Reality view showing a Heinzelmännchen robot.

Afterwards their journey continues and the players meet other robots in different time periods like the medieval times or the future where they help them solve small challenges and finally face the same decision, again.

The game either ends when the players have located and captured (or saved) all robots, or when the time runs out and Agent Morgan activates a kill-switch just in time to prevent the time space continuum from collapsing.

2.2 Game Play

The players take on two different roles throughout the game.

One of them acts as the navigator and communicator. On his device he sees a map of the area, their current location, their taken route so far, their mission progress and the remaining time. The player can also detect Heinzelmännchen and other interesting objects, whose position is then displayed on the map.

Additionally, the player is in control of time travelling which means he can open portals to other time periods. He does this by creating a time portal and placing it somewhere on the map. Then both players have to physically walk into the time portal to travel to a new destination.

This player is also in charge of communicating with the different characters the players are meeting. The dialogues are handled via simple multiple choice options, so he can decide how to react when asked questions by the robots for example.

The other player can see the world in an Augmented Reality view. In each time period, the player can investigate typical buildings and objects, and she can also see the robots which are animated 3d models. Everytime the players encounter such a robot, they have to solve a small task (called "challenge") as outlined later in *4 Challenges* (page 8). The interaction is done by aiming at the object with the device and then pressing one button on the UMPC. Depending on the target object this could stand for picking something up, starting to talk to a character or repairing an object. The player can also enable a GPS fix, which locks the scene at the current position (but not the orientation) and prevents new tracking data being used for positioning. This proved helpful for more delicate interactions or when the player wanted to have a closer look at an object while the GPS signal was jittering.



Figure 2. Navigator interface

2.3 Technology

Both players were equipped with one Sony Vaio VGN-UX280P Ultra Mobile PC each. In order to serve as an Augmented Reality device, we used the camera installed in the back of the UMPC to provide a live video feed of the surroundings. Tracking was done with a xSens MTi-G sensor, which is a combined inertial and GPS sensor with an integrated Kalman filter.

The devices were connected via an ad hoc wireless network to exchange data between the two systems. This way we could ensure that for example all audio and video files would be played at the same time to each player.

All interactions and the interface were scripted using the Interaction Prototyping Tools and the Visual Programming Editor as described in deliverable 4.4.

The media content in the game ranges from video clips, music, sound effects, spoken dialogue up to 2d interfaces and 3d models. The 3d models include all Heinzelmännchen characters, objects necessary for completion of the challenges as well as general backdrop and scenery objects to bring the different time periods alive. The 3d content was designed and created by Imagination Computer Services GesmbH as their contribution to workpackage 8.



Figure 3. Augmented Reality interface

3 Main Changes in Final Year

In this chapter we present a short overview over the main changes that have appeared between last year's game and the final prototype. Please refer to *12.1 Detailed list of changes for final prototype* (page 75) for a more detailed overview and to deliverable 8.3 for a description of the previous version.

3.1 Player roles

In last year's prototype one of the main flaws was the rather underwhelming experience players had when acting as the navigator. We tried to strengthen this player's role by adding new responsibilities and shifting responsibilities over from the other player. In the previous version, only a non-interactive map of the game area was displayed to the navigator player.

We added the following functionality to provide a richer game experience for the navigator:

- Reassigned ability to create time portals to navigator player instead of AR player
- Display current position on the map
- Display walked route on the map
- Display radar and position of interesting objects and characters on the map
- Display countdown before the players run out of time
- Display progress of how many Heinzelmännchen have been saved so far
- Display all sounds and videos on navigator device as well
- Control multiple choice dialogues with virtual characters
- Responsibility to make the final decision on either saving or capturing a robot

In comparison the AR player had the following tasks:

- Inspect Augmented Reality content (objects and characters)
- Initiate dialogue with virtual characters
- Solve challenges by interacting with virtual characters and objects
- Time travel by physically walking through time portals

3.2 Story, characters and decisions

According to legend, mythical elves called Heinzelmännchen lived in the city of Cologne, who helped people with their everyday tasks until they suddenly vanished one night. In the old version of the game, the Heinzelmännchen were still these mythical creatures which created a game where strong fantasy elements conflicted with the pure science fiction approach of using seemingly high-tech devices and time travelling by the means of this technology. For this final prototype, we solved this issue by turning the Heinzelmännchen into little robots who were clearly inspired by the legend – and could have also even been the source for it thanks to their time travelling.

In the previous version there was no narrative conflict as all actors, Agent Morgan, the Heinzelmännchen, and the players had the exact same goal and there was no antagonist.

In the final version there is still no clear or pre-defined antagonist, but the players have to side either with Agent Morgan or the robots. Our goal was to engage the players more into the story and with the characters themselves and confront them with meaningful and moral decisions. This was also aimed at creating more discussion between the players themselves to test our hypothesis that this would have beneficial results on their sense of Presence.

As supporting measures to create characters the players could relate to the Heinzelmännchen were now animated when talking to the players. The animation consists of different kinds of gestures (hand, arm, head movement, ...) and have been synchronized to the audio files to get as convincing as possible,

Agent Morgan appeared as a video feed and not only via audio, and the players had some control over the dialogues between them and the characters by the use of multiple choice options.

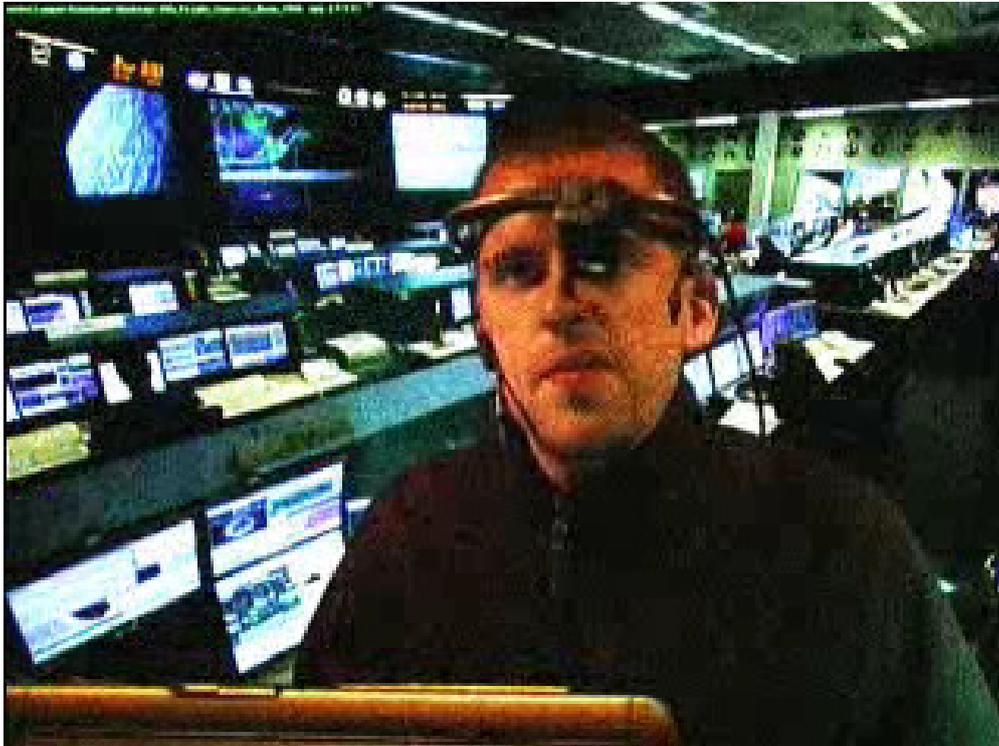


Figure 4. Agent Morgan, a member of the ChronoGuard.

Lastly, we also localized all dialogues in the game from English to German language, so that players who were not completely fluent in English could still understand all parts of the game and thus eliminate one recurring cause for confusion.

3.3 Time periods and challenge design

In last year's version, the players could visit four different time zones: Roman time, medieval time, New Age and the Future. For this year we decided to focus on three time zones and eliminated the New Age time period from the game as the look and feel of it was too similar to the medieval time zone. Furthermore we decided to rather have the players spend more time in fewer time zones to be better able to compare their experiences in the different periods.



Figure 5. Screenshot of a virtual aequeduct in Roman times (the blue tube in the background is real).

The challenges themselves were redesigned as well. One main flaw we identified from the previous version was the fact that some challenges could be solved by standing still in one spot and just turning around. For this prototype we only allowed players to interact with a character or object when they were in a certain range. Furthermore we laid a focus on spatially spreading out challenges where players were forced to walk around in order to find all objects.

4 Challenges

Typically, all challenges start with the players noticing a Heinzelmännchen and player 1 (the AR player) activating it through point and click. The Heinzelmännchen tells its story and Agent Morgan presents his point of view. While talking, the players can usually engage in a very simple and short multiple choice dialogue with them. Then the players have to solve the challenge as such by helping the Heinzelmännchen with different problems they encounter. When successful, Agent Morgan urges the players to send the Heinzelmännchen back to him, while the Heinzelmännchen try to convince the players of a different destination

4.1 Tutorial

The players are greeted by a computer voice and then introduced to Agent Morgan who tells the background story of the game. Then the players are led through the tutorial by the computer voice that explains all features of their UMPCs to the players. In the tutorial players learn how to use the radar, how to pick up objects, and how to engage in dialogue with a virtual character. In the end Agent Morgan teaches them how to time travel and the players travel to the Roman times first where they appear close to the first Heinzelmännchen.

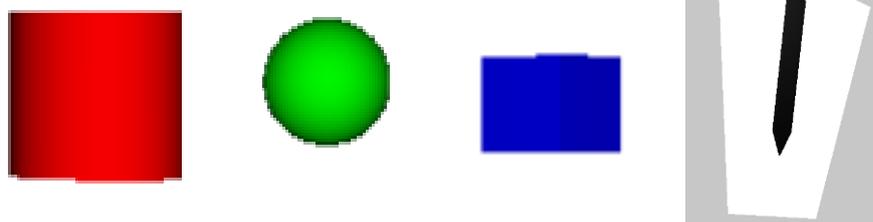


Figure 6. Tutorial objects.

4.2 R1 – Repairing the leader (Roman)

The players encounter HM-RO1 (or Roy) who is the leader of the Heinzelmännchen. His body is scattered around the area and the players have to collect all 4 parts so that he can be complete again.



Figure 7. HM-RO1 and his parts.

4.3 R2 – Dionysus mosaic (Roman)

The players find HM-Z0R4 (or Zora), a female Heinzelmännchen. She is trying to replicate the giant Dionysus mosaic of Cologne but cannot finish the task on her own. The players have to help her and tell her which parts go where. The players can solve the challenge much easier if they have a look through the big windows of the Roman Germanic museum where they can see the real version of the mosaic.

Note: This challenge was later cut from the game to reduce playing time (and also because the location was occupied by a Christmas market during the pilot tests).



Figure 8. HM-Z0R4 and the Dionysus mosaic.

4.4 M1 – The Wedding (Medieval)

At the church the players meet HM-3MA (or Emma) who is looking for her fiancé HM-3ML (or Emil) who has gone missing. The players can find HM-3ML further east at the riverside and guide him back to his bride. After convincing Agent Morgan that it is the necessary thing to do, he performs the wedding of the two Heinzelmännchen.



Figure 9. The bride HM-3MA and the groom HM-3ML.

4.5 M2 – Beer barrels (Medieval)

Next to a big cart filled with kegs of a Cologne beer specialty the players encounter HM-M4X (or Max), who is drunk. However, he still needs to deliver the beer to a historically important party so the players have to follow him through the city streets and collect all beer kegs that fall off the cart.

Note: This challenge was cut from the final version of the game to reduce overall playing time, but reappeared in the Christchurch stagings.



Figure 10. HM-M4X and his cart with beer kegs.

4.6 F1 – Escape (Future)

Immediately after the players start talking to HM-5VN (or Sven) he flies away and tries to escape from the players. If the players do not manage to catch him, he runs out of fuel after a while and is easily overpowered.

Note: This challenge was cut from the final version of the game to reduce overall playing time.



Figure 11. HM-5VN.

4.7 F2 – UFO (Future)

Next to the future spaceport, HM-F4L6 (or Falk) is working at a control terminal. The landing lights are broken and so the players have to walk to three relays and repair them in order to guarantee a save landing of flight FIT-CVAE.



Figure 12. HM-F4L6, the ufo and the landing platform at the space port.

5 Pilot studies

5.1 Overview

A total of 6 pilot tests with 12 players were performed in November 2009. Main tasks for the pilot study were to identify general bugs, usability issues, game play problems, and to identify a suitable gaming area and locations for the various challenges (which were moved around during the pilot studies to find the best solution).

5.2 Results

The most noteworthy results from the pilot studies were the necessity to shorten the game by cutting the amount of challenges, and to relocate the whole game to a slightly more compact area with better GPS reception.

Six challenges plus a tutorial were deemed to take too much time for the players, especially when they were as spread out through the city as originally planned. With such an amount of content the game would easily last between 120 and 180 minutes which would have been way too long considering the cold weather in Cologne's winter and the limited battery life of the UMPCs (with a theoretical on-the-fly switch of batteries introducing another set of problems).



Figure 13. Originally chosen game area, approximately 0.25sqkm (satellite image from Google Maps)

To reduce the game to a more feasible length of 60 to 90 minutes, one challenge from each time period was removed from the game: The mosaic challenge, the beer barrel challenge and the escape challenge. The decision of which challenges to cancel was based on opinions by the test players and general observations by the team.

Additionally, the playing area was moved onto the so-called “Rheinwiesen” at the banks of the river Rhine. This was done to reduce the walking time between challenges, provide a more scenic atmosphere, and it also assured better GPS reception than some of the narrow streets in the original playing area could provide. One of the main concerns however was player safety: During the pilot studies players often were too unaware of their surroundings including car traffic.



Figure 14. Final game area, approximately 0.056sqkm (satellite image by Google Maps)

While it would have been of course desirable to include all challenges as originally planned (as each challenge was focusing on a different, interesting aspect) as well as have a more diverse and urban playing area than the one we finally chose, real life concerns and playability forced us to make these cuts. We believe that they improved the overall gaming experience.

6 Main studies in Cologne

6.1 Overview

The main studies were conducted in Cologne between January 8th and February 3rd. On a typical day there would be one test run in the morning and another one in the early afternoon. All test runs were carried out during daylight.

The evaluation team usually consisted of three people: one camera person, one observer and one jumper who helped out with the equipment.

The players were given a short introduction to the technology and the game and could then immediately start to play.

A typical test run lasted between 60 and 90 minutes. In total we performed 33 test runs with 66 players. Three of the test runs were excluded from the evaluation as the players did not finish the game due to technical problems or comfort issues.

6.2 Participants

The participants, 42 male and 18 female, ranged in age and background from students of different subject areas to professors, and from IT advisors to administration secretaries. In 12 teams the players didn't know each other before playing TimeWarp. In 18 teams the participants were familiar with their game partner.

Regarding previous computer experience all users stated to use a computer daily. 8% of the participants play every day. However, the majority of the probands plays never or less than once a week (see Figure 15).

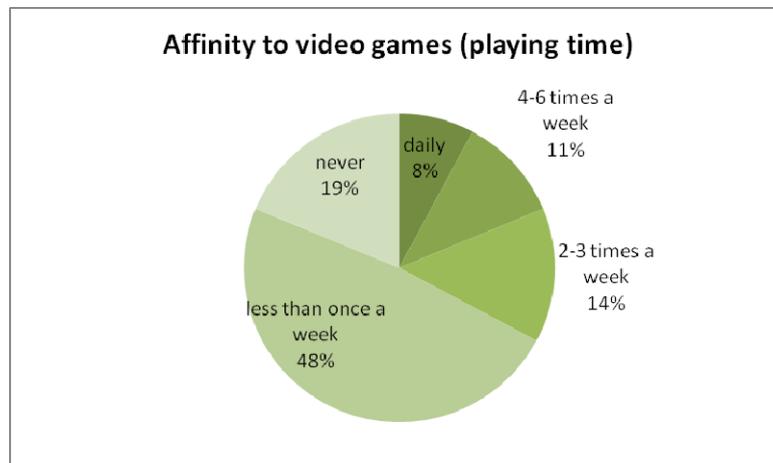


Figure 15. Affinity to video games

6.3 Methods

In order to assure we capture all data that might be significant at a later stage, we decided on a combined evaluation approach including quantitative and qualitative methods. In the following sections user quotes are noted in the following way:

[Ques, p10] : This quote is taken from the Questionnaire of the player with the ID number 10.

[Interview, p11] : This statement was said by the player with ID 11 in the post-game interview. An endnote after the quote points to the original German version which can be found in the appendix.

The figure captions always include the group id in brackets (e.g. "(g5)").

6.3.1 Video observation

During last year's study, we followed the players with a camera and recorded their every move. Afterwards the videos were analyzed by looking at interesting scenes and behaviour patterns (running, gestures, etc.) were transcribed. There were some problems identified during this process and eliminated for this year's testruns.

The video camera was not handheld anymore but attached to a Steadycam which greatly reduced jitter of the video (see Figure 16a). Furthermore, the players were equipped with microphones that wirelessly transmitted their output to the video camera so that all comments by the players were very clear to hear when later looking at the videos. Additionally, all in-game sounds were transmitted to the camera in the same way. As the game relies heavily on sound, this made it much easier to know what exactly was going on in the game while looking at the video.



Figure 16. a) Camera equipped with audio transmitters, b) Camera man and observer

After the testruns, the videos were analyzed with the help of the video annotation tool Transana¹ by transcribing interesting scenes and coding with a pre-defined set of codes. For the set of codes, please refer to 12.2 *Video codes* (page 80).

6.3.2 Observer

In addition to video observation, another observer followed the players around equipped with a tablet PC (see Figure 16b). On it the observer was able to note down interesting behaviour of the players. The observer was also connected to the audio feed of the players and the game itself, and was able to record short time-coded audio notes into the tablet PC.

6.3.3 System logs

During the game, both UMPCs continuously logged all game actions into text-files. The data included (among others): GPS positions, camera coordinates, dialogue choices of players, time portal creation, decisions where the Heinzelmännchen was sent, etc. All data was time-coded to allow for easier synchronization with other evaluation data.

6.3.4 Post-game Interviews

After the testruns, both players were interviewed together and asked about several aspects of their experience. These interviews were also recorded on camera and then later transcribed in the same video analysis tool as used for the testruns. The interviews took between 15 – 20 minutes.

¹ <http://www.transana.org/>

6.3.5 Questionnaires

In common with previous studies we used an adapted version of the MEC spatial presence questionnaire (Vorderer et al, 2004) by adding questions related to the augmented reality experience. MEC itself is broadly speaking based around the Lombard (1997) view of presence in that it considers content related issues such as interest in the topic and cognitive involvement (see below).

We adopted the large MEC questionnaire as from the perspective of virtual environments it has been extensively validated and tested.

- *MEC Spatial Presence Questionnaire: Main Categories*
 - Process factors (Attention Allocation, Spatial Situation Model, Spatial Presence: Self Location, Spatial Presence: Possible Actions)
 - States and actions (Higher Cognitive Involvement, Suspension of Disbelief),
 - Personality characteristics (i.e., Domain Specific Interest, Visual Spatial Imagery, and Absorption)

The largest single change to the MEC consisted of changing the scale used in the questions from five to seven points to support a higher degree of granularity and instead of asking people if they felt present in the real or virtual experience they were asked to rate their experience on a scale from “Real only” through “Overall” to “Virtual Only”. “Overall” relates to if they felt present in a combination of the real and virtual elements. Throughout the remainder of the questionnaire additional questions were added to the various questions specifically related to how the virtual and real elements compared to one another, for example “The virtual and real elements complemented one another”, “I felt in one environment during the experience” and “Different time periods altered my behaviour towards the environment”. Questions were also added to explore the interaction with real people and objects in the context of the game e.g. “Other people (non players) influenced my behaviour”.

MEC itself was insufficient for exploring issues to do with social presence, in particular with respect to virtual characters. It was for this reason that we added questions from the Bailenson et. Al (2001) social presence questionnaire. Finally, we added some questions from the Place Probe (Benyon et. Al, 2006) to find out about which place(s) people felt they had visited as they took part in the experience. These were also modified to reflect certain aspects of TimeWarp, in particular the temporal dimension.

The results from the MEC questionnaire were often inconclusive as they contained large standard deviations, therefore rendering interpreting the data difficult. As a result we have only reported the data where the result and standard deviation provide a clear outcome. Furthermore we found that although the questionnaire was translated into German many concepts remained difficult for people to grasp, therefore some of the data is difficult to interpret.

All players were asked to complete the questionnaire directly after finishing the game. For the questionnaire we used the software Limesurvey (<http://www.limesurvey.org/>) so all data was immediately available in digital form afterwards.

6.4 Presence

6.4.1 Involvement in the game

“Funny game that indeed got me completely involved”ⁱ [Ques, p20]

“The game was a lot of fun; you interact in collaboration with your partner and also forget about the time, even in bad weather conditions”ⁱⁱ [Ques, p52]

“During the game I realized that I was completely immersed, I wanted to succeed with my mission”ⁱⁱⁱ [Ques, p3]

“Exciting, despite the weather conditions I lost my relation to time.”^{iv} [Ques, p60]

Most players experienced TimeWarp as an entertaining game that let them forget about time and place. Some participants even indicated that they were so engaged in the game that they even forgot about cold or rainy weather conditions and were still concentrated on the game experience. The results from the questionnaire approve this finding. The majority of participants agreed to the statement “I thought most about the things which had to do with the game”. The answers are visualized in Figure 17.

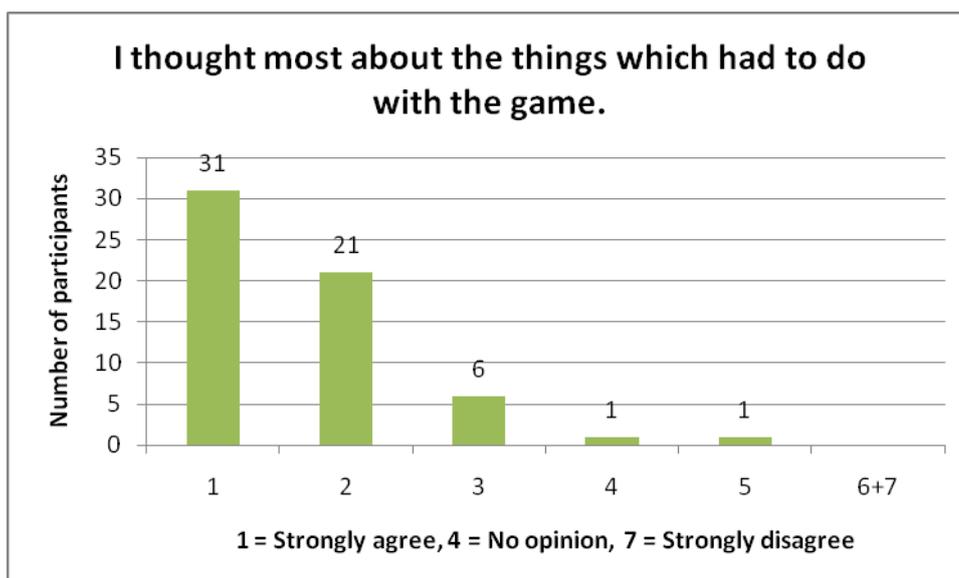


Figure 17. “I thought most about the things which had to do with the game”

6.4.1 Mixing Realities

“I can say that I was completely into the game and did not pay so much attention to the reality.” [Ques, p10]

“Do you remember where we stood in reality?”” [Testrun, p8]

“Interesting experience. I was astonished how much I forgot the reality. I especially realized that when looking for augmented places again and I tried to recognize where I was.”^{vi} [Ques, p8]

“As you were so involved in the game you hardly realized the environment and the city”^{vii} [Ques, p23]

“At first it was a weird feeling running through the city, the game area, like an ,alien‘. But after 10-15 min. I was engaged in the game and did not really differentiate anymore between VR and R – both was mixed and in combination was a very broad experience.”^{viii} [Ques, p63]

The written responses from the questionnaires pointed to people feeling present within the game world. This was primarily driven by their interest and involvement in the experience (see quotations above) and the desire to explore the game-space. The players also agreed with the proposition that they felt in a new reality for the duration of the experience (see Figure 19 and Figure 20). However they noted that they did not feel present in a different time period (a discussion on temporal presence can be found later in section 6.5 Temporal Presence (page 30, also Figure 18). The willingness to ignore pure reality had two primary effects firstly to screen out reality thus making players perceive as if they are interacting in a virtual space or secondly to make them perceive as if they are interacting within a new mixed environment.

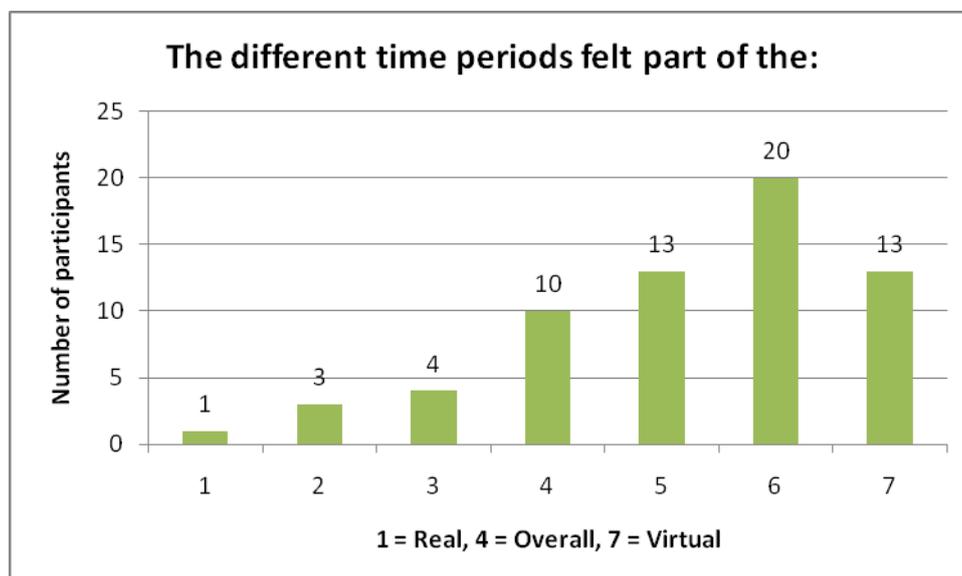


Figure 18. “The different time periods felt part of the“ virtual

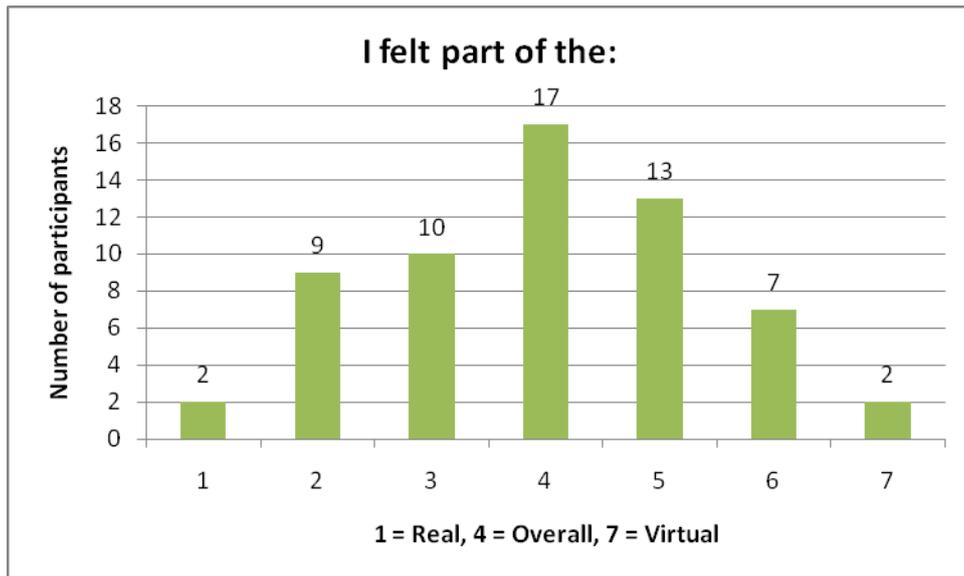


Figure 19. "I felt part of the" mixed reality

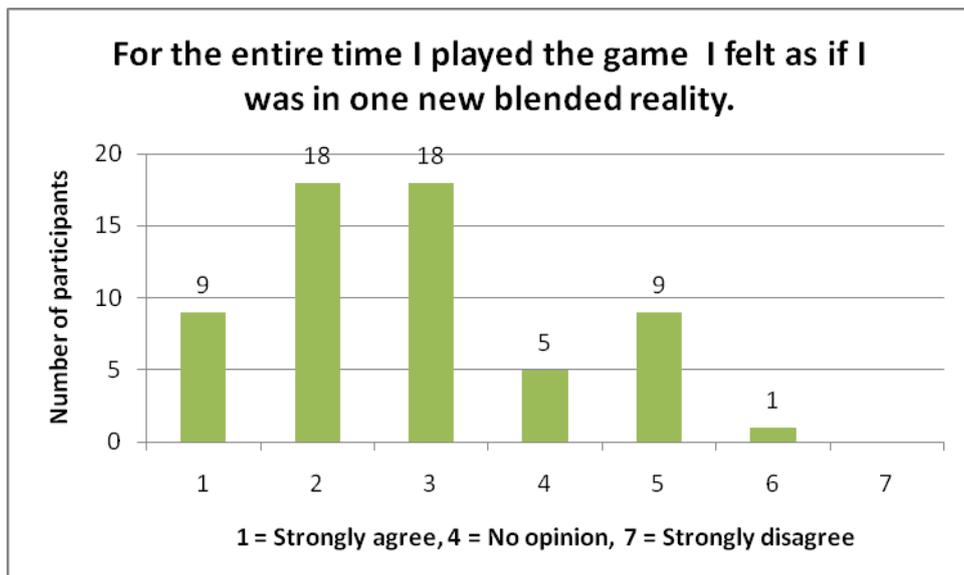


Figure 20. "For the entire time I played the game I felt as if I was in one new blended reality."

6.4.1 Different player behavior

The evaluation of the TimeWarp test runs shows a wide variety of different player reactions ranging from a high degree of fascination to slight boredom. A high degree of fascination often came along with intense scanning of the scenery with the UMPC, preoccupation with the story and corresponding reactions like laughing or commenting on dialogs of the virtual characters. In contrary bored players lowered their devices more frequently and did not listen to the dialogs or watch the virtual scenery.

The following photos (Figure 21 to Figure 24) illustrate different player behavior for two key situations:

- In this scenery of the future-challenge the players are able to see the landing ufo which can be considered as the reward for successfully restarting all the relays².
- In this medieval scenery the player can watch the marriage of virtual characters.

a) Future



Figure 21. Slight boredom: AR-Player (left) is not interested in watching the ufo landing (g3)



Figure 22. Fascination: The same situation is perceived as interesting by these players (g25)

b) Medieval



Figure 23. The players are not interested in watching the marriage of the virtual Heinzelmännchen couple and already walk away to the next challenge (g18)



Figure 24. The players had fun while watching the marriage scene (g2)

² In the future-challenge the players have to activate three different relays, which are located in a triangle around a landing platform, to help a space-ship to land on a space-port.

These examples show that not all players reacted in the same way to the same virtual and narrative content. Nevertheless, it is possible to identify aspects that intensified the experience for many players and aspects that precluded the users from getting involved in the game.

6.4.2 Presence inhibiting elements

This section presents a collection of elements which inhibit the feeling of presence in the game:

- Long dialogs
- Technical problems
- Less activity as navigator
- Security issues
- Distraction by the environment
- Walking between challenges or known places
- Uneasiness of user

Long dialogs

When were you least involved in the game?

“During long dialogs because some were too long.”^{ix} [Ques, p13]

“Intermediate sequences partly too long”^x [Ques, p60]

*Heinzelmännchen: „If you want to set us free, please open the blue portal!”
p36 (impatiently): “Yes, we want that, so please hurry up!”^{xi}*

“During long dialog passages, you are more focused on other things like the cold etc.”^{xii} [Interview, p1]

“I think that it was too often repeated that it is dangerous to send the Heinzelmännchen to the past, although then nothing bad happened.”^{xiii} [Ques, p12]

*“Oh no, now he’s starting like that, too.”^{xiv}
[Testrun, p49, referring to talking future Heinzelmännchen]*

A problem that comes along with narrative game design is the adequate length of storytelling elements. In TimeWarp e.g. the interest conflict between the virtual Heinzelmännchen and Agent Morgan was realized in form of a recurring dispute. While some players found this funny and entertaining, a lot of participants found it difficult to concentrate on the long dialogs.

Technical problems

“The display was mirroring heavily, which limited my perception”^{xv} [Ques, p46]

“Mostly this was a consequence of bad contrast of the display of the UMPC. If my brain has to concentrate too intensively on identifying things on the screen my game experience is interrupted because I experience a technical problem.”^{xvi} [Ques, p59]

“Unfortunately, I was interrupted in my immersion by technical issues (like jittering of objects, bad handling of devices for aiming at something) several times, but nevertheless it was fun.”^{xvii} [Ques, p19]

Technical problems like mirroring displays (see Figure 25), a jittering GPS or the rather unresponsive touchscreen interface of the UMPC sometimes made the users concentrate on the technology rather than the content. Some of the problems were connected to the weather conditions. Thus, many test runs were performed in cloudy and snowy conditions resulting in a particularly strong jittering effect of the GPS signal. On the other hand on sunny days people had problems with the displays due to reflections. In the latter case players often used their hand as a sun block (see Figure 26).



Figure 25. Mirroring of the display (g23)



Figure 26. Player uses his hands as a sunblind (g8)

Less engaging activity as navigator

“An interesting scavenger hunt. Nevertheless as navigator I had the impression to assume a less interesting part than my game partner.”^{xviii} [Ques, p2]

“The device of the navigator was a bit boring and not very interactive.”^{xix} [Ques, p11]

“When I see the virtual creatures or the other game elements by myself I feel involved in the game. As a navigator I am more a kind of person in support of the game and feel a big distance to the game action.”^{xx} [Interview, p21]

“The role of the navigator was indeed not really exciting.”^{xxi} [Interview, p62]

Despite the enhancement of the part of player two (navigator) through more activities players often mentioned that player one had the more active part. The actual balance of activities between player one and two was chosen to avoid a surcharge of interactions for player two. The test runs showed that the actual workload of navigation and decision making was not always correctly understood. In some cases tasks like locating time portals or sending Heinzelmännchen through time portals were misunderstood (e.g. g3, g5). Reasons for this includes: a lack of attention in tutorial because of long dialogs, distraction from listening through environmental disturbances, and technical problems.

Another possibility of course could be the fact that the AR device is intrinsically more interesting than any navigation device could have been. As the AR player you are always surrounded by virtual content which to most players was a new experience. The navigator role however lacked this sense of excitement.

Safety issues

*“I quickly checked if the area in which we went was dangerous. I did that without the system and when I was sure that everything was fine I entered the system.”^{xxii}
[Interview, p22]*

“I sometimes didn’t like to walk on stairs or through mud...”^{xxiii} [Ques, p24]

TimeWarp was played in the old town of Cologne near the Rhine and had no severely restricted game area. Therefore the players had to face all typical elements that belong to that part of Cologne such as stairs, cars and passing pedestrians or cyclists which form potential risks for the players. Although the main game area was carefully chosen to be mostly pedestrianized, it also still included a few streets where cars occasionally drove through (as seen in Figure 28).



Figure 27. The navigator (right) makes a detour due to dangerous icy spots (g25)



Figure 28. A car is approaching (g4)

Players were generally cautious and looked for their own safety before engaging in the game. Typically they would check their surrounding before running around or walking quickly and in snowy weather conditions the players would often make a detour to avoid icy spots (see Figure 27). The Rhinebank seemed to have worked well as a location. Not least due to the cold weather it was relatively quiet and empty, and thus allowed the players to roam quite freely. Putting an application like TimeWarp in a busier environment would require a redesign to make players more aware of safety issues in their environment. Ensuring participant safety is the responsibility of the designers.

Distraction by the environment

When were you least involved in the game and why?

“When there was noise from the streets and distraction from the outside.”^{xxiv} [Ques, p55]

“Where is it? I can’t see it anymore due to all the kids!”^{xxv} [Testrun, p32]

Environmental distractions are uncontrollable in field trials and have a direct impact on the game experience. Any game area has specific advantages and disadvantages which have to be taken into account before setting up a game.

The field trials showed that often large groups like school classes, who actively tried to call the attention of the players, distracted the players from the game experience (see Figure 29 and Figure 30).



Figure 29. A school class is disrupting the players by walking closeby (g16)



Figure 30. A school class is disrupting the players by, watching, shouting and waving (g24)



Figure 31. An innkeeper is not pleased about the players watching through her window (g13)

In one case the players approached the windows of a restaurant and the keeper was obviously not as pleased by the game as the players, as she came out of the restaurant to find out what was going on (see Figure 31).

Furthermore, environmental noise sometimes drowned out the actual game audio content, as trains passed by on the nearby Rhine bridge or cars prevented the players from fully concentrating on the game.

Walking between challenges or known places

When were you least involved in the game and why?

“When walking longer distances with known end points. Then the virtual environment was not that important.”^{xxvi} [Ques, p9]

“When walking to the next object / point of interest.”^{xxvii} [Ques, p52]

“While searching for Emil as the way was a bit long.”^{xxviii} [Ques, p27]

In several game situations in TimeWarp the players have to walk certain distances up to about 150 metres to get to the next point of interest or go back to a place they already know. This is e.g. the case when the players guide the groom Emil with them to his bride Emma or

when they walk back to the Roman character Roy after successfully collecting all his body parts.

In the questionnaire several players stated that in these walking passages they were involved least in the game. The video analysis showed that players often lowered their devices on the way between known places (see Figure 32 and Figure 33) but also when they approached virtual objects that were still far away (see Figure 34). Some participants also started talking about other topics like e.g. the weather.



Figure 32. Players lowering the device on the way back to Emma (g5)



Figure 33. This two players are on the way back to Emma (g16)



Figure 34. These players are on the way to find Emil (g10)

Reasons for the low presence of the players during the way between known places can be manifold. For instance, the way between known challenges was often very sparsely decorated with virtual objects which made looking through the UMPC unnecessary. In addition, if the place was already known from an earlier conversation with a virtual creature most people had build up a mental map and would find back to that place without watching through the UMPC the entire time.

Very active players probably missed interaction possibilities or visual cues on the way. This most likely resulted in a decrease of attention and involvement. Furthermore, many players were more concentrated on their security when walking between different places. Compared to interactive situations like talking to the virtual creatures where the players stayed at one spot, walking around involved new and possibly icy terrain which attracted the players' attention.

Overall, it seemed that interaction mostly happened when the players were standing still, with the notable exception being the run for the time-portals.

It would have been interesting to see the impressions of the players when dealing with two of the challenges we had to cut from the Cologne trials: The beer barrel one (where players had to follow a beer cart and collect dropped barrels, see 4.5 M2 – Beer barrels (Medieval)) and the escape challenge (where a robot was fleeing from the players and they had to run after him, see 4.6 F1 – Escape (Future)).

Uneasiness of user

When were you least involved in the game and why?

“When in the end the ufo started because it was getting cold and I was no longer able to concentrate.”^{xxix} [Ques, p36]

“The weather was definitely too cold for an outdoor game without warm jackets³. “^{xxx} [Ques, p9]

The personal well-being of the player is another important aspect that must not be neglected. As an outdoor game, TimeWarp is always dependent on weather conditions. The test runs 2010 were performed in the German winter - often at under 0 degrees Celsius - and so the weather distracted several users from fully concentrating on the game. One testrun (g7) even had to be stopped due to the uneasiness of a user!

6.4.3 Presence supporting elements

The following sections present elements which help the user to get involved in the game:

- Novelty
- Time pressure
- Interaction
- Story Line
- Searching the scenery
- Social behavior of virtual characters

Novelty

When were you most involved in the game?

“At the beginning, due to the novelty.”^{xxxi} [Ques, p65]

“At the beginning of the game I was most involved, as it was completely new to me and I was very curious.”^{xxxii} [Ques, p5]

“I was thrilled by the optical experience, combined with a playful exploration of the game area. Moving in the AR was the most impressing.”^{xxxiii} [Ques, p16]

Augmented Reality is a technology that is not yet very popular and therefore during the TimeWarp evaluation many participants encountered Augmented Reality for the first time.

³ The player did not follow our advice of wearing warm clothes.

People were curious what this new technology would look like and were very engaged in the game at the beginning when everything was new to them. The first sight of the virtual scenery often produced “wow”-experiences and people found the virtual objects fascinating (see Figure 35 and Figure 36).



Figure 35. The AR player is fascinated and scans the environment with interest (g14)



Figure 36. Scanning of mixed reality (g17)

Novelty is an involvement supporting element that can quickly abate when people get used to the technology. The main challenge is to hold the stimuli up and produce new and inspiring effects that captivate the user. This is of course related to 6.4.2 Presence inhibiting elements when we talk about the lack of engagement for the navigator player.

In TimeWarp this was e.g. realized by very different 3D objects for the different time zones. While in the Roman and medieval time most objects were fixed on the ground the ufo in the future challenge was flying above the users' heads forcing them to look up and look around. In contrast, in the medieval scenario the user was followed by a virtual creature which produced a very positive surprise effect when looking back (see section 6.7.3).

Time pressure

When were you most involved in the game and why?

*“In the future our time was running out [...]. That helped me getting immersed”
[Interview, p11]*

“When creating and searching for time portals I was most involved in the game. It seemed to be a time-critical task”^{xxxiv} [Ques, p22]

*“When I had to restart the relais as quickly as possible as speed was important.”^{xxxv}
[Ques, p7]*

“When I had to search for the portal – due to the time pressure.”^{xxxvi} [Ques, p37]

*“I would have liked to be told to do things faster, so that it gets more stressful.”
^{xxxvii} [Interview, p8]*

Time pressure requires the users to solve the game tasks in a limited time. This effect had a positive impact on many players and helped them to fully concentrate on the game and get engrossed in the story. Besides, the indicated time pressure showed the possibility to fail which appeared to be another incentive to strive and solve the tasks. In TimeWarp the most time-critical action was time-travelling. Specific results can be found in section 6.8.2.

Interaction

“Ufo landing area with 3 relais: the high number of virtual elements and the high degree of interaction was fun.”^{xxxviii} [Ques, p16]

“The more interactive and the less you were just standing around listening for explanations, the more you were engaged in the game.”^{xxxix} [Interview, p56]

The interactive parts that allowed for an active mode of play were seen as a plus by the majority of our test-players. This view was contrasted by that of those players who preferred listening to story lines and concentrating on game instructions (see next section).

Those who preferred the interaction over the story enjoyed the physical activity of moving around, exploring the game space, and rushing for time portals. This interaction was generally supported by providing interactive elements to the players. On the one hand these were clickable objects such as virtual characters or objects, as in the ufo landing example quoted above. Providing enough opportunities for interaction for players can be seen as a design recommendation, as the more densely populated ufo landing challenge was reportedly more fun for many players.

On the other hand the curiosity of the players for the audio-visual appeal of the mixed reality scenery provides a substantial ground for an enjoyable interaction. As players move around and explore the game-space their curiosity for a well made augmented reality scenery can provide an end in itself.

Searching the scenery

When were you most involved in the game and why?

“I was most involved while searching for objects.”^{xl} [Ques, p4]

“While searching for Heinzelmännchen or objects, as I was then perceiving the environment solely through the device.”^{xli} [Ques, p46]

Searching the scenery can be seen as a mode of interaction or as part of the story line, or both. In any case, searching provokes a pro-active engagement with the scenery and calls for immediate action. All our players implicitly accepted searching as part of the game. Moreover they seem to have enjoyed doing so as quotes like the ones above suggest.

Story Line

When were you most involved in the game and why?

“I was most involved in the game during the dialogue sequences, as they contributed to my understanding and were important to advance in the game. Therefore I paid more attention”^{xlii} [Ques, p33]

“When I had to pay attention to what the agent and the virtual characters were saying.”^{xliii} [Ques, p47]

“During the video-sequences and while interacting with the virtual characters.”^{xliv} [Ques, p52]

The story line acts as a “red-line” throughout the game. TimeWarp starts with the tutorial level which provides initial guidance to the players and a first contact with agent Morgan who explains them how to use their equipment. At some point their training mission gets aborted and they are thrown into their first real challenge, which seems straightforward to solve. However, at the end of each challenge the players are confronted with a dilemma situation for which they had not been prepared during the introduction of the game. As they completed a challenge, the players suddenly had the option to decide whether they wanted to send the encountered virtual Heinzelmännchen-character back to its master, as previously discussed, or to liberate it and grant freedom based on moral grounds.

These dilemma situations can be seen as reinforcing for the story-line, and thus for collaboration and social presence in general. Most teams were at least discussing the options they were given. And many of those who initially decided against the Heinzelmännchen changed their attitude towards them at the end of the wedding challenge, where they just helped to re-unite a loving couple that got separated on their way to the church, and did not feel like separating them again. The wedding challenge also serves as a good example for social behaviour of virtual characters as discussed in the next paragraph.

However, the effect was not limited to these kind of dilemma situations. Due to the narrative style of the game the players had to listen carefully to find out what their next task would be. Compared to other games in these adventure-like games the way to reach the final goal still had to be discovered and rules were not known in advance. This resulted in some players highly concentrating when they were given a new order and therefore engaging in the game content.

Having a clear start objective for the players was described⁴ as a key ingredient to story-driven game design already more than twenty years ago by Ron Gilbert, the designer of Monkey Island and many other best-selling adventure games of the 1980s and 1990s. This advice was followed in TimeWarp where players were guided through the initial phase of the game by a clear objective and a lot of audio/video dialogues that were scripted to tell the story. Some players really liked following the story line, as exemplified by the above quotes, and a few even asked for an extension of the story line. But for many players the dialogues were simply too long, as they were seemingly more after a quick interactive experience.

Social behavior of virtual characters

When were you most involved in the game and why?

“When I saw the second robot that had to be collected for the wedding. The reason might be that you were integrated into social behavior.”^{xlv} [Ques: p9]

What was your favorite place?

“I liked the Middle Ages most as the love story between the two Heinzelmännchen felt more „real“ for me than the 3D objects.”^{xlvi} [Ques, p34]

“The Middle Ages because I liked the lovers story most.”^{xlvii} [Ques, p24]

“Of course the Middle Ages due to this heartbreaking story”^{xlviii} [Ques, p61]

In the medieval TimeWarp challenge the Heinzelmännchen Emma is looking for her love Emil who got lost and asks the players to search for him in order to save the upcoming marriage. When the players succeed the marriage performed by agent Morgan takes place.

⁴ <http://grumpygamer.com/adventuregames>

The questionnaire showed that several players liked the love story and that the virtual marriage touched them. The behavior observed from videos also pointed to people sympathizing with the Heinzelmännchen couple. Often they would smile (see Figure 37 and Figure 38) and express their sympathy by commenting the scenery.



Figure 37. These players watch the marriage scenery smiling (g31)



Figure 38. These players also like the marriage (g12)

The challenge showed that social behavior, even if it is the social behavior of virtual creatures, can touch people and get them engaged in the game. Love and marriage are strong emotional topics that are attractive to many players. Applying this human touch to the virtual characters made it easier for the players to identify themselves with the situation of the Heinzelmännchen and to show empathy.

6.5 Temporal Presence

6.5.1 Results

“Due to the surrounding objects you had the feeling of being in a different time zone – and due to the time portal”^{xlix} [Ques, p4]

“I didn't really feel different in the periods. But the buildings that appeared did give me some spatial awareness, e.g. to be able to walk around something.” [Ques, p26]

“I didn't have the impression that I was in the future. I had more the impression that I watched an interactive film that was quite well made.”^l [Interview, p21]

“I did not have the feeling of being in a different time”^{li} [Ques, p48]

The feelings towards temporal presence were varying. However, most players did not have the feeling of actually being in a different time period. This was also indicated by the results of the questionnaire. Here, a lot of players e.g. stated that they didn't feel a time shift when moving between time periods (see Figure 39).

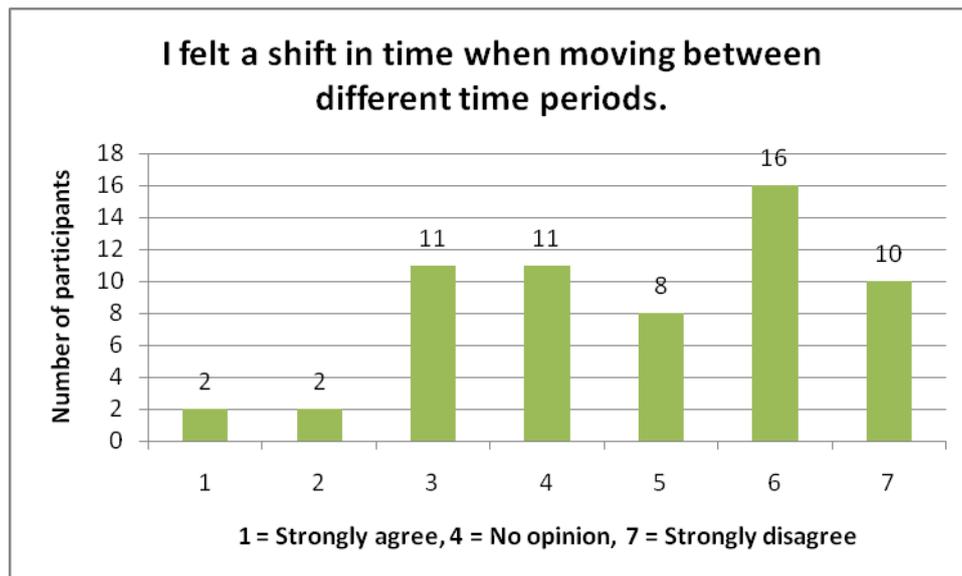


Figure 39. “I felt a shift in time when moving between different time periods”

6.5.2 Possible Reasons

It seems that the feeling of temporal presence is related to a number of factors that were not fully covered by TimeWarp. In this section we present a number of possible reasons for the lack of temporal presence and give advice on how the aspects could be improved:

- Reality too present
- Missing vivid virtual elements
- Not enough virtual objects and details
- Concentration on reaching the goal of the game
- Navigator interface did not change radically
- Logical errors

Reality too present

*“[...] these roman arcs or the bridge. Yes, of course I realized them. There is something but I was never able to fade out the things around, i.e. the present.”^{lii}
[Interview, p55]*

Feeling of time? *“Difficult [...]. The kiosk was standing there or the ship was in the background. That was also there when I watched through the device. There were only additional objects superimposed.”^{liii} [Interview, p20]*

TimeWarp visualizes time-typical elements in the display of the UMPC. Due to the size of its screen and the limited field of view of the camera, the augmented view can only cover a small fraction of the environment that surrounds the players. As a result, the user is still confronted with the surrounding environment of present Cologne at all times. Present buildings, people wearing current fashion and hair-style, up-to-date cars and other objects belonging to the present time all stand in contrast to the computer-generated vision of former or future times and hinder the effect of illusion. It has to be noted that choosing a head-mounted display instead of a screen, as we have done for a previous TimeWarp prototype, presents no solution to this intrinsic problem, but rather introduces a number of different problems which ultimately caused the switch in TimeWarp between the first and second year prototypes from HMD to UMPC based Mixed Reality. Among them were:

- Uncomfortable to wear (either very tight around the head or loose enough to slip)
- Extremely limited field of view
- Display quality too low when used in direct sunlight (or on bright days in general)
- Unable to share screen with a potential second player
- Dizziness when not used to the device
- Attracting strange looks from non-players

Generally, in the context of a typical mobile outdoor augmented reality application, the environment will always be an integral part of the scenery, and any mismatch between the actual environment and the virtual content will cause distraction or confusion. There are several approaches to improving the integration of the real and the virtual scenery in this sense, e.g.:

- 1) Aim for perfect registration and rendering, and try to bring the qualities of the virtual world as closely as possible to that of the real world. This is commonly called photo-realistic rendering.
- 2) Make a conscious decision against photo-realistic rendering.
- 3) Reduce the fidelity of the captured camera view by filtering it down to the quality of the virtual rendering.
- 4) Avoid having disturbing artefacts of the real world in the scenery by choosing a remote area that could be believed to be part of a different time. There is for example an initiative to provide a mobile augmented reality view of the former Roman town of Caistor, UK, which is nowadays invisible and located in the middle of green meadows, with no modern structure in sight⁵. Another example is the LifePlus project set in Pompeii⁶

Approach 1: In an ideal world one could provide a perfect quality AR experience that fully integrates with the perceptual qualities of the world that surrounds us. In addition to providing photo-realistic rendering, one would eventually have to alter the snapshot of reality by adding shadows (Haller et al, 2003), removing certain features (Azuma 1997), or modifying some materials (Khan et al, 2006). Nevertheless, an augmented reality view that is geared towards supporting temporal presence by providing real world like rendering quality will be unrealistic for years to come. Consider a system where images of buildings and passerby need to be translated into another epoch in real-time. While this might prove feasible for buildings to a certain degree, computationally translating the appearance of other people so that they match the frame of the game would require too much effort from today's perspective. Moreover such an approach would tackle the problem from the wrong side, as much can already be achieved when relaxing the requirements a little bit and designing for only the best interactive moments and with slightly less visual detail.

Approach 2 was taken by TimeWarp, which chose a cartoon-like rendering style for its virtual objects. Rendering that doesn't match the visual qualities of the captured camera image can sometimes aid the users in orienting in the augmented world, as the visual objects clearly "stick out".

Approach 3 is embodied in a technique called "Reality Filtering" by Zöllner et al 2008, and can help to better integrate old photos or paintings with realtime-filtered camera images.

⁵ <http://www.south-norfolk.gov.uk/venta>

⁶ <http://lifeplus.miralab.unige.ch/>

Approach 4 could be interesting for certain mobile augmented reality applications, but will prove difficult in urban areas. However, some of our players responded that they could imagine finding TimeWarp equally engaging in large open spaces like, e.g. a soccer pitch.

Missing vivid virtual elements

“In the medieval were the tents but when I think of the medieval time I also think of people wearing ancient clothes etc. and doing something in the background. Just seeing some tents is not enough to get the impression of being in the medieval time” [Interview, p10]

“You could integrate people (virtual passersby) into the environment to make the experience more real”. [Ques, p54]

“As already mentioned some more details in the other time periods would be very helpful for the immersion, especially vivid elements!”^{liv} [Ques, p31]

Several participants didn't have a feeling of being in a different time because they associate more than just a couple of buildings with the time epochs. Especially vivid elements like people performing typical everyday tasks were missed. This effect is possibly intensified by previous experiences of our participants, such as visiting medieval markets or taking part in a life action role play (LARP, Holter et al 2009), which deliver an intense insight into the life in former times.

Not enough virtual objects and details

“I would have liked more tiny, time-typical details (at houses, on the floor); that would let the time periods appear more vivid.”^{lv} [Ques, p16]

“Middle Ages: A virtual plaza with more virtual objects and buildings would have appeared more real and would have immersed you more into the story. Additionally, the virtual people are still very schematic.”^{lvi} [Ques, p2]

Too few virtual objects and missing details were two of the major points of criticism. TimeWarp sketches every time period primarily with a selection of time typical buildings and objects. To feel temporal presence therefore requires a high degree of imagination. For many players the indicated relicts of former times were insufficient to create a feeling of actually being in that time. Designing a virtual scenery with more virtual objects and more detail might improve the players' experience. A possible overload of virtual content has to be taken into account. As the AR technology is new to most users they could get lost in too much virtual content. One solution could be more clearly marking the interactive elements amongst all the virtual elements.

Concentration on reaching the goal of the game

*“Between the time periods I didn’t note any difference because I was more concentrated on reaching the goal of the game than on the virtual environment.”^{vii}
[Ques, p15]*

*„While searching for the H’s I did not really pay attention to the time periods“^{viii}
[Ques, p36]*

Motivation for playing games can be distinct for different types of players and while some might enjoy the process of playing and immersing into the game experience itself, others primarily focus on achieving the game goal. Thus, goal-oriented players have a smaller, but more focused field of attention and will concentrate only on elements that are important for reaching their objective rather than embellishing surrounding visual effects. In consequence, the missing attention on time-typical virtual elements then prevents them from feeling temporal presence.

Navigator interface did not change radically

*“I did not realize a big difference as my map was always looking the same”^{lix}
[Ques, p6]*

Temporal aspects were primarily visualized by the augmented reality content that was only visible on the display of the AR player. The interface of the navigator consisted of a map and a time zone menu. In the different time periods these elements hardly change and therefore the temporal experience of the navigator was highly dependent on the collaboration with the AR player.

Logical errors

“This aqueduct and the arc, with these things you were transferred to the Roman time but the thing was broken – why was it broken in the Roman time?”^{lx} [Interview, p7]

“the Roman time disappointed me, as at that time (500 b.c.) there was no Roman in Cologne and more than ever no aqueduct.”^{lxi} [Ques, p45]

The feeling of being in a different time is connected with the idea people have of this time period. Depending on their background the participants had different knowledge about the history and therefore also different expectations of the game.

In some cases the historic accuracy of the TimeWarp game – especially of the Roman time - was questioned by players. While the majority of players were able to accept the virtual roman scenery as elements that suggest the Roman time period, some players were not able to get a suspension of disbelief and therefore had difficulties to feel the temporal presence of that time period.

6.6 Teamplay, Collaboration, Co-Presence

6.6.1 Playing in teams

“I also liked that we didn’t play alone but in a team”^{lxii} [Interview, p49]

“It would not be that much fun alone.”^{lxiii} [Interview, p61]

“It would have been possible to design the game for one screen [...]. But it wouldn’t have been that much fun. In fact you need the other player and you were able to agree on things, correct errors or just to care for the other one to not run into something.”^{lxiv} [Interview, p62]

The conceptual design as a collaborative game was rated as very positive by the majority of participants. The players often stated that it is much more fun to play in pairs. Several players also found it helpful to have somebody who might know what to do when discovering a new technology like augmented reality.

The video analysis showed that team partners were often very preoccupied with the security of their game partners. They often warned about upcoming obstacles, quickly passing pedestrians or dangerous icy spots. Furthermore, good collaboration of players was often accompanied by frequently showing each other the display of the UMPC, taking decisions together, reading answer possibilities aloud, or describing the game partner what one actually sees or does (see Figure 40 to Figure 45).



Figure 40. The navigator helps the AR player whose headset fell when watching the ufo (g14)



Figure 41. The players read the answer possibilities together (g31)



Figure 42. These players discuss their next answer (g4)



Figure 43. The navigator keeps the AR player back as a pedestrian is crossing suddenly (g24)

Especially in situations which were perceived as kind of spectacular and extraordinary, such as the landing ufo or the following virtual creatures, the players often would try to share their experience with the gaming partner by letting the other know and offering to watch through the display together (see Figure 44 and Figure 45).



Figure 44. These players are sharing the screen when watching a virtual scenery (g24)



Figure 45. These players enjoy watching the marriage of the virtual creatures together (g5)

Additionally, game instructions were often repeated and discussed by the players and so that misunderstandings could often be eliminated. On the other hand conversation occasionally kept the people from listening to important story information. One repeatedly heard suggestion to remedy this attention problem was that it would be handy to have an option that allowed repeating the last piece of advice from the story line.

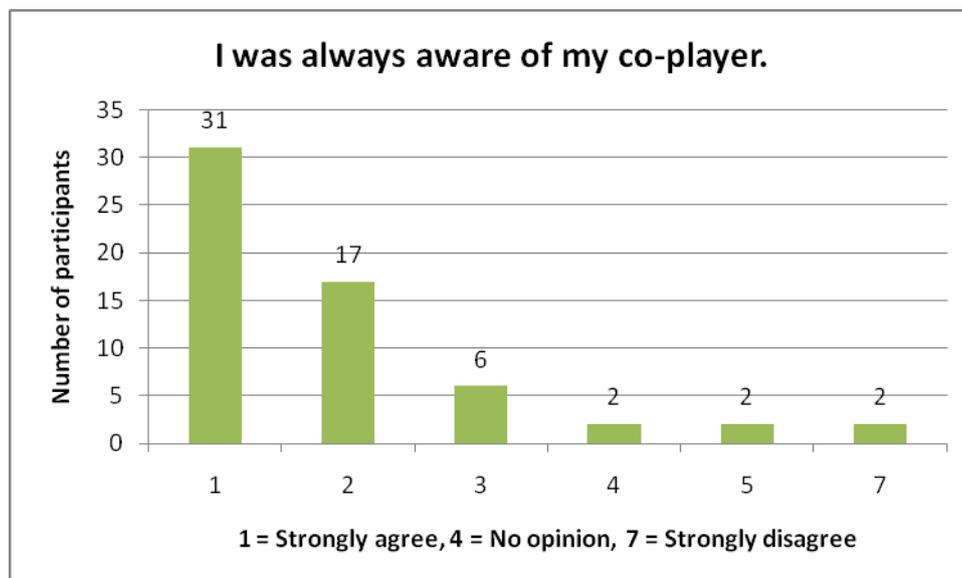


Figure 46. “I was always aware of my co-player”

The presence of the team-partner was very strong for the majority of players, as can be clearly seen in Figure 46.

Equipment

“You would probably feel really stupid, running alone with that equipment. I think it’s much better in pairs.^{lxv}” [Interview, p37]

Regarding the game equipment several players felt less embarrassed by the equipment as somebody else in their vicinity was wearing the same technology. This kind of awareness about one’s own social presence in a public space was generally not an issue for most players, as many mentioned that they were accustomed to seeing people freely use small electronic devices such as mobile phones, digital cameras, or Bluetooth headsets. Nevertheless it was also mentioned that attractive “life-style” devices would be more desirable and socially acceptable and would make players feel more comfortable while using them in public. So the appeal of technology, and how it contributes to one’s persona is definitely an issue.



Figure 47. Steadycam operator and observer following two test-players.

Our survey setup is certainly not bias-free, as we were following each team with two to three people: the steadycam operator, the observer who took notes on a tablet PC, and possibly a third person that acted as a jumper. Overall this group of people (players and team) looked like a film-crew from the outside (see Figure 47), and we had several encounters with passerby who had an interest in being filmed for television. What this means is that our setup in itself might have created some kind of protective social shell in which the players were acting slightly different to their normal everyday behaviour. Thus, we quite possibly altered the effect that we were trying to observe. This is generally not a problem for our study, but worth keeping in mind when looking at quotes like the one above. Our observations and interviews during the pilot-studies revealed that as long as the team kept some distance and did not move too quickly, many players quickly lost their awareness of the team that surrounded them.

Sympathy

Unsurprisingly, the degree of collaboration between players was largely dependent on the players’ sympathy for each other, how open they were as individuals, how easy they felt, and how willing they were to collaborate in the situation at hands. Mobile AR as presented in TimeWarp was a new experience for all our players, and participating in a research trial with video-observation added to the thrownness (Heidegger, 1927) of the situation with which the players had to cope. Mutual sympathy seemed to have helped our players to master the situation and get into a flow.

“I can imagine the game for portals like e.g. ,New-in-town‘.”^{lxvi} [Interview, p62]

We observed that many players who had never met before (e.g. half of the players shown in Figure 40 to Figure 45 had not met before) collaborated surprisingly well. It seems that their common task of playing the game gave them something to talk about, and that the experience of playing in a team helped them to overcome their feelings of being shy with strangers. This was also explicitly mentioned by some of our players during the interviews. One pair of players – who didn’t know each other before – elaborated that they could imagine using a similar experience for mobile friend finding services like “New-in-town” (see quote). The players who mentioned this idea were almost heading off to a bar after the game, and just didn’t do so due to other commitments.

6.6.2 Collaborative interaction with a virtual character

| Group ID | Uncollaborative Interaction (#iai, #ias) | Collaborative Interaction (without portal decision) (#iac) | Collaborative Interaction (only portal decision) (#iac) | Reading answers aloud (#ral) | AR Player watching the other screen (#p1 vos) | Navigator watching the other screen (#p2 vos) |
|---------------------|--|--|---|------------------------------|---|---|
| 3 | 1 | 1 | 0 | 0 | 3 | 3 |
| 4 | 2 | 0 | 1 | 2 | 13 | 20 |
| 5 | 1 | 1 | 1 | 0 | 12 | 14 |
| 6 | 0 | 2 | 1 | 2 | 11 | 18 |
| 8 | 1 | 1 | 1 | 1 | 3 | 5 |
| 14 | 2 | 0 | 1 | 2 | 12 | 20 |
| 16 | 2 | 0 | 1 | 0 | 0 | 0 |
| 17 | 1 | 1 | 1 | 2 | 5 | 3 |
| 18 | 2 | 0 | 1 | 0 | 6 | 6 |
| 23 | 0 | 2 | 1 | 2 | 0 | 11 |
| 24 | 0 | 2 | 1 | 1 | 5 | 10 |
| 25 | 2 | 0 | 1 | 0 | 0 | 12 |
| 30 | 0 | 2 | 1 | 1 | 1 | 3 |
| 31 | 1 | 1 | 1 | 2 | 2 | 3 |
| 32 | 2 | 0 | 0 | 1 | 3 | 4 |
| 33 | 0 | 2 | 1 | 2 | 5 | 10 |
| Totals | 17,00 | 15,00 | 14,00 | 18,00 | 81,00 | 142,00 |
| Mean | 1,06 | 0,94 | 0,88 | 1,13 | 5,06 | 8,88 |
| St.dev | 0,85 | 0,85 | 0,34 | 0,89 | 4,55 | 6,52 |
| Group Count | 11 | 10 | 14 | 11 | 13 | 15 |
| Frequency per group | 1,55 | 1,5 | 1 | 1,64 | 6,23 | 9,47 |

Table 1. Collaborative and uncollaborative interaction (the codes used for video analysis can be found in Appendix 12.2 Video codes (page 80))

Collaboration was a key element of the TimeWarp design, the primary objective being to allow players to co-construct a new reality. The precise level of collaboration varied between groups (see 6.6.1, 6.6.1 and 6.6.1) and was task dependent. At the overall level (see Table 1) 10 of the 16 randomly selected groups where the video data were analyzed engaged in a cooperative way when answering questions during the Roman Time Period. Device sharing, or looking at the other players device was also a key element in co-operation with both

players engaging in this task, for example in 15 of the groups player two (navigator) looked at player one's device while in 13 groups player one looked at player two's device. In general player two was far more active in looking at the other device than player one. Further aspects of co-operation were also identified within the use of verbal and physical gestures (see Table 2), which were used frequently by both players. In some cases when there was little device sharing this was replaced by the use of gestural and verbal information.

| GROUP ID | Player 1 (AR player) | | | Player 2 (navigator) | | |
|---------------------|-------------------------------------|--------------------------------------|--|-------------------------------------|--------------------------------------|--|
| | Verbal directional advice (#p1 dav) | Deictic directional advice (#p1 dad) | Directional advice with head (#p1 dah) | Verbal directional advice (#p2 dav) | Deictic directional advice (#p2 dad) | Directional advice with head (#p2 dah) |
| 3 | 1 | 0 | 0 | 3 | 5 | 0 |
| 4 | 1 | 1 | 0 | 2 | 4 | 2 |
| 5 | 3 | 0 | 0 | 0 | 3 | 0 |
| 6 | 4 | 6 | 0 | 2 | 9 | 0 |
| 8 | 0 | 0 | 0 | 8 | 7 | 0 |
| 14 | 1 | 1 | 0 | 2 | 4 | 2 |
| 16 | 1 | 1 | 0 | 0 | 6 | 0 |
| 17 | 0 | 0 | 2 | 2 | 1 | 0 |
| 18 | 3 | 0 | 1 | 6 | 4 | 0 |
| 23 | 1 | 1 | 0 | 2 | 4 | 0 |
| 24 | 0 | 2 | 0 | 2 | 2 | 0 |
| 25 | 4 | 4 | 0 | 6 | 6 | 0 |
| 30 | 3 | 7 | 1 | 8 | 5 | 0 |
| 31 | 1 | 1 | 0 | 0 | 1 | 0 |
| 32 | 1 | 0 | 0 | 5 | 1 | 0 |
| 33 | 2 | 1 | 0 | 10 | 9 | 1 |
| Totals | 26,00 | 25,00 | 4,00 | 58,00 | 71,00 | 5,00 |
| Mean | 1,63 | 1,56 | 0,25 | 3,63 | 4,44 | 0,31 |
| St.dev | 1,36 | 2,19 | 0,58 | 3,14 | 2,56 | 0,70 |
| Group Count | 13 | 10 | 3 | 13 | 16 | 3 |
| Frequency per group | 2 | 2,5 | 1,33 | 4,46 | 4,4375 | 1,67 |

Table 2. Overview of ways for directional advices the players used (the codes used for video analysis can be found in Appendix 12.2 Video codes (page 80))

Across the videos other patterns of collaboration emerged, for example group dynamics had an impact on the degree of co-operation. However this appeared not to be dependent on the degree of familiarity between players but rather social aspects such as empathy, or the getting to know each other period at the start. The degree of collaboration was also influenced by the task being undertaken, for example whether the players were being asked to undertake a moral or important question, where this was not the case often players would take the decision alone. Further influences were found in the way that players held their devices, or assumed their role within the game. For example some players would refuse to share the device by implying their role was that only they should have access to the device, which might be correlated to previous role-playing behaviour of those players. In contrast loosely defined roles resulted in players frequently sharing or trying to share the device with their co-player.

The following sub-sections provide an overview of different degrees of collaboration.

6.6.1 Example for strong collaboration

These two players are familiar with one another and are regularly in close physical proximity, which indicates they are socially accepting of one another but also gives rise to them being able to share the devices more easily. Moreover they encourage one another to share devices and discuss what is going on.



a) The AR player focuses the virtual creature and presses the red button. The navigator is trying to watch his screen.



b) The virtual Heinzelmännchen is talking and the AR player positions his screen in a way that the navigator can also watch the virtual scenery.



c) The navigator occasionally checks if something happens on her screen. Her view is switching from the AR player display to her own device and back until she discovers the answering choices.



d) Both players watch the answer choices on the screen of the navigator



e) The players briefly discuss what to answer.



f) The navigator presses with the pen on the display to choose the answer while the AR player is watching.



g) Both players react on the auditive answer of the virtual creature and look at each other.



h) The AR player focuses on the Heinzelmännchen again to see the virtual creature while talking. The navigator also focuses her view on his screen.

Figure 48. An example for a strong collaboration (g5)

6.6.1 Example for weak collaboration

This second example provides an example of weak collaboration. Here the players are not in physical close proximity, seem distant from one another, do not share devices and remain rigidly within their roles. Furthermore, one player seems distant from the game.



a) The AR player (right) clicks on the virtual creature and music starts. The navigator doesn't see the creature and wonders why suddenly music starts.



b) The players walk a bit further to approach the creature. Although the navigator is walking at the front he orientates himself according to the AR player.



c) Both players listen to the audio of the Heinzelmännchen. The navigator seems absent. The AR player focuses his display.



d) The AR player (right) reminds the navigator, who seems to be absent, to answer the Heinzelmännchen but keeps his head mainly focused on the display



e) The navigator (left) reads the answers and decides silently. Meanwhile the AR player waits.



f) Both players listen to the audio feedback of the virtual character.

Figure 49. An example for weak collaboration (g16)

6.6.1 Example for average collaboration

In this final example the players were also unknown but their collaboration was comparable to many teams of friends or colleagues. They shared the displays but still held it directly in front of them and did not offer the display actively to the team player. They discussed the answer but when the virtual creature responded to their answer they didn't share the moment by e.g. watching each other.



a) The AR player presses the red button to interact with the Heinzelmännchen



b) The AR player watches the Heinzelmännchen talking while the navigator is trying to watch his screen from the side.



c) When the AR player realizes that he can't answer, he looks at the navigator display and the navigator follows his view.



d) Both players read the answering possibilities while the navigator is reading them aloud.



e) The players briefly discuss the answer and then the navigator presses on the display with his pen.



f) The AR player watches the resulting answer on his screen while both players listen to the audio of the virtual character.

Figure 50. An example for average collaboration (g1)

6.7 Social Presence

“The characters were nicely portrayed.”^{lxvii} [Interview, p46]

“The medieval story was something for the heart.”^{lxviii} [Interview, p56]

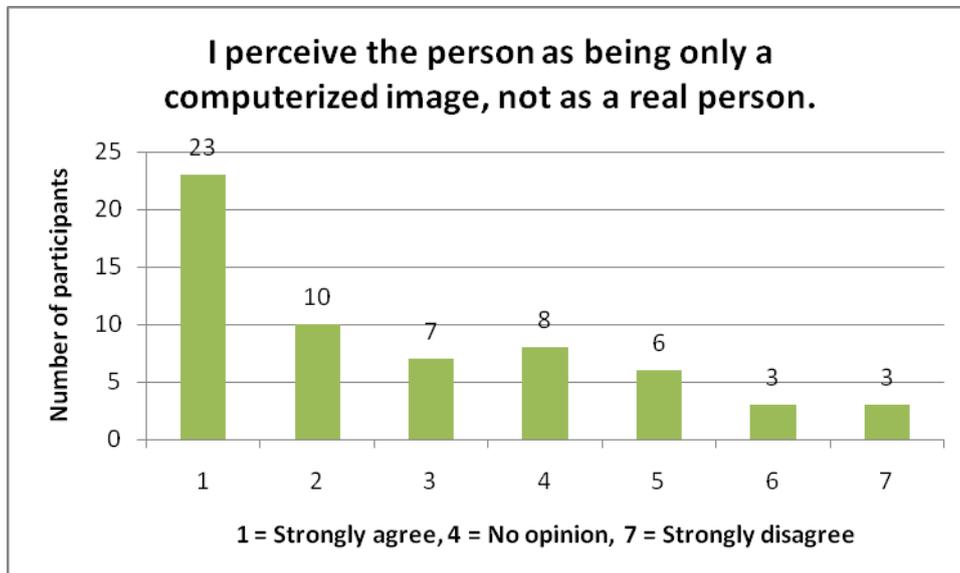


Figure 51. “I perceive the person as being only a computerized image, not as a real person.”

The visual appearance of the characters (graphics) leads most players to the assumption that the Heinzelmännchen were virtual.

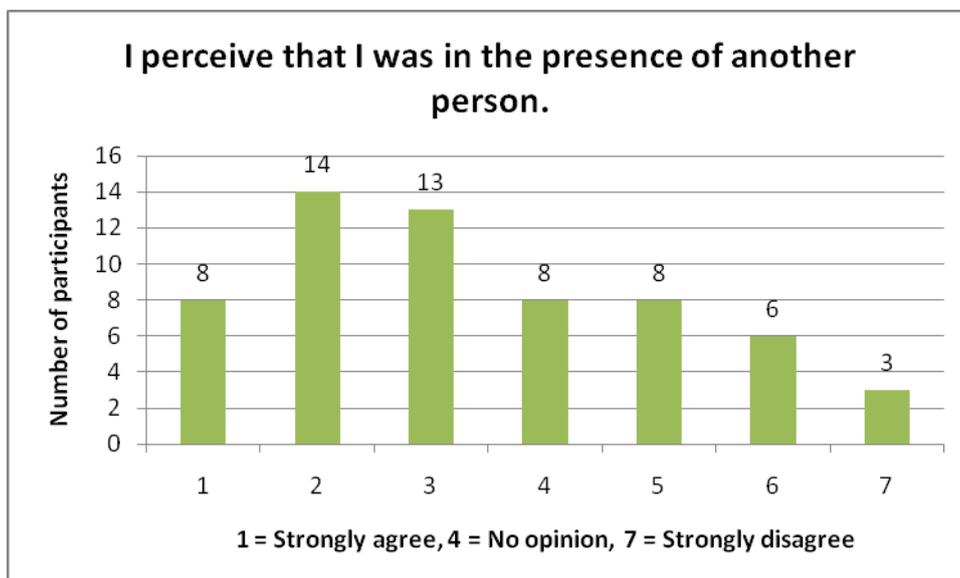


Figure 52. “I perceive that I was in the presence of another person.”

Responses to the cartoon-like nature of the Heinzelmännchen were as expected with people perceiving them as not being real. This approach was used so that people would not seek to compare a computer generated character with a real person, thus leading them to concentrating on the short-comings. Instead a sophisticated narrative structure with accompanying design and game-decisions were used. This approach appears to have been

successful in that the players indicated they perceived they were in the presence of another person when they were interacting with the Heinzelmännchen.

6.7.1 Portal Decisions

*“The moral decision of where to send the Heinzelmännchen preoccupied me a lot”^{lxxix}
[Ques, p34]*

“When we led Emil back and they got married, my game partner got emotional and wanted to rescue them both.”^{lxxx} [Ques, p49]

*“The Heinzelmännchen did argue convincingly and I felt with them.”^{lxxxi}
[Interview, p21]*

*“Come on, let’s open a little commune, a Heinzelmännchen commune.”^{lxxii}
[Test run, p27]*

*“The other one is also in the blue one. In a threesome they can party!”^{lxxiii}
[Test run, p55]*

“These marrying ones were indeed cute. You actually had to bring them together for moral reasons.”^{lxxiv} [Interview, p8]

A narrative framework consisting of a significant element of decision making was utilised to underpin the interactions available within the game; for example deciding whether to follow the Agent Morgan or Heinzelmännchen. Depending on the decision the Heinzelmännchen were either set free or returned to slavery or death. As noted in the quotations above the players felt a strong empathy for the Heinzelmännchen, which in turn altered the importance they attached to the decision making process. This resulted in the decision often being taken as a result of negotiations between the players and also individually. The decision was further influenced by person desires such as to fulfill a duty or to act against Agent Morgan or the particular scenario within the game. For example in the medieval time when players were asked to assist with the wedding scenario the vast majority assisted rather than banished the Heinzelmännchen.

Table 3 provides an overview of all portal decisions made by our test-players. In that table, “blue” means that the players liberated the Heinzelmännchen, and “red” means that the players followed their instructions and sent the Heinzelmännchen back to Agent Morgan.

As “Conflict is an intrinsic element of all games” (Crawford) here the players encounter a rather simple to solve conflict (from a game mechanic point of view), that still engages them from an emotional point of view and makes the decision hard for some of the players. In Table 3 we summarized the absolute amount of the decisions of all players.

| | Blue portal (free Heinzelmännchen) | Red portal (send to Agent Morgan) |
|---------------|------------------------------------|-----------------------------------|
| Roman time | 13 | 17 |
| Medieval time | 23 | 7 |
| Future time | 16 | 14 |
| Total | 52 | 38 |

Table 3. Overview of portal decisions in the different time zones.

While the Roman and Future time are more or less balanced, there is a strong deviation in the Medieval time, which we can look at in more detail in Figure 53. Here it becomes clear that the players made the decision mostly based on their empathy – and their empathy

seems to be higher with the wedding couple than with the other two Heinzelmännchen. This is further empowered by looking at some of the player quotes in relation to this challenge which show that although both characters are virtual, the concept of getting married still creates a strong sympathy for the two of them, something which can arguably only be achieved when the players feel a strong amount of social presence towards the virtual couple.

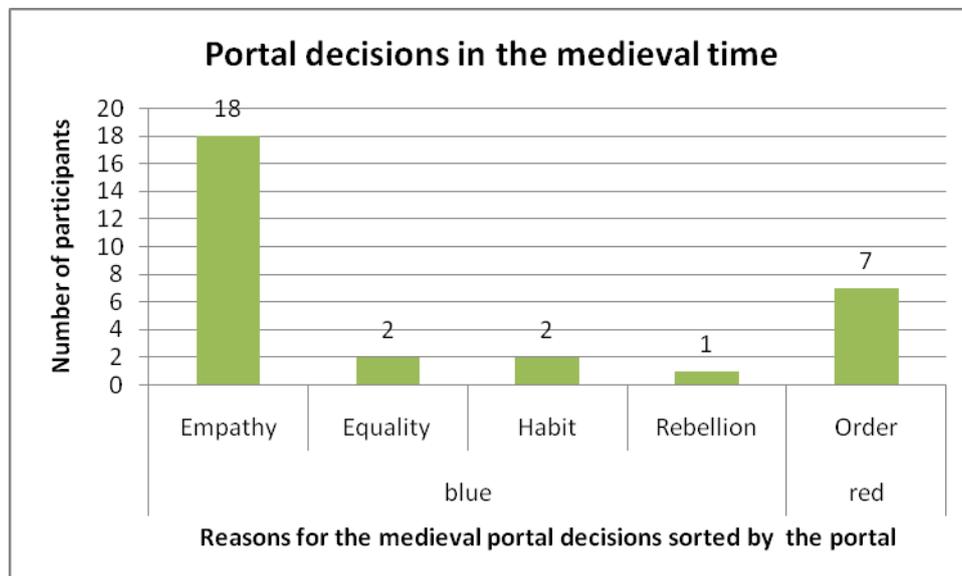


Figure 53. Portal decision reasons for blue and red portal in the medieval challenge based on video observation

6.7.2 Talking to Heinzelmännchen

Interaction with a Heinzelmännchen is initialized when the AR player focuses on the virtual character and presses the red button. The dialog with the Heinzelmännchen is visualized on the navigator display and contains a multiple-choice structure with three possible answers. The response of the Heinzelmännchen is then dependent on the player's decision.

“It is a pity that it is not clear how many possibilities there are to solve the tasks or if the ,right‘ way was chosen. Is it possible to fail at all?”^{lxv} [Ques, p61]

“And then I had the task to answer the text questions and I quickly got the impression that it doesn't matter what I press.”^{lxvii} [Interview, p8]

The interaction technique was well understood by all players. While most players liked the interactive way of getting to know the Heinzelmännchen, some players criticized that the answers were not differentiated and that they got the impression that it “doesn't really matter which answer they chose”^{lxviii} [ques, p8]. However players who believed that the answers impacted on the story and who found the choices meaningful engaged in a higher level of collaboration and often carefully considered the decision and took longer to provide their answer.

Heinzelmännchen: “To whom do I talk?”

Player 2 (navigator): “Yes, hi, I am xx.”

Player 1 (AR player): “And I am yy.”^{lxviii}

The players often interacted with the Heinzelmännchen as if they were in some way real, a finding also indicated in Figure 52. For example on first contact with the virtual characters many players (e.g. g2, g6, g11, g16, g17) answered with natural language. One player explained this as follows:

“At the beginning I wanted to answer the Heinzelmännchen with natural language because I listened to their voices as well. I found it odd to switch between listening and clicking [Interview, p12].”

Another user suggested to

“let the virtual characters start speaking autonomously e.g. when they are close enough instead of clicking on the character [Ques, p7].”^{lxxix}

Appearance and behavior of the Heinzelmännchen led to parasocial interaction. Greeting for example forced players into their social role model as “being greeted” which automatically initiated an answering process in some players despite their knowledge of the virtual nature of the Heinzelmännchen.

6.7.3 Being followed by a virtual character

When were you most involved in the game?

“When Emil followed us and we guided him to the marriage. That was real behavior and could be checked by watching behind yourself with the UMPC”^{lxxx} [ques, p42]

“He is following us. That is really a bit eerie”^{lxxxi} [Video, p2]

“I found it funny, that when we met the one in the Middle Ages, he really followed us when I turned around.”^{lxxxii} [Interview, p37]

Being followed by a virtual character was an experience that fascinated most of the players. In the medieval challenge the players had to find the groom Emil and bring him back to his fiancé Emma in order to marry her. When walking back to Emma, Emil is virtually following the player. This effect can be seen when the user looks behind them to check if the virtual character is following them.



Figure 54. Player walking backwards to watch the following Heinzelmännchen



Figure 55. The players get excited about the following creature and try to attract it



Figure 56. This player is surprised and pleased about the technical realization



Figure 57. The players watch the following creature with interest

Most players intuitively looked behind them and were fascinated. Figure 54 to Figure 57 illustrate some of the players when discovering that the virtual creature was indeed following them. Often the players turned around several times to check if Emil was still there. Some players even attracted the virtual character by sounds as if they would try to attract a little child or an animal. Others could not stop looking at the following creature and walked backwards large parts of the way back to Emma (see Figure 54).

It seemed that a virtual character moving in the real world is a new experience for players and a unique AR-game specific feature. This draws the line between stationary video games which are often used as a comparison to the TimeWarp experience and a location based AR game. "Following" elements evidently create attention and involvement if they are recognized. This unexpected but natural behaviour creates an element of surprise and realism and adds to the richness of the user experience.

6.8 Usability

6.8.1 Hardware

The equipment of the players basically consisted of a UMPC and a headset. Furthermore, a bumbag with audio transmitter was worn by each player to allow for voice recordings.

"It was very interesting. Particularly with all the equipment you really felt like a Chronoguard agent who has to fulfill a mission."^{lxxxiii} [Ques, p38]

"It was an unusual situation to walk around with huge headsets and small computers in our hands, but it was fun."^{lxxxiv} [Ques, p54]

"The device is quite heavy if you have to hold it in front of you for a longer time." [Interview, p27]

"Partly the virtual objects wandered around or were not at the right positions but in trees or park benches."^{lxxxv} [Ques, p38]

"Oh, my arms are getting a bit paralyzed."^{lxxxvi} [Testrun, p37, AR player]

In general, most users did not mind the equipment. Nevertheless several participants found the devices quite heavy and especially holding the AR device up was perceived as exhausting after a while. Another problem of the hardware were mirroring displays – especially on sunny days. Due to the reflections some players found it difficult to concentrate on the virtual content. This effect was worsened if the team player tried to look on the screen of his/her game partner.

Another technical problem was the varying quality of the GPS signal in cloudy and snowy weather conditions, which often caused virtual objects to wander and thereby off-set from their intended positions. The problem of wandering virtual content due to a jittering GPS signal was tackled by a functionality called "GPS fix". The "GPS fix" can be activated by pressing a button on the UMPC. It fixes the positions of the players to the position that was reported by their GPS receiver when the button was pressed. In that way, the user can interact with the virtual objects in a more convenient (static) way, without having to cope with wandering virtual objects. The "GPS fix" button was used frequently by most of the participants.

The public impression of the user using a lot of technical equipment on passersby during the test run didn't bother the majority of players. Often they would not even notice passing pedestrians or cyclists at all. Most participants therefore stated that they did not feel

embarrassing. One user even stated that the equipment made him feel like a Chronoguard agent and therefore worked well with the game scenario. For future use most participants would nevertheless appreciate smaller devices and

“.. in some way equipment that is qualified for the public even for a specific age”^{lxxxvii} [Interview, p62].

6.8.2 Handling

“I found it relatively user-friendly. Both sides. Navigation was also self-explaining.”^{lxxxviii} [Interview, p53]

“Everything was easy understandable and good to handle”^{lxxxix} [Ques, p36]

The handling of the devices was well understood by the majority of players. This was also reflected in the questionnaire in which most players indicated that the equipment was “easy to use” (see Figure 58).

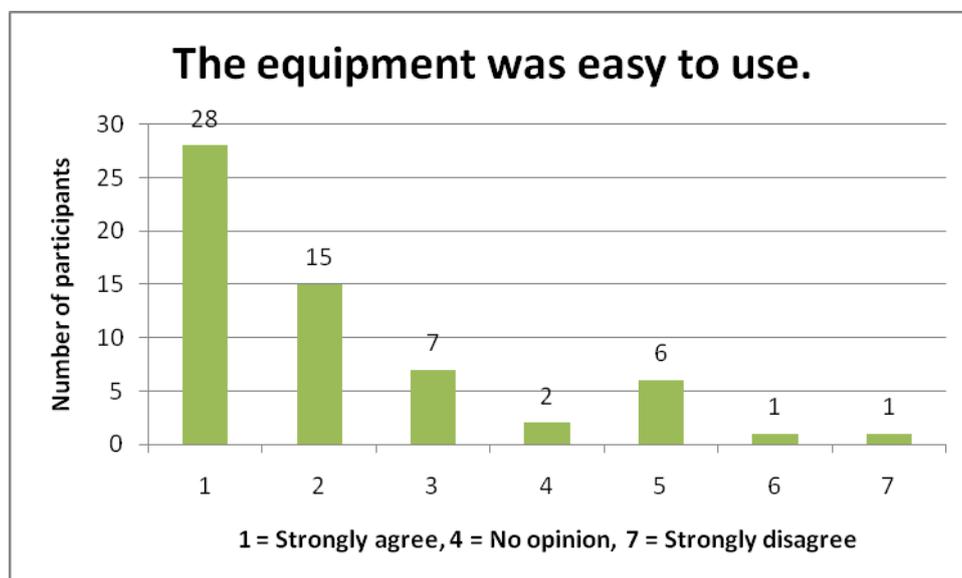


Figure 58. “The equipment was easy to use”

However, both user interfaces were very different and the test runs showed that people generally had more problems using the navigator interface.

In the next sections the specific characteristics and problems of the two user interfaces are presented in detail.

AR player user interface

“Regarding the handling the devices were very user-friendly: you only had to use two buttons”^{xc} [Ques, p29, AR player]

“I can’t guess the distance, yet”^{xcii} [Testrun, p61]

“I could not really tell if it is something big or if it is far away.”^{xciii} [Interview, p22]

“Problems with guessing when virtual objects were spatially behind real objects. No idea if in front or behind and how big the objects should be.”^{xciii} [Ques, p66]

The interface of the UMPC of the AR player with one interaction button and one GPS fix button was kept simple and the majority of players regarded the device as very easy to use. However, as a lot of players experienced augmented reality for the first time, they did not know how to deal with properties like the ability to see through real buildings (we did not implement occlusion). In combination with the fact that the users didn't know the real dimensions of the virtual objects and distances were therefore hard to guess, this sometimes resulted in difficulties in locating specific virtual objects. To overcome this problem users suggested to "display a distance information"^{xciv} [Ques, p19] when hovering with the crosshairs over a virtual object.

Navigator user interface

"I would like to have a higher resolution. And I would like to have a kind of flashing cursor to know where I am."^{xcv} [Interview, p21]

The interface of the navigator player consists of a map of the game area in Cologne, an information display monitoring time and progress and a time travelling menu. In the map the path history of the players is visualized by a red line while their current position and viewing radius is displayed by a black circle (see Figure 2).

The expectations of the players were not entirely fulfilled by the navigator interface. Especially the map was often criticised by the players as the game area was displayed "too small" and a zoom functionality was missing which made it inconvenient to navigate. Furthermore, the users commented on the need to integrate a compass or even rotate the entire map according to the current direction. Some users even found the choice of symbols ("H" for "Heinzelmannchen") not self-explaining and missed an explaining caption.

Regarding the visualization of the users' covered way people stated that it is difficult to interpret the data when walking on the same places again. In this regard one user suggested using different colours for different time periods (p60, G39 interview). For future applications this problem could be solved by the use of alpha blending techniques that fade out paths that have been walked long ago.

Time portals

"When creating and searching for time portals I was most involved in the game. It seemed to be a time-critical task"^{xcvi} [Ques, p22]

"The time portals were good"^{xcvii} [Ques, p61]

"The portals were always a bit hard to position. How far you had to walk then."^{xcviii} [Interview, p37]

"Crazy, we are walking through the time."^{xcix} [Testrun, p27]

"The most diverting part was to search for the portals and approach them because you had the time pressure of 30 seconds and really had to walk over rough and smooth."^c [Interview, p38]

Time portals are necessary to switch between the different time periods. The process is performed by first choosing the time period in the time traveling menu of the navigator interface and then clicking on the map to create a time portal approximately on the position where the user clicked. Then a virtual portal becomes visible on the display of the AR player UMPC and the players have 30 seconds to get through the virtual time portal.



Figure 59. Group 2 reaching the time portal



Figure 60. Group 29 walking quickly towards the time portal

For most players this process worked fine and players experienced this time-critical activity as an action-packed task that amused them (see Figure 59 to Figure 61). Often the players had to walk faster or run to reach the time portal which caused a higher involvement in the game. Nevertheless, the snowy winter weather conditions and “barricades” like the Rhine or buildings sometimes made solving of this task difficult. Several failed time portal jumps in a row tended to result in frustration on the player sides. In consequence, the game area should offer enough empty space to increase the chance of successful time portals. Additionally, it should not be possible to open a time portal directly nearby as this sometimes resulted in players “falling” accidentally through the time portal which on one side caused confusion and on the other hand kept the players from getting the sense of achievement when successfully travelling in time.

Occasionally players did not understand the second step of choosing the position of the time portal on the map when they missed the relevant text passage in the instructions of Agent Morgan. Due to the same fact some people also thought that it is necessary to click on the red interaction button to enter a time portal. A possibility to recall relevant information for the task would be reasonable to avoid those kinds of problems.



a) Navigator (left) chooses a time and sets a time portal. The players stand next to each other and are concentrated on their roles. AR player is watching his display.



b) After the timeportal sound occurs, navigator asks AR player if he can already see something on this display. Navigator turns towards AR player and tries to look on his display.



c) AR player is spinning around to scan the environment. Navigator waits and checks his display again.



d) AR player abruptly breaks his spinning movement when he finds the time portal and then guides navigator by telling him "There it is" pointing with his body into the direction and calling the navigator to accompany him.



e) AR player is quickly approaching the virtual time portal with the navigator following.



f) Both players abruptly stop walking when they hear the success-sound of the time portal.

Figure 61. Typical steps of a time travelling activity

7 Christchurch Study

7.1 Study Overview

During January and February 2010 a study was conducted in Christchurch New Zealand to explore the impact of the real environment on the users perception of the game. The primary objectives were to explore: (1) how paths altered the users perception (2) how the wider environment would have an impact (3) to identify common themes across locations. The study was designed to capture data using a quasi-grounded theory approach. For example while a standard questionnaire was used for all participants a repertory grids approach was used to elicit more information and the relationship between elements. As the latter approach does not force participants into choosing any particular range of themes or topics this allows for a view of how participants perceived their own experience.

7.2 Game Design

In order to cater for the requirements of the Christchurch study we created a smaller version of TimeWarp that focused on specific aspects as staging the whole game would have caused an unjustifiable amount of additional work and would have not given additional insight to the comprehensive studies in Cologne.

The following aspects were changed:

- The role of the navigator was eliminated, so that it became a single player game
- The introduction by Agent Morgan was drastically reduced
- The Heinzelmännchen were now time agents sent by Agent Morgan to scout out the problems and to instruct the players with further detail
- Time portals appeared automatically at pre-defined positions (game start, after the first challenge, after the second challenge)
- Players started in the present time, travelled to the medieval time, then to the future and back to the present again
- In the medieval time, the players had to solve Beer Barrel challenge which required the plazers to follow an animated beer cart along a pre-defined path and look out and then collect all beer barrels that would fall down (see 4.5M2 – Beer barrels (Medieval)).
- In the future, players had to solve the UFO challenge (see 4.7F2 – UFO (Future))

We used the same graphical elements as in Cologne however it consisted of narrative drawn from the history of Christchurch. Two city locations were chosen The Botanical Gardens and the route from the old University Campus to the Cathedral in the Centre. The locations were chosen such that one (The University) would have a very clear and simple route structure, while the botanics would allow for participants to within a limited degree walk wherever they wanted. Furthermore the university location also included more relevant historical content.

For the university scenario, the game started at the historic university complex and then led on one low traffic street along some other buildings of historic interest (Figure 62). This had the player walk to the cathedral square, overlooked by Christchurch Cathedral. Here the player switched into the Future and had to solve the UFO challenge.

The botanic garden scenario started at the East end of the gardens at a historical fountain. From here the path led the players on some paths along trees before it ended in the middle of a rose garden. Then the players had to walk over to a nearby grass area, where they encountered the UFO challenge (Figure 63).



Figure 62. The route from university to cathedral.

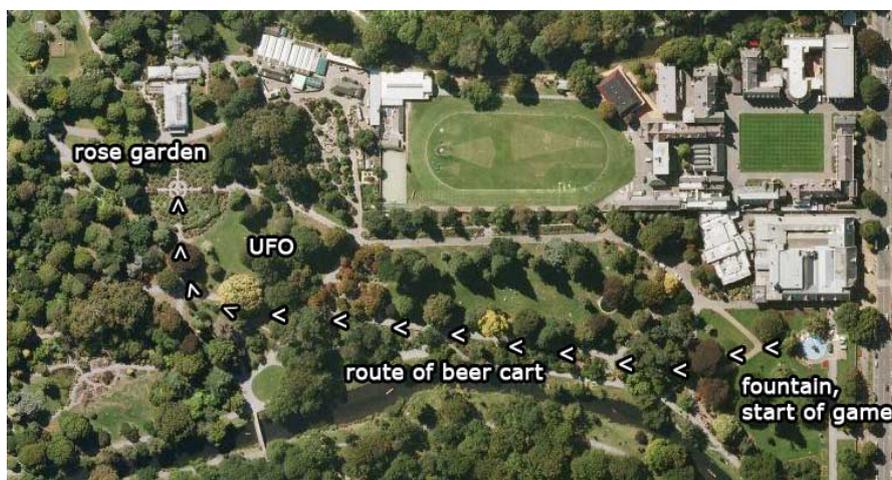


Figure 63. Route through the Botanic Gardens.

7.3 Participants

A total of 11 participants took part in the final test, a small number also took part in a pilot study before the final tests were conducted. One person failed to complete the test due to battery failure, therefore only the results of 10 people are reported here. There were 5 males and 5 females, most had familiarity with augmented reality and were aged from 21-38. Within this group the majority were students visiting HIT Lab NZ.

7.4 Methodology

All participants were asked to play the game in both locations, although the order they experienced them was altered to remove ordering effects. On completion of each game they were asked to complete a short questionnaire (See Appendix: Christchurch Study Questionnaire) which consisted of the following elements:

- Five words or terms which the players were asked to provide
- General comments which asked the participants for their overall views, then which elements they liked most and least
- A sketch map (they were asked to draw what they remembered, including the route they took)
- They were asked to write down where their attention and interest was highest in the gaming experience (e.g. start/middle/end) they were also asked to mark this on the sketch map.
- They were asked to answer 14 presence and experience related questions on a five point Likert scale.

- Two final questions asking them what distracted them from the game and any final closing remarks.

The numerical questionnaire data was analysed using basic statistical methods such as mean and standard deviation calculations. The sketch maps were analysed by two evaluators, each of whom were firstly asked to rate the number of deviations within the route taken as high, medium, low or none. They also listed and counted the number of instances of all real and virtual elements drawn in the map. The results for each evaluator were then compared and where differences were found the first evaluator would judge what changes to make, the most common differences were missing elements or the same element being described in different terms. There were no major variations between the two evaluators.

The free form and written responses in the questionnaires were analysed by firstly grouping them together into related themes and whether the comments was positive or negative. In general the written responses contained little information relating to presence and instead concentrated on more generic aspects of the user experience including technical issues, dialogues and feelings of interest. As a result the written data was not analysed from the perspective of how it implied a sense of presence. The report specifically excludes comments where responses are directly related to having the same experience twice, for example where a person indicates they are now able to complete the task more easily. The data was coded into a set of themes for example relating to feelings of safety and whether it was positive or negative for each location.

On completion of both locations the players were then asked to undertake a repertory grid analysis. This approach is drawn from the work of Kelly (Kelly, 1955) on personal construct theory and is designed to allow people to answer about their experience in a way which reflects how they perceived it. For example, in contrast with pre-set questionnaires the participants essentially develop their own questionnaire based on the keywords or terms chosen in the earlier part of the experiment. They are then asked to rate each of the locations (Botanical Gardens, and the University) in terms of the keywords they have chosen. Approaches such as this allow for a highly personalised view of the user's perception of the game, however the analysis applies only to each player. In the results presented later summaries and generalisations are provided where appropriate however it is not possible to provide traditional statistical methods of analysis across participants using this form of data collection.

The process is divided into three main stages. The first is the selection of the elements (keywords or terms), in this study these were drawn from the words chosen in respect of each gaming experience. Where too few words were chosen the participants were asked to provide a few more. During the second stage they are asked to create constructs, each construct consists of choosing three words, two representing a similar or related concept and one which is different (known as triading). They are then asked to confirm which they deem to be positive and negative, with one word being chosen to represent a positive aspects and one the negative aspect. In the third stage they are asked to rate each experience, in this case the locations on a scale of 1 to 5, with 1 representing the left side of the construct and 5 the right side, 3 represents a balance or no-opinion. In the example below (Table 4) a participant has chosen peaceful and travelling (positive) and dangerous (negative), they have then chosen peaceful to represent the positive side of the construct. They then rated the Botanic Gardens as 1, meaning it is very peaceful and the university as being dangerous. The grids were analysed using an online system known as Webgrid5 (Webgrid) to produce cluster analysis and crossplots to indicate relations, the figures presented later are the standard output options.

| | | | |
|----------|----------|------------|-----------|
| (1) | Botanics | University | (5) |
| Peaceful | 1 | 5 | Dangerous |

Table 4 An Example Construct

7.5 Results

7.5.1 General Findings

In this section an overall perspective of the differences between the two locations is discussed using the data from the range of methods. A more detailed analysis of specific aspects follows in later sections. As there was found to be no statistically different results across locations from the likert style questionnaire elements the results can be found in the appendix and are referenced as q1, q2 etc.

Initially players responded more positively overall to the botanics (see Table 5 and Table 6) with it receiving a much higher ratio of positive to negative comments than the university routes. This can in part be explained by the university being seen as more dangerous than the botanics: due to players having to avoid more people, cars and other hazards. When the five comments relating to this are removed both locations received broadly speaking similar results. Although players reported focussing more heavily on the game environment (Questionnaire: q1) a cluster analysis of the responses points to a variation in how people perceived the gaming environment. For example the ratings by P1 (Figure 65) point to there being only 45% similarity in responses between the two locations, with this rising to around 75% in the case of P2. Further differences can be found within the cross-plot analysis, for example Tim (Figure 64) pointed the university feeling uncontrollable and difficult, conversely the botanics is simple and interesting. Across all players a degree of difference was found between both locations both in terms of responses and data sources.

The findings in Table 7 suggest that in terms of excitement both environments provided the same experience, however many more participants indicated they felt as if they were travelling in time within the university route as opposed to the botanic gardens. This could be due to the nature of the route which covers many older and newer buildings in addition to the game content.

As presence is an abstract concept for many people it was unsurprising that it was not mentioned on a high number of occasions. However what is interesting is that it was only mentioned in respect to the university environment, although the number of negative comments cancelled out the number of positive comments). At this stage it is not possible to say why players felt a stronger inclination to highlight presence for the university location however it could be speculated that this is due to the aspects such as architecture or the need to be more aware of oneself in relation to the environment.

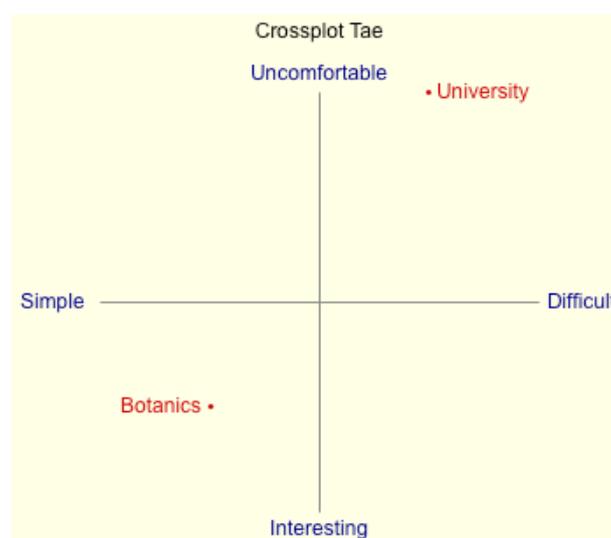


Figure 64 A cross plot indicating the difference conceptualizations between the botanics and the university from P3.

| Coding | Botanics | University |
|---------------------------|----------|------------|
| Interesting | 4 | 4 |
| Story or content elements | 4 | 5 |
| Finding objects | 3 | 4 |
| Fun | 1 | 2 |
| Enjoyed | 1 | 1 |
| General positive comment | 1 | 1 |
| Blended realities | 2 | |
| Felt present or immersed | | 3 |
| Engaging | 1 | |
| Entertaining | 1 | |
| Time challenge | 1 | |
| Environmental Dangers | | 1 |
| Reality | | 1 |
| Total | 19 | 22 |

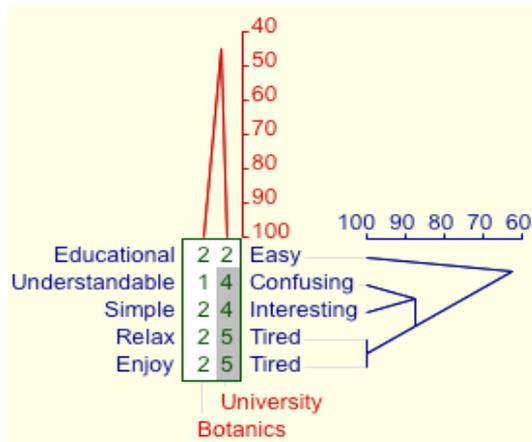
Table 5 Positive Written Responses for both locations

| Coding | Botanics | University |
|----------------------------------|----------|------------|
| Content/Story Boring | 2 | 1 |
| Lack of content | 2 | |
| Unclear rules | 1 | 2 |
| Orientation problems | 1 | |
| Distracted by environment | 1 | |
| Confusing start | | 1 |
| Lost interest as time progressed | | 1 |
| Low immersion/presence | | 3 |
| Environmental dangers | | 5 |
| Total | 7 | 13 |

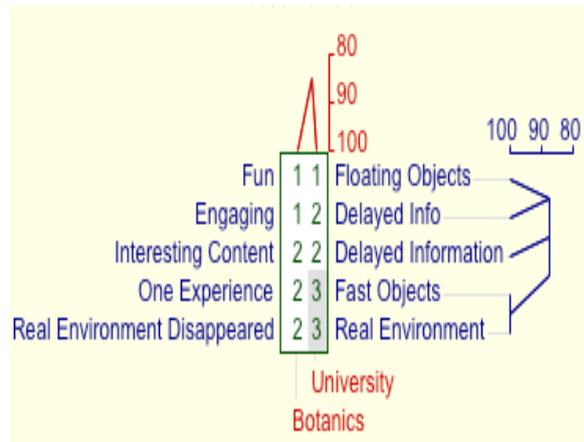
Table 6 Negative Written Responses

| | Botanics | University |
|---|----------|------------|
| Felt Most Excited | 4 | 4 |
| Game felt most related to environment | 1 | 7 |
| Felt as though they had travelled in time | 2 | 5 |

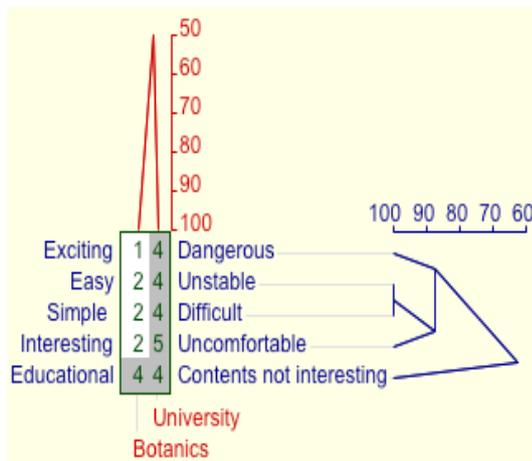
Table 7 Participants preferences.



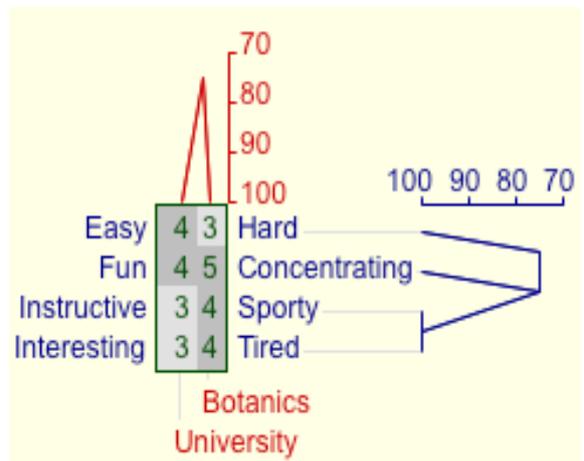
a) Focus P1



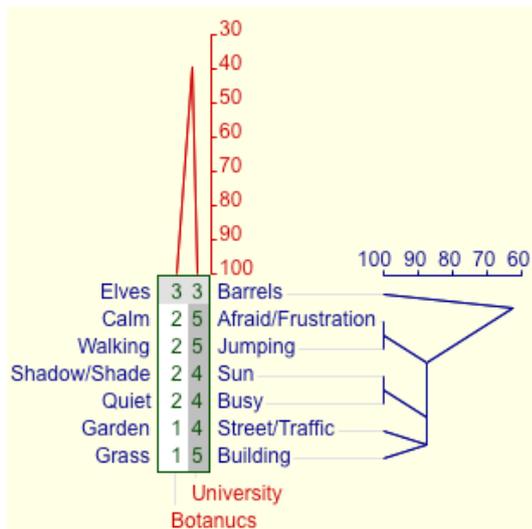
b) Focus P2



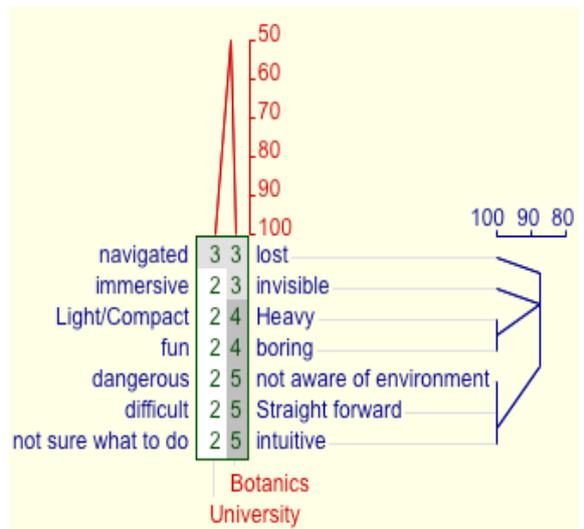
c) Focus P3



d) Focus P4



e) Focus P5



f) Focus P6

Figure 65 Cluster Analysis illustrating the relationships between different elements identified by the end players. For example in P5's grid jumping (graphics) and frustration being 100% related, the score on the top of the charts represents the similarity in responses for example Susan has around a 40% similarity in responses across locations. The scores within the chart indicate those given by the players with respect to each construct and location.

7.5.2 Interest, Attention and Engagement

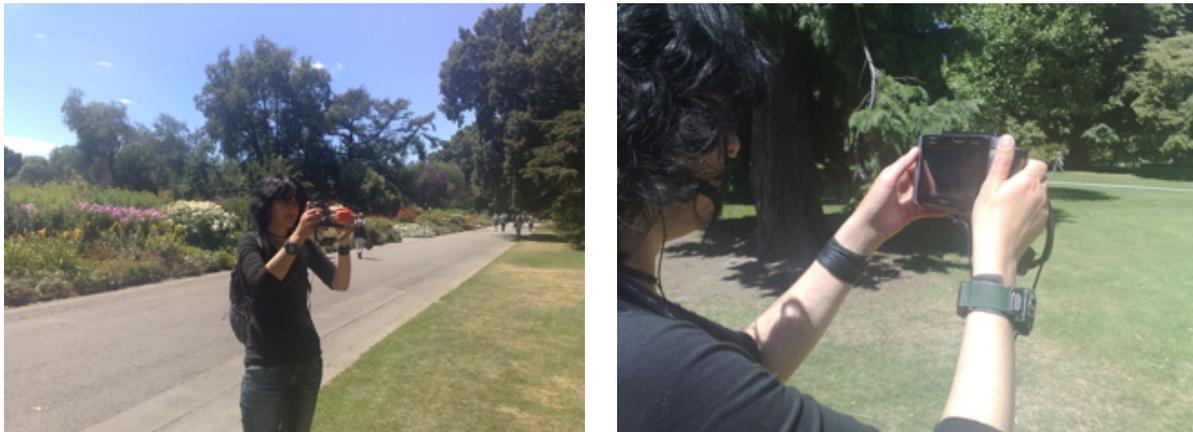


Figure 66: A player in the Christchurch Botanic Gardens, holding the device as it is used during play.

“interesting, felt in reality and game both” (John, botanics)

“engaging” (P9, botanics)

“immersive, intuitive” (P6, university)

“fun” (P2, University)

“it was fun and challenging” (P4, Botanics)

Overall both experiences were rated as interesting, as noted within quotations and words chosen (see Table 8) or from the free form responses provided by participants (see Table 5). The level of interest may go some way to explaining why people focussed their attention primarily on the gaming elements within both environments (q1, q12) and the more mixed responses to whether the real environment took their attention (q9). They also pointed to finding the experiences engaging (q10). Furthermore both environments were described as fun or funny by participants, which also indicates they found them appealing in some way (see quotations and Table 8 below) which in turn would be expected to make people feel more interested and engaged within the experiences.

| Location | Word or Phrase | Frequency |
|------------|----------------|-----------|
| University | Interesting | 4 |
| | Fun / Funny | 4 |
| Botanics | Interesting | 2 |
| | Fun / Funny | 4 |

Table 8 How often the above words were chosen by the participants

“holding the device was tiring” (P8, Botantics)

“carrying the equipment” (P1, botanics)

“device is quite heavy” (P2, university)

“harder to hold equipment for long time” (P7, university)

“it is quite heavy” (P6, university)

Data from the cluster analysis also provides some indication as to the elements are related to feelings of interest or engagement For example in Figure 65a the data from P1 points to their being a strong relationship between the level of interest and the confusing nature of the experience, for example less interest is aroused when the experience is confusing. One area which would appear to impact on experience is fatigue caused by carrying the device (Figure 66).

7.5.3 Paths and Movement

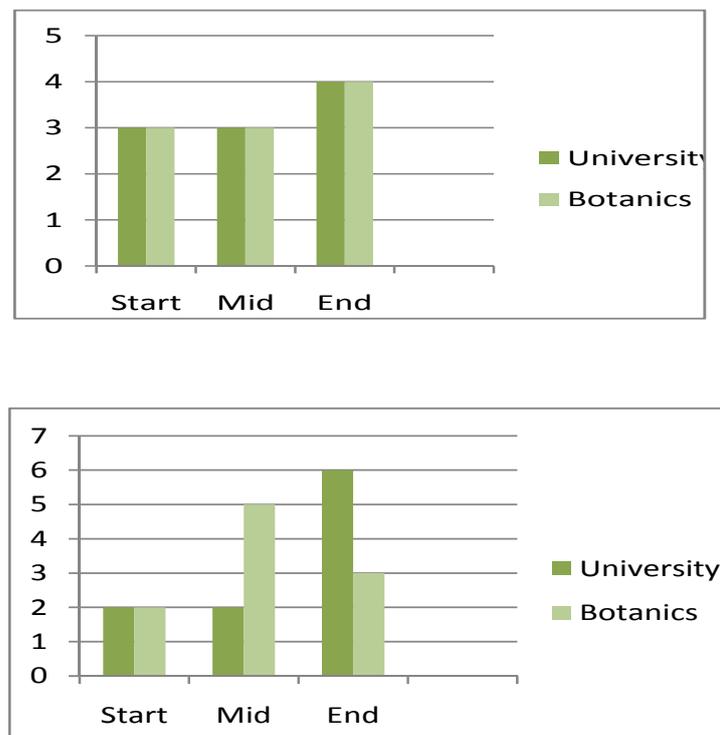


Figure 67. The level of Attention (top) and Interest (bottom) Exhibited by respondents at the start middle and end of the experience.

One aspect was to explore how attention and interest varied as the participants travelled towards their destination (see Figure 67). Statistical analysis from the numerical question responses did not provide any evidence of there being a difference between locations, however other responses did indicate that the game became more exciting as players neared completion (q2). Furthermore, there were very slight increases in awareness of the virtual gaming components the longer the game lasted (q11). There was also a very slight increase in the number of people who indicated that their attention rose towards the end of the game, however points where the players were most interested varied between the two locations. In the case of the botanics the midpoint of the game experience was marked as being the most interesting, where as it was clearly the end point (Cathedral) with the

university location. This may in part be explained by the game structure. With botanics the end point comes after the rose garden, which is the most interesting location in the game space. In contrast with the university location participants are guided through the city and eventually arrive at the cathedral which is situated within a square. This is both a visually and semantically important landmark within Christchurch (Figure 68).



Figure 68 The Cathedral in Christchurch

7.5.4 Narratives and Commentary

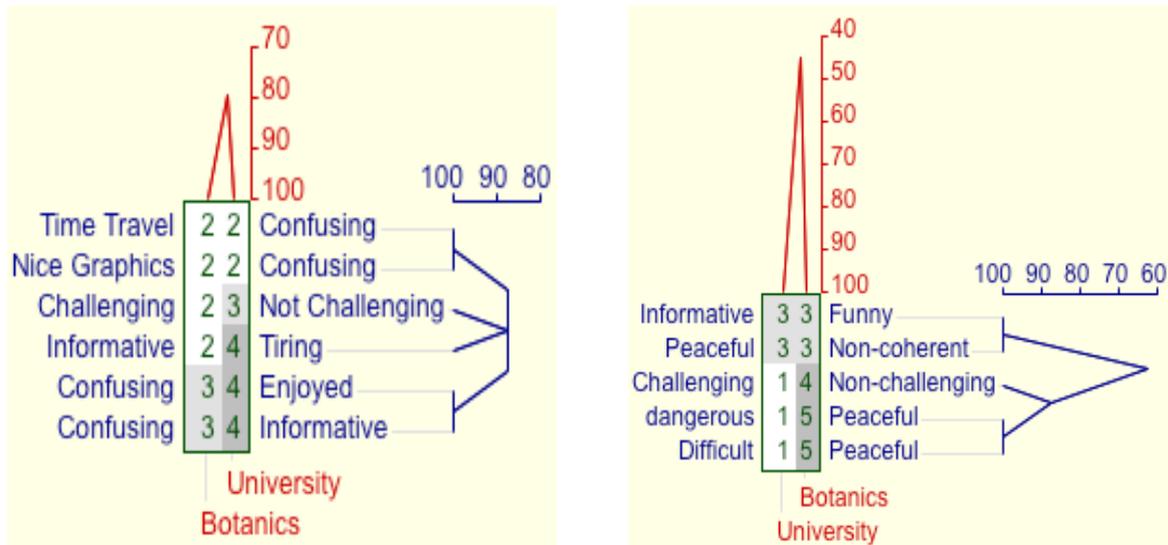
“commentator” (P5, botanics)

“Too have speaker who tells me story about the place “ (P4, botanics)

“walk and learn about the place.” (P9, botanics)

“Entertaining to a limit... (more of) a way to discuss environment not really a game” (P9, botanics)

The importance of narrative across both experiences can be found in the words chosen to describe them; with the educational elements being key terms used within the botanics and university experiences. For example the university was described as education, instructive or fun on three occasions, while the botanics was described as informative, education and instructive on five occasions. Further evidence for the importance of informative narrative content can be found within the repertory grid information (see below). The informative nature of the experience was also noted positively and making the experience less confusing or funnier (see Figure 69 P8 and P9).



a) Focus P8

b) Focus P9

Figure 69 The Cluster charts for the players P8 and P9.

7.5.5 Game Design: Challenge & Difficulty

“immersive, intuitive” (P6, university)

“simple and straightforward” (P6, university)

“challenge to find six barrels” (P4, university)

“it gets easier” (P6, botanics)”

| Location | Word or Phrase | Frequency |
|------------|--|-----------|
| University | Intuitive Simple | 2 |
| | Not challenging | 1 |
| | Difficult Hard | 4 |
| Botanics | Challenging | 1 |
| | Easy Simple Easy Easier Straight Forward | 7 |
| | Non-challenging | 1 |

Table 9 Frequency of Selected Words

From a game design perspective the participants found it easy to understand and follow, this was reflected in the comments and the words chosen by them. The main criticisms were levelled at usability related aspects, for example when the objects were difficult to see due to sunlight this made it hard for them to select them. However despite the experiences being the same many more people rated the botanics as easier than the university location (Table 9). This is perhaps again related to it being a safer environment and more open than the university location which means that they can walk around more freely.

7.5.6 Discussion

Augmented reality games such as TimeWarp take place on location and one critical area of discussion has been how the underlying environment impacts on the experience. While the normal questionnaire data did not provide evidence of differences the other sources indicated that locations can impact upon various aspects of the gaming experience, even when the game itself is identical. The underlying environment appeared to have an impact not only on the level of interest from the players, but also whether they found the content educational. Furthermore the layout of the route had an impact on the participants interest at different points during the game.

7.5.7 Conclusion

The results point to the need to fully consider the impact that the underlying environment has on the design of a game. This ranges from selecting locations, through to the design of specific path a route structures within the space. As without taking these elements into account there is a risk that the overall gaming experience will not be as interesting or induce a sense of presence in the players.

From a methodological and future work perspective it is clear that the approaches used require refinement. For example the normal questionnaires were not sensitive enough to capture the differences between the locations, where as the richer more free-form responses seem more able to do so.

8.1 Presence Guidelines

These guidelines cover the main Presence related aspects concerning our work. In general it is a good idea to not solely focus on the visual aspects of your Augmented Reality but also activate other senses. This can range from bodily interaction as expressed in the first two guidelines but also encourages the use of strong audio elements to support graphical content. This can greatly enhance social Presence between players and virtual characters, as well as confronting the players with meaningful decisions throughout the game that trigger their emotions and morals.

Get physical!

One big advantage from Augmented Reality games set in the outside world is the fact that players have to physically move around to explore the game area. Try to create situations where they not only have to casually stroll along but have to walk faster or even run. This creates a more engaging gaming experience.

Based on: 6.8.2 Handling, 6.4.3 Presence supporting elements

Make it urgent!

Giving the players time-critical tasks can greatly increase their involvement within the game. This does not mean that the entire game needs to have a time limit, but rather that certain tasks should be time critical. If the players have to walk around to solve the tasks, this also gets them physically more involved (as their walking speed increases).

Based on: 6.4.3 Presence supporting elements

Hard choices are good choices!

While problem solving can be the main part of the game, it is very valuable if you confront the players with moral questions or other important story dilemmas where there is neither a clear nor a correct solution. While players will not argue much about questions like “How much is five plus three?” meaningful decisions evoke discussions between them that engage them on different and potentially much richer levels.

Based on: 6.7 Social Presence, 6.6.2 Collaborative interaction with a virtual character

Virtual Characters are humans too!

When trying to create convincing virtual characters, give them (possibly unsuspected) social behaviour. Equip your characters with believable personalities and emotions, and get the players involved with these emotions. This extends themselves also to non-verbal social behaviour like characters that actively follow the players instead of just transporting themselves to the final destination are a simple but easy example.

Based on: 6.7.1 Portal Decisions, 6.7.3 Being followed by a virtual character

Looks are not everything!

While players will expect the same high-end graphics in an Augmented Reality game as in the latest first person shooter for their desktop PC, you can easily make up for it by focusing on different attributes of your characters. By choosing professional sounding voice actors and emotionally engaging dialogue, you can create convincing characters nonetheless for example.

Based on: 6.7 Social Presence

I have heard enough!

When your virtual characters engage in dialogue with the players or other virtual characters, pay close attention to the length of this dialogue. Make sure to tell them enough to understand the important things, but be short enough to not bore them. Do not let them stand around just waiting for somebody to finish their monologue, so avoid long periods of passiveness.

Based on: 6.4.2 Presence inhibiting elements

8.2 Sense of Place Guidelines

Very related to the previous set of guidelines, the ones presented here deal with increasing the sense of place that players feel while walking around a real location. It is advisable to aim for a close connection between the virtual and real parts of the game, and therefore also advice on offering a full experience for all senses of the users. Furthermore, when developing scenarios where the players are actively walking around a bigger area, there are certain characteristics that should be taken into consideration.

Reality is not just for your eyes

Location scouting should not be limited to only look for visually interesting places. Although this is an obvious and important quality to look for, other aspects are also worth investigating. Every place can also have certain audible, olfactory or other features that can greatly affect your game and are worth exploiting. This could for example be traffic noise, rock music always playing in the evening, church bells ringing, the smell of flowers, a windy and cold bridge, freshly baked bread near a bakery, ...

Show and tell!

While adjusting and connecting the virtual content with the real world, do not forget to do this with your narrative. Clearly relate them to the locations and have your characters reference real objects frequently.

Based on: 7.5.4 Narratives and Commentary

The more the merrier!

When creating virtual content, it is appreciated by the players if you have a considerable amount of it. While you do not want to overwhelm the players and create so much virtual content that they lose complete sight of reality, do not save on the wrong side. Atmospheric scenery objects help the players to immerse themselves into a place.

Based on: 6.5.2 Possible Reasons

Take them somewhere new!

When plotting routes for your players to follow and locations to visit, try your best to keep everything new without them having to walk back the same way they came. This is something that players easily find unexciting and therefore reduces their immersion and sense of presence. One way to overcome this problem if there are no other solutions is of course to provide new and exciting virtual elements for their second visit.

Based on: 6.4.2 Presence inhibiting elements

Make the journey interesting!

When you lead players along a path, choose a route designed to fit the theme of the game and narrative structure. This could be a street where the buildings give a heightened sense of interest at specific points. Additionally you should choose clear start and end points (and perhaps middle point) for placing content in order to create a dramatic build up and a reward for the players.

Based on: 7.5.3 Paths and Movements

8.3 Collaboration Guidelines

Enabling and encouraging collaboration between users has direct benefits for their Sense of Presence and is therefore desirable. Good player-player interactions are crucial for a satisfying gaming experience.

Equal opportunities for everyone!

When players are fulfilling different roles in the game, make sure all roles are equally important or exciting. This prevents players from feeling less useful and creates a more balanced teamwork between two (or more) equal partners.

Based on: 6.4.2 Presence inhibiting elements, 6.8.2 Handling

Let me show you!

Not all players necessarily need to be equipped identically. To foster collaboration it helps if players perform different tasks with their devices as this way each player is needed. It is however a good idea to encourage device sharing or showing the screen to the other player. This brings the players physically close together and creates collaboration when they work on a problem together.

Based on: 6.6 Teamplay, Collaboration, Co-Presence, especially 6.6.2 Collaborative interaction with a virtual character

8.4 Real world implication Guidelines

Going out in the real world creates a rather high degree of uncertainty into any gaming or application scenario. Being in an uncontrollable environment can easily have negative effects on literally every aspect of the experience. Therefore it is necessary to be well aware of the potential problems that might arise at any time.

Beware of a series of unfortunate events!

You have scouted your locations, you measured everything and created a detailed virtual model to overcome occlusion problems, you ran tests and everything worked perfect. But you forgot to check the calendar for events taking place that completely change the space you choose. This could be ongoing construction work but also festivities or other urban events. At this point in time it is typically too late to change anything, and postponements might also not be possible. Therefore it is a good idea to not only check the physical suitability for your chosen locations, but also the temporal one.

During both TimeWarp testruns in Cologne as well as in Christchurch we encountered these problems. The mosaic challenge from the TimeWarp Cologne game had to be removed from the game as a Christmas market was occupying the whole square where the challenge had to take place (as it was closely tied to the real location). Another seemingly suitable space for a challenge only proved unusable after a few test runs during the pilot studies: Underneath the area is the concert hall of the Cologne Harmonic Orchestra and during shows and rehearsal it is forbidden to walk on it. The test runs in Christchurch on the other hand coincided with the Busker's Festival - a giant street artist festival taking place all over the city with 300,000 visitors, occupying many of the spaces we had selected for gaming content.

Crowdsurfing is not for you!

People are one very unreliable element for your game. It is hard to foresee how strangers will react when they see the players equipped with (possibly strange looking) devices. However, this especially becomes a problem when there happen to be crowds. Technically it is nearly impossible to incorporate them into the game (i.e. concerning occlusion problems), and they are also very distracting for the players. If you cannot incorporate them into your game play, it is best to avoid overly populated areas.

Based on: 6.4.2 Presence inhibiting elements

Better safe than sorry!

When placing your virtual content and deciding where the players will walk along, try to be overcautious. Walking around while being immersed in an AR environment greatly inhibits the user's abilities to correctly judge dangers or notice them in the first place. This includes obvious ones like roads. If players do not pay enough attention to traffic, they are in serious danger. But if they take care of traffic, this greatly limits their immersion into the game. Less obvious are obstacles like stairs, especially when only consisting of very few steps so that they are easily overlooked.

Based on: Experience from pilot study that required relocation, Table 8 (comparing botanic gardens to university scenario)

8.5 Technical and usability Guidelines

Our last set of guidelines deals with rather mundane topics which are still unavoidable when creating a heavily technologically supported Augmented Reality game or application.



Figure 71. Screenshot of time portal

Float along with the GPS!

If you use GPS for positioning your virtual objects in the scene, you should be aware that this type of tracking is extremely imprecise. Even under the best possible weather conditions, GPS jitter will make your objects float around, which can be very distracting to the users. Therefore, use objects where this imprecision is not harmful for their believability. Good examples in TimeWarp are the time portals and the UFO in the future challenge. The timeportal only has a very vague shape and has a ghostlike appearance. Furthermore it is very easy for the players to suspend disbelief when a time portal is moving around. After all it is seemingly made out of pure energy, and we all know how unstable these time portals are, don't we? The UFO on the other hand has no problems with bad GPS reception while it is flying around in the sky above the players. First of all the players can never get very close to the object thus negating some of the imprecision, but on the other hand the UFO is moving around by itself. The animation of the movement hides many of the undesirably effects you get when employing GPS.

Based on: 6.8.1 Hardware, 6.4.2 Presence inhibiting elements (Technical problems)

Your Magic Lens might be magical, but it is still heavy!

Head-mounted displays come with other problems, but their alternative comes with its own problems. Although tablet PCs and especially Ultra Mobile PCs are designed to be carried around and do not seem to be too heavy, this changes if you use them as a see-through device for Augmented Reality applications. Players need both hands to hold up the device in front of their face when walking around the area and looking at the virtual scenery, characters and objects. You can certainly do this for a short time, but when you are expected by the game or application to do this for a longer time, your arms tire easily. Therefore you should not design the experience so that the users have to hold up the device "the whole time", but instead provide them with breaks where they do not have to use the device at all or at least can point it at the ground instead of in front of them.

Based on: 6.8.1 Hardware, 7.5.2 Interest, Attention and Engagement

You cannot hide everything!

Occlusion between real objects and their virtual counterparts is a common issue with AR applications. If a virtual character moves around the corner of a real house, the house should

hide the character from sight. If you have an accurate virtual model of reality (and accurate tracking) you can use this to achieve the effect. But what do you do with trees? Cars? Temporary construction sites? Scout out your locations in advance and make sure you are aware of these real life obstacles, and if you cannot solve the occlusion technically in a convincing manner, rather place your virtual objects elsewhere. This is of course another reason why to avoid crowds.

Based on: 6.8.2 Handling

Players will go there anyways!

Even if you instruct the players thoroughly about the problems that come with using GPS and tell them to avoid tunnels and building walls (and the inside of them), players without a technical background will easily forget about it and walk exactly there where the GPS is not working or not working properly which then of course negatively affect their experience. When possible, avoid areas with such qualities. One other possible solution for this problem is to give players direct feedback concerning the quality of the GPS signal to make them aware in-game of such problems. Alternatively GPS shadows can be incorporated into the game with seamless design (Chalmers and Galani, 2004).

Based on: Many occurrences during the test runs.

9 Conclusions

In this report we have outlined the re-design and evaluation of the TimeWarp game from the perspective of several research questions covering aspects such as narrative, collaboration and sense of place. The new system represented a substantial change from previous versions not least because of the re-structured game flow but also the inclusion of richer and improved media content. Furthermore, the basic concepts of TimeWarp and location-aware augmented reality game design have been tested in two locations (Cologne and Christchurch). This approach allowed for a thorough examination of specific topics using a variety of data sources.

From the perspective of methodologies we found that numerical questionnaire data is only useful as a starting point for identifying themes and in particular it is not suited to exploring rich and complex experiences. This was particularly true of the adapted MEC questionnaire which provided a useful way to gain an initial insight into the players experience, but in itself does not help to explain why or provide additional data on what actually occurred. Also in common with all questionnaires it is prone to problems with players selecting average options. Instead the written responses, interview and video recordings of player experience provide a far richer and more useful source of data.

From the perspective of findings we have concentrated on providing generic design guidance derived from initially identifying common behaviour (activity) patterns and then exploring which elements give rise to a successful or unsuccessful experience. We have further complemented this with a study of how perception of the gaming environment is altered by the environment in which it is located. These two approaches have allowed for the identification of set of guidelines which are readily useable by developers and evaluators. The guidelines encompass a range of areas including: collaboration, selection of locations, technical and design aspects. Furthermore during the final year the results have built on the work of previous years by not only further validating earlier concepts but also identifying a range of higher level themes and new concepts.

In conclusion as the area of location-aware augmented reality gaming grows in popularity within industry and academia the provision of such guidelines will provide a strong basis upon which researchers, designers, developers and evaluators can gain a better understanding of such experiences. Furthermore the provision of such guidance will ultimately improve the experience for end-users and potentially reduce the time to develop such systems.

10 Dissemination

The main focus for dissemination in the final year lays on a considerable higher amount of test runs than in previous years and extensive media coverage. As the test runs were only completed in early February, the evaluation results will only be presented at conferences after the project has ended.

Pilot study Cologne: late November to early December 2009, 12 participants

Testruns Cologne: January to early February 2010, 66 participants

Testruns Christchurch: late January to early February 2010, 11 participants

10.1 Appearances in public press / television

| Date | Type | Title | Circulation | Coverage | |
|-----------|------------------------|--|-------------|-----------|-------------------|
| 19.1.2010 | Radio | „Virtuelle Zeitreise durch Köln“, auf DRadio Wissen – Medien, 9 min | | | ⁹ |
| 23.1.2010 | Print | „Heinzelmännchen zurück in Köln“, Rheinzeitung Nr. 19, 23.1.2010, p.36 | 205.000 | 700.000 | |
| 31.1.2010 | TV / Online | Report, „neues“, 3sat, 4 min | | | ^{10, 11} |
| 1.2.2010 | Radio / Podcast | „Eine Zeitreise mit TimeWarp“, Computer Club Zwei, Folge 205, 15 Min | | | ¹² |
| 1.2.2010 | Print, newspaper | „Tages Thema: Im Papier steckt mehr drin“, Rheinzeitung Nr. 26, 1.2.2010, p. 4 | 205.000 | 700.000 | |
| 1.2.2010 | Print / Online | Webpage for „Tages Thema: Im Papier steckt mehr drin“, www.rheinzeitung.de/ar (paper augmentation with video report) | | | ¹³ |
| 1.3.2010 | Print, weekly magazine | „Ufos überm Rhein“, in : „Focus“ Nr. 09/10, p.78-79 | 580.000 | 5.730.000 | ¹⁴ |
| 03.2010 | Online | CeBIT, Dossier “Connected Worlds” | | | ¹⁵ |

⁹ http://wissen.dradio.de/details.36.de.print?dram:article_id=159&sid=&random=fb359e

¹⁰ <http://www.zdf.de/ZDFmediathek/beitrag/video/959218/Time-Warp---Eine-virtuelle-Reise>

¹¹

<http://www.3sat.de/dynamic/sitegen/bin/sitegen.php?tab=2&source=/neues/sendungen/magazin/141510/index.html>

¹² <http://www.cczwei.de/index.php?id=issuearchive&issueid=276#a605>

¹³ <http://www.rheinzeitung.de/ar>

¹⁴ <http://meedia.de/typo3conf/ext/m2analyzer/analyzer/graph.php?time=10&category=3&titel=12>

¹⁵ http://www.cebit.de/_push_dossier_augmented_reality

| | | | | | |
|---------|-------------------------------|--|---------|-----------|---------------|
| 03.2010 | Online | Medieninformatik Blog "MI meets Dr. Who" | | | ¹⁶ |
| 04.2010 | Print, monthly magazine | Playboy Deutschland, April 2010 (to appear) | 257.000 | 1.120.000 | ¹⁷ |
| 0x.2010 | Uni | TV-style report, student work, final year project "Technikjournalismus", Hochschule Bonn-Rhein-Sieg (www.h-brs.de) | | | |
| 0x.2010 | Radio | "Forschung aktuell: Computer und Kommunikation", auf Deutschlandfunk (to appear), 4 min | | | |

¹⁶ <http://blog.medieninformatik.de/index.php/?archives/50-MI-meets-Dr.-Who.html>

¹⁷ <http://meedia.de/typo3conf/ext/m2analyzer/analyzer/graph.php?time=10&category=3&titel=347>

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All web reference assessed March 10th 2010.

12 Annex

12.1 Detailed list of changes for final prototype

12.1.1 UMPC1

UMPC1 is showing an augmented view of the reality by applying the Magic Lens metaphor and using GPS and an inertial sensor for tracking. This way the player can interact with all objects and characters during the game. Interaction is done by aiming at an object (with the help of a crosshair) and selecting it with a button. Depending on the current state of the game, this could start a conversation, pick up an object, repair an object, ...

Old version

- Ability to create time portals

New version

- Transferred ability to create portals to UMPC2

Reasons

- Give second player more responsibilities

12.1.2 UMPC2

UMPC2 is not showing an augmented view but displaying a map of the gaming area to help navigating. Player 2 controls UMPC2.

Old version

- UMPC2 showed a full screen of a static map of Cologne with no interactive elements

New version

- Visible user interface
- Player movement is tracked on the map
- “breadcrumbs” showing on the map where the players have already been to make navigation and finding Heinzelmännchen easier
- Players have to use a “radar” to find Heinzelmännchen: If they are close enough little blips appear on the map to point them in the right directions
- Countdown showing time left before time space continuum collapses, continuously updated
- Progress shown: How many Heinzelmännchen have been saved already and how many still need to be saved
- Time travel controls: player can activate a time portal and by clicking on the map place it in reality
- All sounds and videos are also played on UMPC2
- Simple dialogue system controlled to talk to Heinzelmännchen
- Decision on where to send Heinzelmännchen

Reasons

- Player roles were not balanced at all in previous version as player 2 had not really much to do

12.1.3 Story

According to legend, mythical elves called Heinzelmännchen lived in the city of Cologne, helping people with their everyday tasks until they vanished one night.

Agent Morgan is a scientist from the future and gives the task of locating these Heinzelmännchen to the players.

Old version

- Heinzelmännchen = mythical elves
- Heinzelmännchen were stranded in different time zones due to undisclosed accident
- Agent Morgan and the Heinzelmännchen are on the same side
- Players send Heinzelmännchen back to Agent Morgan

New version

- Heinzelmännchen = little robots that were built in the future to help in households, only design inspired by legend
- Heinzelmännchen became self-conscious and decided to escape by using experimental time machines and are now stranded in different time zones
- Agent Morgan wants to get the Heinzelmännchen back to repair them
- Heinzelmännchen do not want to go back to Agent Morgan as they do not want to be deleted
- Players have to decide whether they sent Heinzelmännchen back to Agent Morgan or their own preferred time

Reasons

- Old version used both magical creatures (Heinzelmännchen) and extremely modern technology (time machines) at the same time which did not fit well together
- Attempt at increasing dramatic potential as there was no real narrative conflict

12.1.4 Moral dilemma

Players have to decide whether they send the Heinzelmännchen back to Agent Morgan or to the preferred destination.

Old version

- Heinzelmännchen and Agent Morgan had the exact same goals.

New Version

- Heinzelmännchen are afraid of being deleted and proclaim to be conscious beings worth saving
- Agent Morgan sees mainly the dangers for the time space continuum and wants to have the Heinzelmännchen where they belong – and also to fix them as they were only meant as household robots.

Reasons

- By presenting the option of choice to the players, the goal is to engage them more in the game and develop stronger opinions and/or feelings for the different characters
- By making choices players are also forced to talk to each other, thus hopefully providing us into more insights of the perception of the game

12.1.5 Countdown

The players have only a limited amount of time to find and rescue all Heinzelmännchen.

Old Version

- There was no time limit, so playing time was only limited by the battery life of the UMPCs

New Version

- Players have to save all Heinzelmännchen before the time runs out otherwise Agent Morgan activates a kill-switch to keep the time space continuum from collapsing.
- Players get bonus time when saving a Heinzelmännchen as this stabilizes the time space continuum a bit
- If players send the Heinzelmännchen to Agent Morgan they get more bonus time than if they send them where they like to go.

Reasons

- Easily warranted by back story
- Attempt to create a greater sense of urgency and importance to their task while playing the game

12.1.6 Rewards

When the players save a Heinzelmännchen, the Heinzelmännchen either improves their technology or they get a bigger amount of bonus time.

Old Version

- There were no rewards

New Version

- Possible increase of radar range (so that other Heinzelmännchen are easier spotted)
- Either big or small amount of bonus time
- Visual display of progress in the game

Reasons

- Motivate players
- Make choice between sending them to Agent Morgan or where they want slightly harder (as this choice influences the type of reward)

12.1.7 Dialogue

Players encounter Heinzelmännchen during the game and can talk to them.

Old version

- Heinzelmännchen and Agent Morgan gave monologues

New version

- Very simple multiple choice options enable player 2 to steer dialogues a little at fitting moments between themselves and the Heinzelmännchen and Agent Morgan

Reasons

- Give player 2 more responsibility
- Enable more interaction between players and virtual characters

12.1.8 Timezones

Apart from the beginning of the game (tutorial, set in current time period), players have to travel to different time zones throughout the game.

Old version

- 4 timezones: Roman, Medieval, New Age, Future

New Version

- 3 timezones: Roman, Medieval, Future

Reasons

- Weak contrasts between medieval timezone and New Age timezone made it hard for players to distinguish between them
- With one time zone less more time to concentrate on designing for remaining timezones (sounds, music, 3d models)

12.1.9 Challenges

Whenever the players encounter a Heinzelmännchen, they have to solve some kind of problem before they can send the Heinzelmännchen to a different time zone. (see 4. Challenges)

Old Version

- It was possible to solve all challenges more or less from the same spot as there was no necessity for moving around
- Objects could be activated from an unlimited distance
- 4 challenges plus 1 tutorial challenge

New Version

- Most challenges now include a bigger area
- Objects can only be activated when players are close enough
- Some challenges even require the players to walk several hundred meters while e.g. following a Heinzelmännchen
- 6 challenges plus longer tutorial challenge

Reasons

- Enable more continuous sense of Presence as players are forced to move around while still playing the game
- Attempt at increasing sense of Presence with path structures that players have to follow

12.1.10 Media

Throughout the game, several different media are played on both UMPCs. These can be sounds, music, speech and video.

Old version

- All dialogue in English
- Agent Morgan gave a lot of information about the city of Cologne via audio

New Version

- All dialogue in German

- Reduced “tourist guide” feel of Agent Morgan
- Agent Morgan appears now as a video overlay

Reasons

- As game is set in Cologne, the vast majority of all test players is German. English distracted those players from the gaming experience.
- Players complained about Agent Morgan being too chatty with unnecessary information
- Players have to decide between following the wishes of the Heinzelmännchen or Agent Morgan’s, so it was necessary to present Agent Morgan also visually

12.1.11 3D Models

3D models are used for the augmented view of UMPC1.

Old version

- Heinzelmännchen design based on garden gnomes
- No animations
- All objects in the game were relevant to the game

New version

- Heinzelmännchen are now little robots
- Animated Heinzelmännchen
- Also a wide variety of so-called scenery objects that are not necessary for solving the game

Reasons

- Apart from fitting in with the main story, robotic Heinzelmännchen have the advantage of being easier to be modeled convincingly, especially when animating them (as compared to the human-like Heinzelmännchen of the old version)
- Non-animated Heinzelmännchen seemed bleak
- Addition of scenery objects attempt at increasing sense of place

12.2 Video codes

The following codes were used for the video coding with Transana:

<P> = p1 or p2 to indicate the player with p1 being the AR player and p2 being the navigator

| | |
|------------|--|
| #iai | → interaction answer individual (did only one answer) |
| #iac | → interaction answer collaborative (did they answer together) |
| #ias | → interaction answer secret (did p2 not tell at all p1 about the answer) |
| #ral | → Navigator reading answer loud |
| #<P> vos | → Player P viewing other screen (players view the screen of the other player to know what is going on) |
| #<P> dav | → directional advice verbal (say where to go) |
| #<P> dad | → directional advice deictic (show where to go with hand/ finger) |
| #<P> dah | → directional advice head (show where to with the head) |
| #<P> lvc | → laughing at virtual content |
| #rvc | → respond to virtual content (giving answers, comment to Heinzelmännchen etc) |
| #dvc | → description of virtual content |
| #pds | → portal decision start (starts when last audio file before the decision has to be made has ended) |
| #rp | → red portal chosen (send to Agent Morgan) |
| #bp | → blue portal chosen (set free) |
| #dd | → drops device (put device down) |
| #dc | → device change |
| #tec prob | → technical problem |
| #tp start | → time portal start (as soon as sound starts) |
| #tp suc | → time portal success (until sound is off again) |
| #tp fail | → time portal fail (until sound is off again) |
| #run | → running (fast walking also counts!!!) |
| #fsovo | → first sight of virtual scenery |
| #nltt | → no listening to text (players click on a Heinzeln while Morgan is still talking) |
| #secad | → security advice (e.g. "watch the stairs...") |
| #compprob | → comprehension problem (e.g. press red button when walking through TP) |
| #peopa | → People around (school classes etc.) |
| #peopreac | → Reaction on people around |
| #timeIssue | → Player experience time pressure |
| #emil | → Emil appears |
| #follEmil | → Player see Emil following |

- #quote → Good quote
- #wow → Highlight of game (player is impressed)
- #nono → Opposite of wow
- !!! → General highlight for evaluation

12.3 Original quotes

- ⁱ German Original: „Witziges Spiel, das es schafft mich tatsächlich voll eintauchen zu lassen.“
- ⁱⁱ „Das Spiel macht eine Menge Spaß, man interagiert mit seinem Partner zusammen und vergisst dabei auch die Zeit die es dauert (selbst bei schlechtem Wetter)“
- ⁱⁱⁱ „Während des Spiels empfand ich mich voll in "meinem Element zu sein", damit meine ich, dass ich meine Mission bewältigen wollte.“
- ^{iv} „Spannend, trotz Wetterbedingung die Zeitrelation verloren.“
- ^v „Hast du dir gemerkt, wo wir in der Realität gestanden haben?“
- ^{vi} „Interessante Erfahrung, ich war überrascht, wie sehr ich die Realität vergessen habe, dies wurde mir vor allem beim wiederfinden von Orten der AR deutlich, wenn ich versuchte mich zu erinnern, wo ich war.“
- ^{vii} „Dadurch, dass man so stark in das Spiel eingebunden ist, bekommt man von seiner Umwelt und damit der Stadt als solche kaum etwas mit“
- ^{viii} „Zuerst merkwürdiges Gefühl, wie ein "Alien" ausgerüstet durch die Stadt, das Spielfeld, zu laufen. Nach ca. 10-15 Min. war ich dann im Spiel drin und habe nicht mehr wirklich zwischen VR und R unterschieden - beides vermischte sich und bot in Kombination ein sehr umfassendes Erlebnis.“
- ^{ix} „Bei langen Dialogen, da diese teilweise zu lang waren.“
- ^x „Zwischensequenzen zum Teil zu lang.“
- ^{xi} Heinzelmännchen: „Wenn ihr uns die Freiheit schenken wollt, öffnet das blaue Portal!“ p36 (ungeduldig): „Ja wollen wir, also mach schon!“
- ^{xii} „In langen Dialogpassagen ist man mehr auf andere Dinge wie z.B. Kälte konzentriert.“
- ^{xiii} „Ich fand die Sache etwas zu oft wiederholt, dass es gefährlich ist, die Heinzelmännchen in die Vergangenheit zu schicken, obwohl dann doch nichts Schlimmes passiert.“
- ^{xiv} „Och, jetzt fängt der auch noch damit an!“
- ^{xv} „Der Bildschirm spiegelte sehr, was die Wahrnehmung stark einschränkte.“
- ^{xvi} „Zumeist war dies eine Folge der schlechten Kontrastverhältnisse auf dem Display des UMPC. Wenn das Hirn sich auf die Erkennung zu stark konzentrieren muss und dennoch kaum etwas zu erkennen ist, werde ich aus der Spielerfahrung herausgerissen weil mir die technischen Schwierigkeiten bewusst werden“
- ^{xvii} „Ich wurde leider durch technische Begebenheiten (wackeln der Objekte, schlechte Bauart der Geräte zum zielen, etc.) immer mal wieder etwas aus der Immersion gerissen, aber auf jeden Fall war hat es Spaß gemacht“
- ^{xviii} „Eine interessante Schnitzeljagd. Allerdings hatte ich als Navigator das Gefühl, einen weniger interessanten Part zu übernehmen als mein Spielpartner.“
- ^{xix} „Das Gerät des Navigators war ein wenig langweilig und nicht besonders interaktiv.“
- ^{xx} „Wenn ich die Heinzelmännchen selber sehe oder auch das Geschehen bin ich im Spiel involviert, als Navigator bin ich so eine Art Betreuer des Spiels. Also ich empfinde da eine sehr große [...] Distanz zum Spielgeschehen.“
- ^{xxi} „Die Funktion als Navigator war echt nicht spannend.“
- ^{xxii} „Ich hab sozusagen nur kurz gecheckt ob der Bereich in den ich mich jetzt begeben gefährlich ist - und zwar ohne das System - und dann wenn ich sicher war, dass es ok war bin ich in das System rein.“
- ^{xxiii} „Ansonsten fand ich es in der Realität manchmal nicht so gut, auf Treppen hinzu zulaufen, oder durch Matsch zu gehen....“
- ^{xxiv} „Wenn Straßenlärm und Ablenkung von außen vorhanden waren.“

-
- xxv "Wo ist es hin? Ich seh' s nicht mehr vor lauter Kindern!"
- xxvi "Beim Laufen von längeren Strecken, deren Ziel schon klar war. Dabei kam es nicht so sehr auf die virtuelle Umgebung an."
- xxvii "Beim laufen zum nächsten Objekt/ Punkt."
- xxviii "Während der Suche nach Emil, da sich der Weg ein wenig lang hinzog."
- xxix "Als zum Schluss das Raumschiff gestartet wurde, weil es langsam zu kalt war und ich mich nicht mehr so konzentrieren konnte."
- xxx „Das Wetter war eindeutig zu kalt für ein Outdoor-Game ohne dicke Winterjacken.“
- xxxi "Zu Beginn, aufgrund der Neuheit des Reizes."
- xxxii „Am Anfang des Spiels war ich am vertieftesten, da es ganz neu für mich war und ich sehr neugierig war.“
- xxxiii „Ich fand die optische Erfahrung spannend, in Kombination mit dem spielerischen erkunden des Areal. Sich in der AR wirklich zu bewegen war das beeindruckendste.“
- xxxiv "Bei der Erzeugung und der Suche eines Zeitportals war ich am stärksten in das Spiel vertieft. Es erschien mir eine zeitkritische Aufgabe zu sein."
- xxxv „Wo es darum ging, möglichst schnell die Relais neu zu starten, da es um Geschwindigkeit ging.“
- xxxvi „Wenn man das Portal suchen musste, wg. des Zeitdrucks“
- xxxvii „Ich hätte es gerne zwischendurch so gehabt, dass gesagt wird <Macht doch mal ein bisschen schneller!> das man so mehr Stress hat oder so.“
- xxxviii "Ufo-Landeplatz mit den 3 Relais: Die Vielzahl der virtuellen Elemente und der hohe Grad der Interaktion haben Spaß gemacht."
- xxxix „Je interaktiver es wurde, je weniger man auch langatmig rumstand und sich die Erklärungen angehört hat, desto stärker war man halt drin."
- xl "Am stärksten war ich vertieft, wenn ich auf der Suche nach den Objekten war."
- xli „Während der Suche nach Heinzelmännchen oder Objekten, da ich dann die Umgebung ausschließlich durch den UMPC wahrgenommen habe.“
- xlii "Am stärksten in das Spiel vertieft war ich, während Gesprächssequenzen abliefen, da diese zum Verständnis beitrugen und für den Fortlauf sehr wichtig waren (und somit gesteigerte Aufmerksamkeit weckten)."
- xliii „Als ich mich darauf konzentrieren musste, was der Agent und die virtuelle Personen sagen.“
- xliv "Bei den Videosequenzen und Kommunikation mit den Als. Um nichts zu verpassen."
- xlv "Als ich den zweiten Roboter für die Heirat einsammeln musste. Der Grund könnte sein, dass man in ein soziales Verhalten integriert wird."
- xlvi „Ich fand das Mittelalter am interessantesten da sich die Liebesgeschichte um die zwei Heintelmännchen wesentlich "realer" für mich angefühlt hat als die 3D Objekte.“
- xlvii "das Mittelalter... weil ich die Geschichte der beiden Liebenden am ansprechendsten fand..."
- xlviii "na das Mittelalter natürlich, wegen dieser herzerreißenden Geschichte"
- xlix "Aufgrund der umgebenen Objekte, hatte man das Gefühl in einer anderen Zeitzone zu sein und durch den Sprung durch das Zeitloch."
- l "Ich hatte nicht das Gefühl, dass ICH in der Zukunft bin. Ich hatte mehr das Gefühl, ich sehe einen interaktiven Film und der ist recht gut geworden."
- li „Ich hatte nicht das Gefühl in einer anderen Zeit zu sein.“
- lii „[...] diese römischen Torbogen oder die Brücken. Ja klar, ich hab sie wahrgenommen. Da ist was, aber ich hab das drum herum... die Gegenwart natürlich auch nie komplett ausblenden können.“

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- liii Zeitgefühl? "Schwierig [...] Das Büdchen stand da oder das Schiff was im Hintergrund war, das war ja auch wenn man durch das Ding durch geguckt hat nicht ausgeblendet. Es waren ja nur zusätzliche Objekte eingeblendet."
- liv "Wie erwähnt wäre etwas mehr Detailreichtum in den anderen Zeitaltern sehr nützlich für die Immersion (vor allem belebte Elemente!)"
- lv „Ich hätte mehr kleine zeittypische Details (an Häusern, auf dem Boden) schön gefunden, das würde die Zeitzonen lebendiger machen.“
- lvi „Mittelalter: Ein virtueller Platz mit mehr virtuellen Gegenständen und Gebäuden hätte realistischer gewirkt und mehr in die Geschichte hineingezogen. Die virtuellen Personen sind auch noch recht schematisch.“
- lvii "Zwischen den Zeitperioden konnte ich keinen großen Unterschied feststellen, weil man sich viel mehr auf das Erreichen des Spielziels konzentriert als auf die virtuelle Umgebung."
- lviii „Auf der Suche nach den H's habe ich die Zeitperioden nicht so richtig wahr genommen.“
- lix "Ich habe keinen wesentlichen Unterschied bemerkt, da die Karte immer gleich aussah."
- lx "Dieses Aquädukt und dieser Torbogen, damit wird man dann in die Römerzeit versetzt, aber das Ding war ja kaputt. Warum denn in der Römerzeit?"
- lxi "die Römerzeit hat mich enttäuscht, weil zu der angegebenen Zeit (500 v. Chr.) in Köln garantiert nicht ein Römer war und erst recht kein Aquädukt."
- lxii "Ich fand es auch ganz gut, dass man es nicht alleine gespielt hat, sondern im Team"
- lxiii "Alleine würd's nicht so viel Spaß machen."
- lxiv „Man hätte es auch auf einem Screen abbilden können [...], aber es hätte halt nicht denselben Spaß gemacht. Man braucht ja den anderen schon und konnte sich dann auch abstimmen und Fehler korrigieren oder einfach nur aufeinander aufpassen dass man nicht irgendwo reinstolpert."
- lxv German Original: "Da kommt man sich glaub ich ziemlich blöd vor, wenn man da ganz alleine rumrennt mit so nem Equipment. Ich glaub zu zweit ist das viel besser."
- lxvi German Original: "Ich kann mir gut vorstellen, dass man das als Spiel gut ansetzen kann für Portale wie New-In-Town oder so."
- lxvii „Die Charaktere waren ziemlich gut dargestellt.“
- lxviii "Die Mittelaltergeschichte war schon was fürs Herz"
- lxix „Die in das Spiel eingebaute Wissensfrage wohin die Heinzelmännchen geschickt werden hat mich sehr beschäftigt.“
- lxx „Als wir Emil zurückgeführt haben und die beiden getraut wurden, ist meine Partnerin emotional geworden und war dafür, diese beiden zu "retten" und in eine vergangene Zeit ca. 200000 Jahre vor unserer Zeit zu schicken.“
- lxxi "Die Heinzelmännchen haben schon überzeugend argumentiert und ich hab dann auch mitgeföhlt."
- lxxii „Komm, wir machen ne kleine Kommune, ne kleine Heinzelmännchen-Kommune."
- lxxiii "Der andere ist auch schon im Blauen. Zu dritt können die feiern!"
- lxxiv „Diese Heiratenden waren schon ganz süß. Die musste man eigentlich aus moralischen Gründen schon zusammen führen.“
- lxxv „Schade, dass nicht klar wird, wie viele Möglichkeiten es gibt, die Aufgaben zu erledigen oder ob der "richtige" Weg gewählt wurde. Kann man überhaupt etwas falsch machen?"
- lxxvi „Und da hatte ich ja die Aufgabe diese Textfragen zu beantworten und da hat sich bei mir schnell der Eindruck eingestellt, dass es egal ist, was ich drücke.“
- lxxvii German Original: „es entstand der Eindruck, dass es egal ist, welche Antwort ich gebe, das ist etwas schade“
- lxxviii "Mit wem habe ich die Ehre?" Player 2: „Ja hallo, ich bin xx“ Player 1: „Und ich bin yy“
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- lxxix German Original: „Klicken sollte unnötig sein. Das nimmt den Bezug zur virtualität. Charaktere sollten selbständig anfangen zu sprechen, eventuell schon aus gewisser Entfernung rufen.“
- lxxx „Als Emil uns gefolgt ist, als wir ihn zur Trauung führten. Das war reales Verhalten und konnte überprüft werden, wenn man "hinter sich" schaute mit dem UMPC“
- lxxxi „Der rennt uns jetzt hinterher. Das ist schon ein bisschen unheimlich.“
- lxxxii "Ich fand's lustig, als wir im Mittelalter den einen eingesammelt haben, dass der hinter uns war als ich mich umgedreht habe."
- lxxxiii „Es war sehr interessant, vor allem kam man sich durch die ganze Technik tatsächlich wie ein Chronoagent vor, der eine Mission zu erfüllen hat.“
- lxxxiv „Es war eine ungewohnte Situation, mit riesigen Kopfhörern und kleinen Computern in der Hand durch die Gegend zu laufen, aber es hat Spaß gemacht.“
- lxxxv „Teilweise sind die virtuellen Objekte gewandert oder waren nicht an den richtigen Positionen, sondern z.B. in Bäumen oder Bänken.“
- lxxxvi „Och, meine Arme werden ein bisschen lahm.“
- lxxxvii "Ich würds machen, aber es müsste ein Gerät sein, was auch in irgendeiner Art und Weise für jemanden in meinem Alter öffentlichkeitstauglich ist."
- lxxxviii "Ich fand's relativ benutzerfreundlich. Eigentlich beide Sachen. Navigation war eigentlich auch selbsterklärend."
- lxxxix „alles war sehr leicht verständlich und gut zu bedienen.“
- xc „Von der Bedienung waren die Geräte sehr Benutzerfreundlich, man musste ja nur zwei Knöpfe betätigen.“
- xcI "Ich kann die Entfernung noch nicht einschätzen."
- xcii "Ich konnte überhaupt nicht sagen, ist es jetzt was Großes oder ist es weit weg."
- xciii „Problem bei Einschätzung, wenn virtuelle Gegenstände sich räumlich hinter realen Gegenständen befinden. Keine Ahnung, ob davor oder dahinter, und wie groß die Gegenstände sein sollten.“
- xciv „Wenn der Kringel noch nicht grün ist, wäre evtl. das einblenden einer Entfernungsangabe gut.“
- xcv "Ich hätte gerne eine größere Auflösung gehabt. Ich hätte gerne eine Art blinkenden Cursor gehabt, dass ich weiss, DA bin ich."
- xcvi „Bei der Erzeugung und der Suche eines Zeitportals war ich am stärksten in das Spiel vertieft. Es erschien mir eine zeitkritische Aufgabe zu sein.“
- xcvii „Die Zeitportale waren gut“
- xcviii "Die Portale, die waren immer so ein bisschen schwer zu lokalisieren. Wie weit man dann noch musste."
- xcix „Crazy, wir gehen durch die Zeit, man“
- c "Ich find am Meisten Spaß gemacht hat die Portale zu suchen und da so hinzulaufen. Weil man da so den 30-Sekunden Zeitdruck hatte. Und dann wirklich versuchen musste über Stock und Stein dahin zugelingen."
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1.1.1 Christchurch Data

| Question | Mean | | Stdev | |
|---|------------|------------|------------|----------|
| | University | Botanics | University | Botanics |
| 1. The task and technology took my attention | 4,2 | 4,1 | 0,79 | 1,45 |
| 2. The nearer I got to completing the game the more excited I feel | 3,9 | 3,9 | 1,20 | 1,29 |
| 3. The real city environment altered my perception of the game | 3,8 | 3,4 | 1,03 | 0,97 |
| 4. The real city and the virtual (graphics/sounds) felt related | 2,9 | 3 | 0,99 | 1,33 |
| 5. I really wanted to complete the game | 4,4 | 4,2 | 0,70 | 1,40 |
| 6. The real world locations made it easy for me to understand how I was progressing with the game | 3,4 | 3 | 1,07 | 1,41 |
| 7. My awareness of the real environment increased the longer the game lasted. | 3 | 2,9 | 1,25 | 1,29 |
| 8. There was a clear start, middle and end point | 3,3 | 3,8 | 1,06 | 1,14 |
| 9. The real environment took my attention | 3,1 | 3,3 | 1,20 | 1,06 |
| 10. The game was engaging | 4 | 3,9 | 0,82 | 1,10 |
| 11. My awareness of the virtual gaming element contents increased the longer the game lasted. | 3,4 | 3,5 | 1,26 | 0,97 |
| 12. I mainly navigated using the gaming elements | 3,9 | 3,8 | 0,99 | 0,92 |
| 13. I felt distracted by the real environment | 3,4 | 2,8 | 1,07 | 0,92 |
| 14. I felt a though I had traveled in time | 2,8 | 2,7 | 1,32 | 1,34 |

Christchurch Questionnaire with accompanying Data

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For further information regarding the IPCity project please visit the project web site at:

ipcity.eu