

**Master Thesis Media and Knowledge Engineering**  
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The design and evaluation of a

# **Multi-Modal Memory Restructuring System**

**for patients suffering from a combat-related PTSD**





**Title:** The design and evaluation of a Multi-Modal Memory Restructuring System for patients suffering from a combat-related PTSD

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**Abstract:** As soldiers can be exposed to various different traumatic stressors, such as fire fights and terrorist attacks, during their deployments, chances increase that these people develop a combat-related Post-Traumatic Stress Disorder.

Various methods exist to treat veterans suffering from this type of disorder, each having both several advantages and disadvantages. One persisting problem is the high drop-out rate of patients. This and several other problems have led to the exploration of new emerging treatment methods to help patients with a combat-related PTSD as well as to increase appeal relative to traditional face-to-face therapy. This thesis discusses a new and unexplored concept which uses computer assisted technology to support trauma-focused psychotherapy, focusing on restructuring and relearning of past events. The proposed application allows patients and therapist to visualize the patient's past experience using maps, personal photos, stories and self created 3D virtual worlds. The tool aims to allow patients to restructure, reappraise and relearn about their past experience involving the problematic stressors.

The design of the system followed a situated cognitive engineering approach. The first step of this approach was to do a domain analysis. This was done in close cooperation with a psychiatrist experienced in treating veterans suffering from a combat-related PTSD, which eventually led to the establishment of an inventory of human factor knowledge, operational demands and envisioned technology. The knowledge was used to create several scenarios and prototypes. Experts with a psychology background were asked to review these scenarios and discuss various possibilities and limitations, while prototypes were evaluated and tested by experts with a background in Human-Computer Interaction. The acquired feedback made it possible to constantly refine the requirements baseline.

The experiment which followed suggested that all three main interface components were easy to use. Also, differences were found in a way a story was told with the application compared to a story told without the use of the system. The results hinted at a more structured and precise way of storytelling. A case study with a veteran showed that the patient enjoyed working with the application. He felt encouraged to work with it as he saw the purpose of talking about past events by managing a media archive.

**Keywords:** PTSD, trauma-focused psychotherapy, memory, multimedia, restructuring, reappraisal, case study





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# 1 Introduction

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## 1.1 Definition and chapter overview

Whether people go to work, study, or plan their holidays, there is most likely something out there that puts them in an inevitable stressful situation. Despite the fact that most people want to avoid such situations, the involved stress is still manageable. However, this is not the case when someone is exposed to a traumatic event, an occurrence beyond the bounds of common, everyday human experiences. This results in a 'Post-Traumatic Stress Disorder' (PTSD) (Emmelkamp, Bouman, & Scholing, 1995). According to the 'Diagnostic and Statistical Manual of Mental Disorders IV' (1995) this disorder is characterized by re-experiencing the traumatic event accompanied by symptoms of increased arousal and avoidance of stimuli associated with the trauma. Such traumatic events vary widely, causing a variety of PTSD forms. Traumatic events can be related to war, assault, child abuse, accidents or natural disasters. This study focuses on combat-related PTSD, one of the health problems many soldiers face upon their return from deployment. In this case traumatic events include: getting injured, being threatened by death or witnessing another person's death. These events are often referred to as stressors.

The chapter starts with discussing the problem definition, followed by the research question and several associated sub-questions. A situated cognitive engineering approach is chosen for acquiring and validating the requirements needed for the design of the proposed system. The various steps taken in this approach are briefly explained in paragraph 1.3. In the remainder of the chapter a short description is given of the proposed system, the 'Multi-Modal Memory Restructuring (3MR) system, a system which is developed to be used in a therapeutic setting to support patients suffering from a combat-related PTSD.

## 1.2 Problem definition

War is known for its high rates of potential stressors. Fire fights, terrorist attacks, losing comrades and taking care of dead bodies are only some of the events a soldier is exposed to during war. A study (Hoge, et al., 2004) among 'Operation Iraqi Freedom' veterans concluded that up to 18% of the returning soldiers were affected by traumatic experiences and exhibited PTSD symptoms. Another study (Milliken, Auchterlonie, & Hoge, 2007), also concerned with returning soldiers from Iraq, has shown that over 66% of the soldiers were exposed to potential stressors. The same study reported that almost 17% of active duty soldiers and over 24% of reserve soldiers screened positive for PTSD. When soldiers or other military personnel get deployed multiple times, the chance of developing a PTSD multiplies by a factor of 1.5. Other reports (Garcia-Palacios, Hoffman, Carlin, Furness, & Botella, 2002) have shown that a large number of people do not seek treatment, unless the disorder causes drastic changes in their lifestyle. People tend to rather avoid various stimuli than seek appropriate treatment (Emmelkamp, et al., 1995). A reason mentioned by Hoge (2004) is the stigmatization attached to the treatment, causing soldiers to experience anxiousness towards possibly losing their jobs or facing others who know about their treatment.

Another issue is requiring data needed for treating patients with combat-related PTSD. The therapist needs information about the deployment and the problematic stressors in order to

address them. Some patients are not willing to go into detail as some events may be too painful to remember. It is also possible that the patient does not recall what happened accurately or does not feel required to share aspects related to a particular time period. Of course therapists have acquired general data about a deployment through an intake session and reports, but this is often not sufficient. The therapist needs to let the patient re-experience, relearn and reappraise past events in order to process the traumatic ordeal.

Two effective methods to treat combat-related PTSD are 'Cognitive Behavior Therapy' (CBT) and 'Eye Movement Desensitization and Reprocessing' (EMDR). However, a recent review (Schottenbauer et al., 2008) reports high drop-out rates for both CBT and EMDR. The risk of a patient not receiving sufficient treatment adds up because of patients who are not willing to finish their treatment. This has led to the exploration of new emerging treatment methods to help patients with a combat-related PTSD as well as to increase appeal relative to traditional face-to-face therapy (Cukor, Spitalnick, et al., 2009). One such treatment is Virtual Reality Exposure Therapy (VRET). It allows therapists to gradually expose patients to distressing stimuli in virtual scenarios using computer assisted technology. An unexplored field is the use of computer assisted technology to support trauma-focused psychotherapy. The emphasis is on restructuring and reappraising memory elements. The exploration and design of a system that allows the patient to re-experience, restructure and reappraise particular moments of a past deployment is the main focus of this thesis.

### 1.3 Research question

The initial idea was to let the patient recreate a particular setting from the past by adding and rearranging 3D models in a virtual world. This allows patients to better explain what they experienced and to rethink of what they thought that happened is really true. At that time VRET was the only treatment that used computer assisted technology to treat patients with a combat-related PTSD. VRET also showed similarities with the concept as it puts the patient in a virtual representation of the real world. With VRET, however, the focus is not on restructuring and relearning. Patients can talk about what they experienced, but the patient is not given any tools to flexibly facilitate memory. Although analyzing VRET was found to be useful when designing the new system, it did not provide sufficient information to see if treatment would really benefit from the new envisioned approach. The envisioned system is a new concept and therefore needs a thorough domain analysis to obtain the knowledge required to establish a first requirements baseline. The research question of this thesis is as follows: *Is it possible, and what is required, to enhance the treatment of combat-related PTSD, focusing on the restructuring and relearning of a past event, using computer assisted technology?*

Only an analysis is not sufficient to properly answer the main research question. Various expert reviews are necessary and several prototypes of the 3MR system have to be built to evaluate, verify and refine the initial obtained requirements baseline.

### 1.4 Research methodology

The design of the system followed the situated cognitive engineering approach as described by Neerincx and Lindenberg (2008). It is an iterative approach where the requirements baseline is continuously refined as new insights are acquired through prototype evaluations and reviews with

experts in the field during the entire design process. The first step that has to be taken is a Work Domain and Support (WDS) analysis to establish an inventory of all relevant human factors, operational demands and envisioned technology. Knowledge can be gained by analyzing the current situation, resulting in a better understanding of all involved actors, used theories, activities and the therapeutic setting. Using the data acquired from this analysis, core functions and claims can be defined and scenarios can be created. This results in a preliminary requirements baseline. Afterwards this baseline needs to be refined and verified which is done in the last phase. Figure 1-1 shows an overview of all the separate phases of the approach.

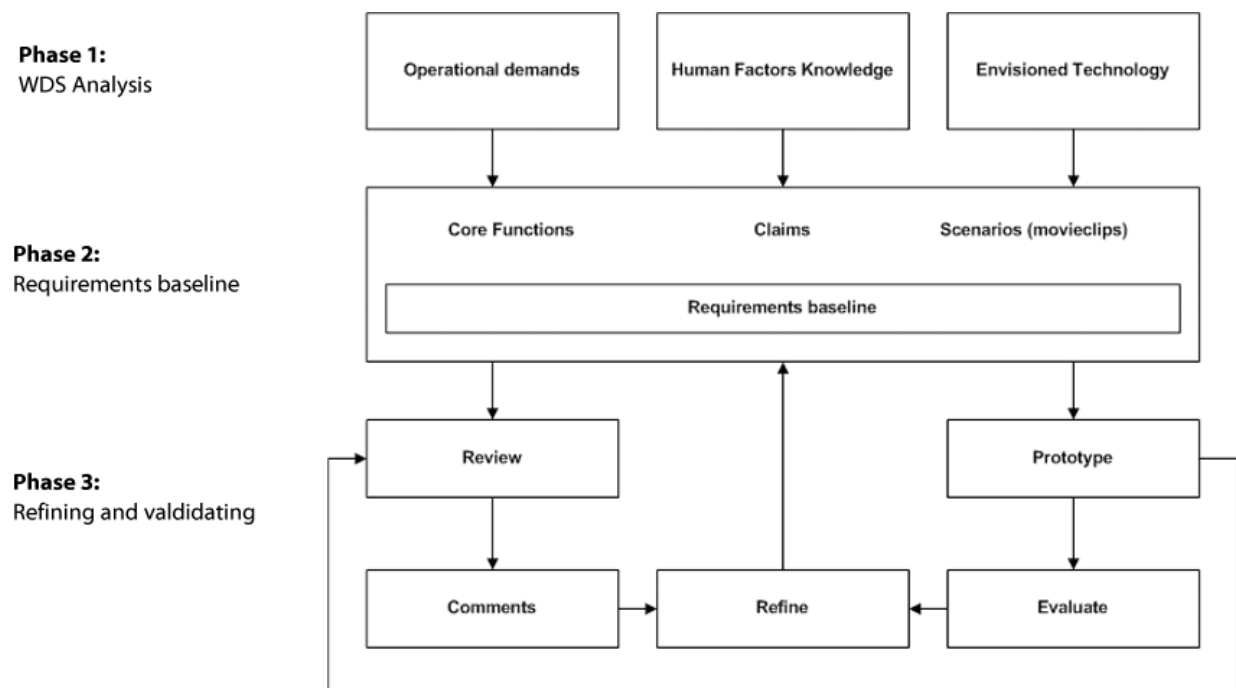


Figure 1-1: Three phases of the situated cognitive engineering approach (Neerincx, Lindenberg, 2008)

During the first phase several meetings with therapists at the 'Universitair Medisch Centrum' (UMC) Utrecht took place to obtain the necessary data required for the WDS analysis. During these meetings theories and technologies were explained, followed by discussions on how technology could support traditional treatment. First the 'People Activities Context and Technology' model was applied to acquire a better understanding of the current therapeutic situation and all involved actors and their behavior. All the acquired knowledge and characteristics were written down for further analysis. Additional meetings took place to explore the operational demands, human factors knowledge and envisioned technology, resulting in a preliminary vision of the system and its setup. The acquired data from both the PACT analysis and the results of exploring the three components of phase 1 can be found in chapter 2.

Instead of going straight to the construction of the requirements baseline, scenarios and claims were first used to probe the experts' thoughts on the envisioned system. A set of scenarios with associated claims were made to get a better understanding what was needed in the therapeutic setting. In these scenarios a 3D world editor was shown, allowing the patient to place, delete and move 3D objects on a pre-defined template. This way the user is able to talk about a past event by creating a virtual representation of this situation. The first few reviews showed that a 3D editor showed potential, but it was not something they would immediately use. The application lacked features, such as the option to add personal photographs and documents. Therefore new insights were gathered during the reviewing session and refinements were made to the preliminary design rationale. This resulted in new core functions, claims and scenarios. The new textual scenarios were then visualized into short films focusing on the three main aspects of the system. Feedback was obtained by presenting these scenarios to ten different experts in the field. Chapter 3 describes the two separate scenario phases, together with the given feedback and the changes that were made to the design rationale.

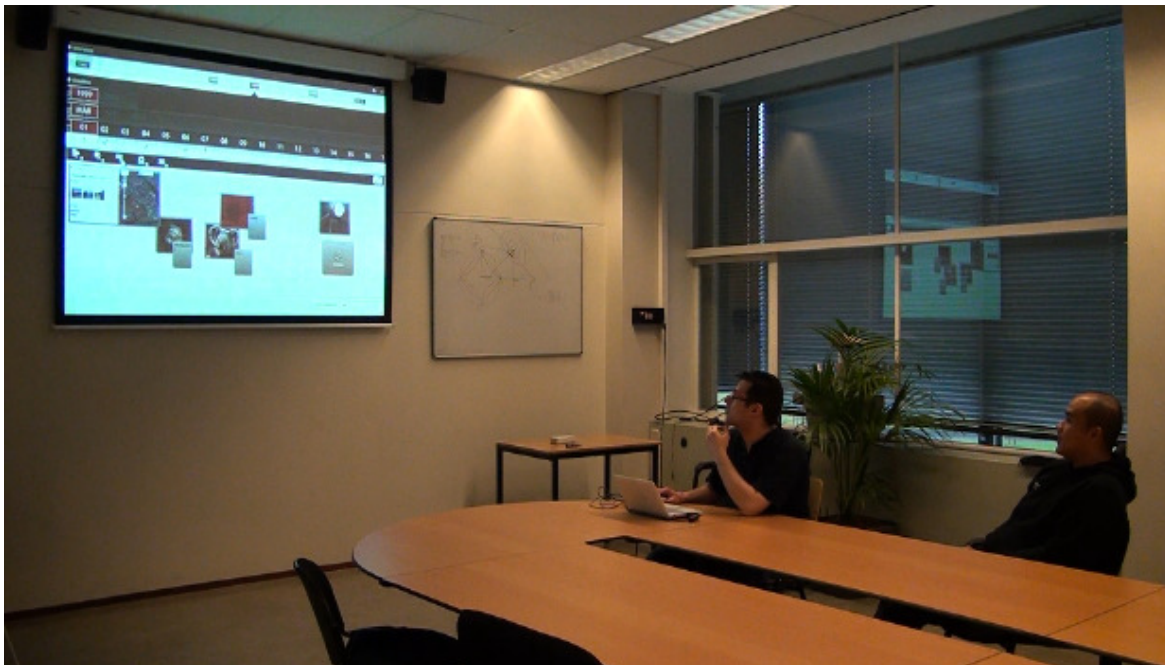
Chapter 4 covers the right side of phase 3, pictured in figure 1-1. In this chapter a detailed description is given of the first created high-fidelity prototype based on the results given in chapter 3. After a heuristic evaluation, focused on the usability of the system, multiple prototypes were made and again evaluated. The prototypes were not only evaluated by experts at the University, but they were also shown to the therapists at UMC Utrecht. Using a formative evaluation approach at the University various usability issues were addressed. Figure 1-1 shows a line going from 'prototype' to 'review'. This link was made to let experts also directly comment on the created iterations of the prototype. Thus, in this phase a distinction was made between reviewing and evaluation the prototypes. Meetings at UMC Utrecht resulted in additional features and minor changes to the requirements baseline. Evaluation resulted in refinements regarding the way the system was used. In this chapter all core functions and associated requirements and features are listed. The prototype needed for the experiments and case study is described at the end of chapter 4.

Detailed information on the implementation of this final prototype is given in chapter 5. In this chapter all features incorporated into the system are explained in detail. This is done by going through every feature of the application. The last prototype consists of basically two applications; one is the main application which allows the patient to manage memory elements on a timeline and the other is an external 3D editor which is linked to the main application. Of both applications the design decisions and metaphors are given together with several limitations and future improvements.

When the last prototype was finished an experiment took place. A total of 18 participants were used in the first experiment. All participants were asked to do two tests; one to evaluate the usability of the system and the other to see if the application would enhance the way a story is told. For the second part of the experiment two stories, one with and the other without the help of the application, were needed to make a comparison. Chapter 6 describes this experiment in more detail together with the acquired results. Next to this experiment a small case study and interview was done with a real patient suffering from a combat-related PTSD. The feedback and results can also be found in chapter 6.

## 1.5 Proposed system

In traditional group therapy patients talk about their past deployments and share their experiences with each other in the presence of a therapist. In these situations pen, paper and a flap-over are used to allow patients to express themselves better. Also, memory is often compromised and due to memory distortions or amnesia for details these facilities can help the patients to remember and rethink about what happened. The envisioned application, the Multi-Modal Memory Restructuring (3MR) system, takes this a few steps further. The 3MR focus does not lay on direct exposure, but on the way patients facilitate and manage their memory to restructure and relearn about their past experience involving the problematic stressors. The system allows patients to organize various deployment-related multimedia elements on a set timeline. Of course by managing these multimedia elements there is a chance that the patient will be exposed to past traumatic events from the past.



*Figure 1-2: Possible setup 3MR in a therapeutic environment*

One of the advantages of this approach is that patients now have the flexibility to rearrange content themselves and add more memory elements as the overall therapy progresses. Letting patients accomplish this by using their own material, such as personal photographs and geographical maps, and linking those to a specific day could provide a more effective way of restructuring and discussing their past experience. False memories, such as the order of events and the location of a particular stressor, can be addressed and forgotten memories may be triggered. Using a timeline which keeps track of the personal progress may even encourage patients to add more details and continue with the treatment. Another possible advantage is that the use of personal data can result in a different perception of the, often seen as problematic, deployment; good memories can be triggered of events not directly related to the stressors. These memories are often forgotten as the focus is mainly on the problematic events which occurred during that time. The additional option to

let patients create a virtual representation of the real world in 3D allows them to rethink about the event to see if everything they remember is (sequentially) correct. The system is designed for use in a group therapy, but can easily be adapted for a single patient-therapist setting. When the system is used in a group therapy setting, it can provide an easier and more efficient way of sharing stories with the other patients. This is because everything is projected on a wall for everyone to see. Group members can discuss the events shown on the wall and share similar experiences with each other as part of the treatment method. A possible setup for a group setting is shown in figure 1-2.



## 2 Domain analysis

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### 2.1 Chapter overview

Before the requirements baseline could be established, it was important to do an extensive analysis of the therapeutic domain first. More knowledge and a better understanding were needed regarding activities, theories, involved people and the used setup. Furthermore, possibilities on how technology could support or take over certain activities in the therapeutic setting had to be analyzed thoroughly. This data could then be used to create scenarios and to define core functions with associated claims for the following phase of the situated cognitive engineering approach.

This chapter is concerned with the first phase of the approach and starts with a description of the work domain, acquired by applying the 'People Activities Context and Technology' (PACT) model on the traditional therapeutic setting. In this analysis it became clear that the treatment of soldiers was more complex than initially expected. The primary problems were (1) the patient's memory, (2) the avoidance of emotional subjects and (3) the potential risk of high drop-out rates. A wide range of treatment possibilities were incorporated into the analysis as well, as there are various different ways to treat patients suffering from a combat-related PTSD. All obtained data and characteristics were then used to explore the operational demands, human factors knowledge and envisioned technology. Trust and emotion were found to be two of the main factors that would have a big impact on the design of the system. Other human factors, together with the operational demands and envisioned technology are discussed in the remainder of this chapter.

All necessary information needed for this domain analysis was acquired in close cooperation with a military psychiatrist from UMC Utrecht. This psychiatrist does not only treat patients suffering from combat-related PTSD, but also has a strong interest in emerging treatments and related research. Several meetings took place to discuss topics related to treatment options, theories, patients and activities. Various problems, limitations and important aspects used in traditional face-to-face talk therapy were discussed and written down for further analysis. During this stage various ideas were discussed on how technology could help patients restructure and narrative about a past deployment. Various parts discussed in this chapter were the result of not only discussions and interviews with the psychiatrist, but also an extensive literature study. This study was necessary as additional information about theories and treatment options were needed to discuss various possibilities and limitations of both traditional and emerging treatment methods. Figure 2-1 shows that this study, together with the discussions and meetings, was a helpful component in acquiring all the information concerning the therapeutic domain.



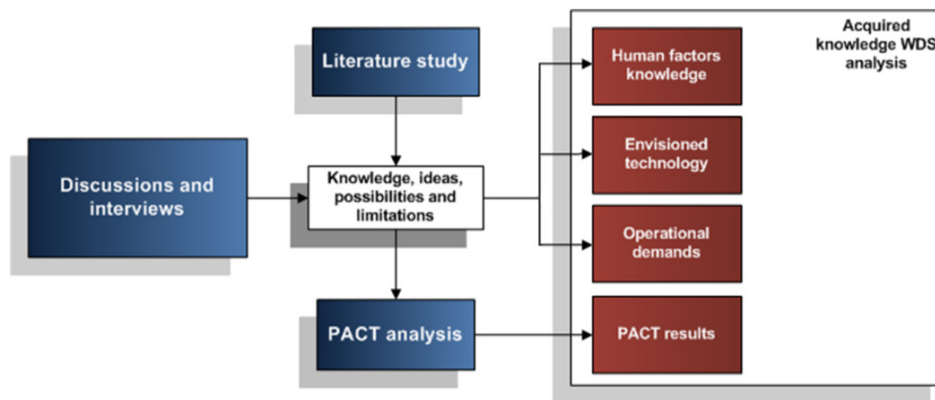


Figure 2-1: Overview work domain analysis

## 2.2 People

Throughout the analysis a wide range of existing treatment options to treat patients suffering from a combat-related PTSD were discussed. Therapists all over the world used methods such as EMDR, Virtual Reality Exposure Therapy (VRET) and various forms of face-to-face talk methods. Even at the hospital in Utrecht a variety of different methods were used to help patients cope with their disorder. This made the analysis complex, yet interesting as different theories and features of current therapies could be discussed for the creation of a new approach involving computer assisted technology. The one thing all methods had in common were the two main actors; a therapist and patient. More actors are present in so-called group therapy sessions. For these kinds of sessions 5-6 service members attend a session together to share their experiences with each other with the presence of a therapist or psychiatrist. The following two subparagraphs describe both the characteristics of the therapists and the patients within the therapeutic domain as part of the PACT analysis.

### 2.2.1 Therapists

During the interviews and discussions with the psychiatrist and two of his colleagues it became clear that the procedure of treating patients suffering from a combat-related PTSD is different compared to other forms of PTSD treatment procedures. One of the most noticing characteristics is that therapists at the 'Militair Geestelijke Gezondheidszorg' (MGGZ) department occasionally visit military bases in places such as Afghanistan and Iraq. By visiting these places and supporting the people they do not only get a better understanding on what is going on there, but they will also put themselves in the same stressful situations as the patients they are treating. This helps to create a bond between therapist and patient even before the actual sessions start. Therapists are also well aware of events that happened in the past. This is due to treating patients with different military backgrounds and experiences, but also to various military reports and summaries they have access to. Another characteristic is concerned with expertise related to different treatment methods. One of the options, which will be described in detail later, is the option to treat patients in groups. But also other treatment options or combinations are possible. The procedure of every individual patient depends on the acquired information gathered in an intake session and by reading the corresponding reports. Some of the therapists at the department were more involved with group therapy sessions while others were more involved with face-to-face talk sessions.

Also, the background education and amount of experience differed from therapist to therapist. Some therapists were also more involved with research and emerging treatments, while other therapists solely concentrated on treating veterans suffering from a combat-related PTSD. However, during this phase two general characteristics were found which were later used for the design and implementation of the system. The first one was concerned with trust and the bond between the therapist and patient. In the case of stories related to combat, a lot of sensitive information might be shared which could, if not carefully kept, be harmful to the reputation of the patient. The job of the therapist is therefore to create a bond with the patient and maintain trust during the sessions. The other characteristic is related to maintaining a session. The psychiatrist told that at a start of a session there is usually time for a reflection of what happened in the previous sessions. Also, there is time to shortly discuss things that are currently happening in the patient's life. According to the psychiatrist notes are usually not taken during sessions, but afterwards. All notes, drawings and documents are kept in a personal file and stay at the office of the therapist.

### 2.2.2 Patients

Of course not every patient is the same or behaves the same. However, some general cognitive characteristics can be described that fits the majority of the patients. The patients in the observed situation are all veterans who have faced one or multiple traumatic events during their deployments. Traumatic events can be related to being threatened by death, being injured or seeing someone else die or getting injured. Symptoms of a PTSD can be distinguished by three different symptom clusters (Emmelkamp, et al., 1995). Each cluster is related to one of the following: re-experiencing, avoidance or arousal. These symptoms can occur after the person has been exposed to a specific kind of traumatic event. However, not everyone will experience these symptoms immediately after such an event. In many cases the symptoms occur days or even months after being exposed to the stressor.

#### *Background theory*

DSM-IV (Diagnostic and Statistical Manual of Mental Disorders IV, 1995) states that a person's response to a stressor must involve fear, helplessness or horror. Next to this response, people who have developed a PTSD also experience certain symptoms related to the trauma. One such a symptom is the persistent re-experiencing of the stressor, as mentioned in the definition of a PTSD. There are various ways this symptom can occur. DSM-IV describes these as a new criterion:

- Recurrent recollections of the event. This includes thoughts, perceptions and images. Not only when the person is awake, but also when the person is asleep.
- The person feels or thinks as if the traumatic event recurs.
- The person is distressed when exposed to various stimuli related to the traumatic event.
- Physiological reactivity on exposure to the stimuli mentioned in the previous criterion.

Strongly related to this symptom is the persistent avoidance of specific stimuli. Of course the avoidance must occur after the exposure of the stressor. DSM-IV states that avoidance is one of the criteria related to PTSD. At least three of the following indicators should be true.

- Avoidance of feelings, thoughts or conversations associated to the trauma
- Avoidance of activities, places or people which may trigger recollections of the trauma

- The inability to recall an important part of the traumatic event
- Lost interest in certain activities
- Feelings of detachment from friends or family members
- Limited experience of feeling or emotion
- Only thinking about the near future

### ***Memory and avoidance***

During the meetings with the psychiatrist two aspects were discussed in further detail: (1) the patient's memory and (2) the avoidance of feelings and thoughts related to a certain event. In order to treat the patient, information about the problematic events is needed. A therapist also wants the patient to talk about his or her emotions at that time. Acquiring all this information can be a problem. A patient may not see the importance of sharing certain facts. He or she might even not remember them or does not want to share the information because it is too painful. The psychiatrist at Utrecht also said that sometimes the patient is not the victim, but actually the offender. In these cases the patients are reluctant to share their stories because they think it might get them in trouble. Although it is possible that they might share relevant information later, it does take a while and that can be problematic, especially if only a few sessions are planned per patient.

The psychiatrist pointed out that many patients have photos and documents of their deployment kept away in their house. Although most of the photos are not directly related to the traumatic events, they can, according to the psychiatrist, be valuable items for use during treatment. Because of the stressors patients experienced, deployments are referred to something bad. However, they often forget about the good things they experienced back then. Most of the mentioned photos are made during breaks or when helping people in towns. Discussing these might change the way a patient perceive his or her past deployment. It might be a big step for patients to bring photos and documents to a session, but the therapist will get a better understanding of what happened if he or she has access to this material.

### **2.2.3 Discussion**

The patients mentioned in this analysis were already following a treatment procedure, but this does not necessarily mean that they are fully committed. High drop-out rates can still occur, even when effective methods such as CBT and EMDR are used. Other characteristics vary as almost every soldier, despite age or gender, can be faced with a PTSD. If a system is to be introduced, it should keep the patient motivated to continue with his or her treatment. This is often the problem with traditional treatment methods. Patients do take the first step, but may get unmotivated or do not see any progress and drop out. The envisioned system should also provide some way of allowing the patient to enrich his or her story, provoking details and information about what he felt and experienced. As mentioned by the psychiatrist, many soldiers have photos and documents related to their deployment somewhere in their house. One option is to let patients use the system to manage this material to restructure or reappraise specific moments during the, often seen as problematic, deployment.

The goal of the work domain analysis is to acquire knowledge to eventually establish a requirements baseline. At this stage it was not decided yet if it would be better to give either the

patient or the therapist control over the system or let only one of these actors interact with the application. If the future system requires input from a therapist, this would be, at least in the observed context, no problem. The interviewed psychiatrist and one of his colleagues both use computers in their office. It is important to note that these computers are not used during a session with a patient. During a session all the attention of the therapist goes towards the patient. The therapist does not even take notes during that time. If required, the notes are taken after a session. The interaction between therapist and patient is important and if a system is to be introduced, this interaction should not be constantly interfered.

### 2.3 Activities and context

In this paragraph several important theories and treatment options are discussed as part of the PACT analysis. These methods are currently used by therapists all over the world. It is obvious that activities between these therapies differ. In this paragraph a small description is given for each treatment method, together with a short summary about the activities within the corresponding sessions.

One important aspect that changes the activities within a session is the context. Two situations can be distinguished (figure 2-2). One is traditional face-to-face talk therapy where the therapist talks to one single patient. The other is group therapy where a group of usual 5-6 patients share their stories with each other in the presence of a therapist.

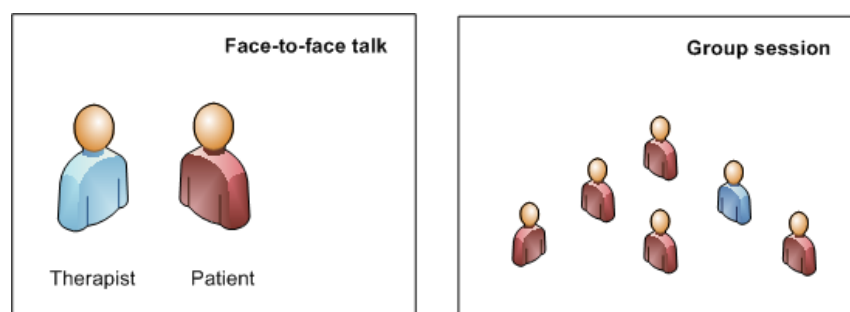


Figure 2-2: Two separate situations, face-to-face talk and group sessions

Traditional treatment at UMC Utrecht is set within a group context as soldiers are often familiar to operate in a group (Rademaker, Kleber, Vermetten, 2009). Several different activities can take place in these regular sessions, ranging from sharing experiences with each other to more creative sessions, asking the patients to create something related to the deployment they were in. The role of the therapist is to manage these sessions, take appropriate actions if things get out of hand and follow various protocols similar to those of face-to-face talk therapy. Both situations usually take place in a therapeutic setting. Therapist and patient(s) talk with each other in an office setting, which is safe, private and not embarrassing. However, therapy can also take place outside if this particular setting, in vivo exposure is one such example. Another example is the use of homework assignments. The patient works on small exercises at home, without the presence of a psychiatrist or therapist.

### 2.3.1 Background theories

Some of the treatments described in this paragraph are strongly related to the emotional processing theory by Foa and Kozak (1986). This theory states that patients with a PTSD have developed so-called 'fear structures' consisting of information about the stimuli associated with a traumatic event, their behavioural responses and meaning representations (figure 2-3).

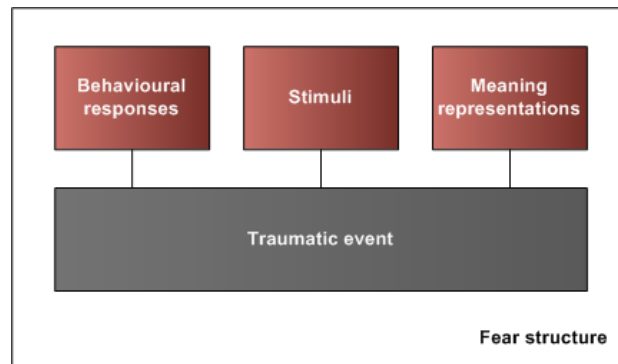


Figure 2-3: Fear structure

People exposed to a stressor will remember facts about associated stimuli. For example a vehicle that exploded after it hits another car or seeing a comrade die by a mine. Not only information about the stimuli is remembered but also facts about the behavioral response of the person at that time. For example a racing heart beat and perspiration. And the last aspect is information about the meaning representation of the traumatic event. The meaning representation of a certain event can, of course, differ from person to person. The representation is strongly related to the stressors the person has faced. One can, for example, associate an explosion to death or pain. Some treatments are based on activation of this fear structure using repeated exposure and adding new learning elements while anxiety is reduced (E. B. Foa & Kozak, 1986; E. B. Foa, Riggs, Massie, & Yarczower, 1995). Studies (E. B. Foa, et al., 1995) have shown that there is a correlation between activation of this fear structure and improvement in treatment.

Two important mechanisms in overcoming traumatic events are habituation to the frightening stimuli and cognitive reappraisal of the traumatic experiences (Ehlers & Clark, 2000; Jaycox, Foa, & Morral, 1996; Lange, et al., 2001). Ehlers and Clark describe so-called 'hotspots'. These hotspots reflect moments of the highest emotional impact of intrusive trauma memories. Ehlers and Clark propose that negative appraisals of these traumatic events need to be identified and modified. Patients will need to reappraisal the situation, which will often lead to a better understanding of the situation they were in.

### 2.3.2 Cognitive behaviour therapy

Throughout the years various options and combinations of methods have been taken place on how to treat people suffering from a PTSD. Empirical evidence and various reviews (Bradley, 2005) have shown that Cognitive Behaviour Therapy is the most effective treatment for PTSD. Cognitive Behaviour Therapy aims to change patients' patterns of thinking and to make them prepared to face their fears (Harvey, et al., 2003). Sessions usually take 60 to 90 minutes. Depending on the type of trauma, patients have to enrol in 9 to 12 separate session.

An intervention drawn from CBT is exposure therapy. Two variations exist; prolonged imaginal exposure and in vivo exposure. Prolonged imaginal exposure uses the imagination of the patient to recreate the feared situation. The patient has to tell the therapist what happened before, during and after the traumatic event. In order to maximise the experience, the patient is asked to tell the story in the present tense. The patients should not only tell what they have seen, but also state other sensory cues and their responses. This type of treatment relies heavily on the memorial and imaginative capabilities of the patient. This can pose a problem, especially because the patient must feel as anxious as they would in a real, physical, situation. However, Foa, Hembree and Rothbaum (2007) proposed techniques to enhance these capabilities and, in effect, improve activation of the fear structure. One technique is to ask questions regarding emotion-producing content such as sounds and smells during treatment. Certain stimuli or memories can put the patient in a highly distressed state. If this is the case, there is a possibility that the patient is not possible to learn anything new. Opening a patient's eyes during the treatment or letting them talk in the past tense is the other technique used. The generated images of the patient are important in this kind of therapy. The affective intensity and the vividness of the images determine the success of the therapy (Lang, 1977). Vividness has to do with the degree of completeness of a situation. Patients describing highly vivid images are able to determine many factors associated with, for example, the stimuli and their response. Affective intensity has to do with the amplitude of verbal, visceral and somatic muscle responses related to the traumatic event. The other form of exposure therapy is in vivo exposure. In vivo exposure does not rely on the memorial and imaginative capabilities, at least, not heavily. Instead, a physical recreation is needed in order to put the patient in a feared situation. The biggest advantages over imaginal exposure are that the anxiety response is easy to achieve and the success rate is considered higher (Bush, 2008; P. M. G. Emmelkamp, et al., 2002; Riva, Molinari, & Vincelli, 2002). However, the exposure must be done in public and might therefore be unappealing. In vivo exposure can also be very expensive, especially for patients with combat-related PTSD, as they might have to go back to the country they were deployed.

Other interventions drawing from CBT are cognitive psycho-education and cognitive restructuring. Sometimes these are combined with the exposure therapy mentioned earlier. For psycho-education the therapist explains and gives information about the symptoms which can occur after a traumatic event. This is done during the first session. Afterwards a discussion will take place to tell the patient how the core symptoms will be treated. Cognitive restructuring is concerned with teaching patients to evaluate, after identification of, negative automatic thoughts associated with a traumatic event. It also teaches patients to evaluate their thoughts about the trauma itself, the world in general and the future (Harvey, et al., 2003).

### 2.3.3 Other treatment options

Besides CBT, there are various other methods found used to treat patients suffering from a combat-related PTSD or PTSD in general. Sharing and self-confrontation are two features that might be useful for the envisioned application. This sub paragraph briefly describes these two potential options. The ability of sharing essays and assignments with a therapist is a great feature; studies (Rime, Mesquita, Philippot, & Boca, 1991) have shown that sharing of traumatic experiences with trusted people or parties can be of great importance. It is also stated that especially victims of rape could benefit from this in the distant future. Self-confrontation in the assignments is another



element which is present in these variants. This aspect of treatment was shown to be effective in several studies e.g.(Schoutrop, Lange, Hanewald, Duurland, & Bermond, 1997). In those studies, participants were required to write in the present tense. They were not only supposed to write about what has happened, but also describe their emotions and thoughts. This shows great similarities with imaginal exposure therapy. Next to these two approaches a wide range of other methods exist to support PTSD. However, these are not relevant for the prototype and subject of this thesis.

## 2.4 Technology

Often used facilities used during treatment are pen, paper and a flap-over. Therefore, the concept of using computer assisted technology to focus on the restructuring and relearning of past events cannot be based on existing technology currently being used. However, the use of technology in treatment is not new as Virtual Reality Exposure Therapy (VRET) has also been extended for the treatment of (combat-related) PTSD (figure 2-4, 2-5). In this case the therapist is in control of the stimuli that are being presented to the patient. The question is if the new envisioned approach should also give the therapist full control over the application. Because the patient's memories play an important role, it might be a better idea to let the majority of the interaction with the system take place with the patient. The therapist can now concentrate on the patient instead of the system.



Figure 2-4 & 2.5: Virtual Reality Exposure Therapy<sup>1</sup>

## 2.5 Operational demands

The description of the work domain, acquired by applying the PACT model, was necessary to get a better understanding of the actors, context and activities in the current situation. The results of the PACT analysis and the knowledge acquired from additional discussions with the psychiatrist were then used to explore the operational demands, human factors knowledge and envisioned technology. The operational demands are given in this paragraph.

### *Emerging treatment for group therapy*

As seen in paragraph 2.2, there are various options to treat patients suffering from a PTSD. The traditional CBT approach is currently the first-line treatment of PTSD (Harvey, et al., 2003). However, a review of PTSD treatments by Schottenbauer et al (2008) reports that high drop-out rates still persist. Various attempts have been made to make treatment more appealing compared to

<sup>1</sup> <http://www.virtuallybetter.com>

traditional face-to-face talk therapy. Computer assisted technology can open new paths to support treatment of combat-related PTSD and at the same time try to make the treatment more appealing, as seen with VRET. The psychiatrist pointed out that group therapy might benefit from the initial idea that existed during this phase. Projecting the output of the computer on a wall enables other service members to understand what happened. These patients can then, in return, give their input on the story. Sharing and explaining an event might become more appealing and effective. Although this operational demand was taken into the design of the prototypes, it was impossible to completely evaluate this claim in this thesis. However, continued discussions with the psychiatrist, a colleague and a small interview with a real patient supported the claim.

#### ***Patient memory and exposure***

Because the patient's memory plays an important role in addressing the fears and stressors, the envisioned system should give either the patient or the therapist the tools to organize various memory elements. Patients exposed to memories of a past deployment will remember more facts and details of the problematic stressor (E. B. Foa & Kozak, 1986). As seen in the PACT analysis, compared to other people with PTSD, soldiers usually keep personal photos, documents and other items related to a deployment save in their home. This material can be useful to trigger good and also forgotten memories. Even if this material is not available, the system should provide other tools to let the patient facilitate memory.

#### ***Different backgrounds***

During the discussions it also became clear that there are remarkable differences in the way therapists treat their patients. Some only focus on imaginal exposure therapy, while others are focused on cognitive reappraisal or restructuring. A future system may not support all the different styles of treatment currently available. However, if components are introduced which can be used in various different ways, the system can become an attractive new approach to many therapists, irrespective of their background.

#### ***Managing group sessions***

Group therapy is currently used at the UMC Utrecht. Patients therefore do not share their stories with only the therapist, but also with other service members within the group. A group does not necessarily exist of patients who have been in the same deployments. Managing these sessions can therefore be a difficult task, especially if patients need to explain to others what happened and what they experienced. Currently a flap-over is used in therapy, but not so often. After a session the drawings will be gone and probably never mentioned again.

#### ***Treatment awareness***

Letting the patient be aware of their treatment is an important aspect of therapy and was pointed out by the psychiatrist during the analysis of the second cycle of scenarios (Chapter 3). At that stage the application had changed into a tool which allows patients to manage an archive consisting of pictures, digital maps, text and other media. This, in itself, makes patients more aware of both their past deployments and also the progress of their treatment. However, this triggered the idea to expand this aspect further. The application should therefore provide more psycho-educational features to make the patient more aware of the whole therapy he or she is currently involved in.



## 2.6 Human factors knowledge

Although the involved people were already described in the PACT analysis, some aspects were not yet covered. In this paragraph other important characteristics are described that will have an impact on the design of the application. The first human factor which is found crucial in therapy with soldiers is trust. Trust is an essential factor which is needed between therapist and patient. Other important factors are the emotional state of the patient and the task load of the therapist. All these factors are discussed in this paragraph.

### *Trust*

As mentioned in chapter 1, one of the reasons patients do not seek treatment is the stigmatization attached to it. People may be afraid to lose their jobs when their boss finds out about their problems, or they are afraid others might think different of them. When using a system that holds sensitive information about a patient's deployment, trust is one of the important elements that come into play. Because the system takes care of most of the data storage and managing tasks, the patient should be aware that data is handled correctly. This can be accomplished by saving everything to the patient's USB-stick. The patient may not be aware of the possible encryption technology the system uses, but the data has been put onto a physical object which only the patient has access to. Trust can also be accomplished by showing icons when something is saved or by adding a personal page, where the patient can set preferences and other options.

Also, the relation between the therapist and patient is important during the treatment process. Several meetings take place to establish a bond of trust (Rizzo, et al., 2007). This bond should not be endangered by, for example, a system failure. It may therefore be crucial that the therapist keeps a distance from the system and that someone else takes care of the more technical aspects of a session if needed.

### *Emotion*

Although the system cannot detect the user's emotion, the system should take the patient's (possible) emotional state into account. Images or other items and objects can be linked to stressful or emotional events. The system should allow the user to hide and unhide these elements. Also, some thought need to be put into what the patient can or cannot do when he or she gets too emotional. Should the patient be able to close the application? Or should the image stay on the screen?

### *Cognitive task load*

Almost all interaction with the interface should take place with the patient, as it is the patient who holds the memories of the past events. Stressful situations can only occur when a patient gets emotional, but then everything switches back to a traditional scenario without the use of the application. The task load factor might be important for the therapist who has to keep track of everything that is discussed during a session. This can already be a problem when there is one patient. Managing a whole group of people would be an even more cumbersome task. It would be easier for the therapist if the envisioned system would take care of these things.

## 2.7 Envisioned technology

Virtual Reality Exposure Therapy is an example of an emerging treatment and has shown to be a useful technique for helping people suffering from a wide range of anxiety disorders. The initial idea of a possible computer application was to include possibilities Virtual Reality offers to let patients build the environments related to the traumatic events themselves. A so-called 3D world editor allows the patient to select buildings, people and vehicles and place them on an empty template. Patients can use 3D objects to express themselves. The use of realistic objects may also trigger memories and enables them to go into more details about what they saw and felt at that time. Later, the patient can, together with the therapist and group members, recap what happened by looking at the situation through different camera angles. Patients do not only re-experience past events, but also makes them rethink about what exactly happened during that time. They may see that the order of events or the notion of time is incorrect. Various aspects of VRET were analyzed first to see if a 3D editor would be a good idea to support treatment. Although VRET does not allow a patient to create his or her own scenarios and environments, some elements are still useful for the design of the envisioned application. Information was acquired by doing an extensive literature study covering recent studies involving VRET and PTSD and VRET in general. The results are briefly discussed in this sub paragraph.

### *VRET and imaginal exposure*

One of the disadvantages of imaginal exposure is that this kind of treatment heavily relies on the patient's imaginative and memorial capacities. Virtual reality can do what imaginal exposure can, but also augments the patient with visual, auditory and also haptic computer-generated capacities (Hoffman, Garcia-Palacios, Carlin, Furness, & Botella-Arbona, 2003; Hoffman & Ieee Comp, 1998). Better yet, the treatment can be done gradually. Also, virtual reality helps patients who are reluctant to engage in recollections of feared memories. Hardware, such as tracking devices and other sensors, can help the user to emerge into the world, encouraging the patient emotionally. This last element is an important aspect to activate the patient's fear structure. The pace of a session can be adjusted to the patient. This is usually not the case with traditional treatment where the therapist has limited control.

### *Other findings*

The VR world does not involve the same risks as going to a (similar) feared location which is the case with in vivo exposure. Especially for PTSD patients this can be a benefit. Next to the advantages discussed earlier, patients can feel supported knowing the therapist is there and watching the exact same thing they are seeing. The patients are actually sharing their experiences (Difede, et al., 2007). Rothbaum and colleagues (Rothbaum, et al., 1999; Rothbaum, Hodges, Ready, Graap, & Alarcon, 2001) introduced VR therapy for PTSD. They proposed that the illusion of being present in the virtual 3D world facilitates emotional processing of the memories associated to the traumatic event. They also showed that VR therapy reduced PTSD symptoms of Vietnam veterans. A case report (Difede, et al., 2007) says that gradual exposure using VR was successful for reducing acute PTSD symptoms. In this case a patient suffered from acute PTSD symptoms after September 11th (WTC) (figure 2-6, 2-7). During gradual VR treatment the patient eventually started telling the story in

more and more detail. The patient could remember events she could not remember at first. During treatment she also was very emotional. This was not the case with other treatments she applied to.



Figure 2-6 & 2-7: Virtual 11<sup>th</sup> September (Difede, et al., 2007)

Another paper states that presence is very important. Not only presence, but also should the virtual world resemble the natural environment as best as possible to “ensure generalization of fear reduction” (Beck, Palyo, Winer, Schwagler, & Ang, 2007). This paper also mentions that, in contrast to in vivo exposure, the therapist is more in control. In this case the authors wanted to see the effects of VRET for people suffering from a PTSD after a road accident. With VRET they were able to make sudden changes in real time, such as the direction of the car and the view of the patient. A recurring advantage is that the virtual world is less threatening compared to the real world, in this case a real driving situation. In this case the virtual world did not resemble the actual traumatic event. The virtual world had all the elements, such as cars, trucks and road, but it did not resemble the environment where the stressor(s) took place. The world did, however, simulate a driving experience.

### **Discussion**

A huge difference between PTSD and other anxiety disorders is the memory aspect. Creating a virtual environment for people with a spider phobia does, at first sight, not appear to be too complex; a general world (featuring several stimuli to change the level of exposure) may already be sufficient. However, this is not the case with PTSD. The virtual worlds need to correspond to the stories of the patients, or at least, the virtual worlds have to engage the patient emotionally. Elements associated to the patient’s ‘fear structure’ are needed. So far nothing is known about how exact the virtual world should resemble the patient’s memory. However, even if the virtual worlds do not need to be very exact, it will still be a cumbersome task to create virtual worlds for each and every patient. Especially if only a short amount of time is available. Creating a virtual environment for a group of people who have faced the same stressor(s) or were present at the same location is more sufficient. Parts can be reused and a toolset can be developed to customize the more general virtual world according to the patient’s needs.

As seen with traditional methods, sharing and self-confrontation can also benefit patients suffering from a PTSD. This can be done by, for example, letting patients write down their emotions and feeling at the time the trauma took place. However, it can be very difficult for patients to write about their emotions or to remember specific events. Similar problems arise with other exposure variants.

The use of images or 3D objects may trigger a patient's memory or emotion. One possible way to combine these elements is to let the patient create its own virtual world. Creating a world from scratch may be impossible, but letting the patient, with the help of the therapist, add buildings, people and actions to a specific unfinished world sounds more within reach. In some situations the patient's notion of time can be wrong. Together with the option of viewing the environment from different angles new learning, self-confrontation and reappraisal can take place. Objects within the environment can trigger a patient's memory and emotion, allowing habituation of the stressor(s). Because the patient has to create the virtual world together with the therapist, the aspect of sharing is included as well.

## 2.8 The initial idea: a 3D world editor

The idea described in the previous chapter elaborated on the idea of using a 3D editor that allowed users to restructure their memories and relearn about past events. Towards the end of the analysis phase the initial idea was getting shape. By allowing the patients themselves to select objects, such as houses, tanks and other vehicles and placing them on an empty template, they can explain how the situation looked like, what they experienced and in which order specific events occurred. Therefore something was needed to let the patient manage 3D objects easily, as the focus should not be on the creation of the world but on the story the patient is telling. For the base of the application a game environment was chosen which includes a wide range of 3D objects related to war and combat. This game, *Armed Assault*<sup>2</sup>, already had the option to allow users to edit existing game maps by adding objects and actions (figure 2-8). Of course the standard features of this internal editor were not sufficient to answer the main research question. Also, the interface in this editor showed complex options not interesting for future patients, which made it a very hard to work with. Modifications had to be made to the interface and additional scripts had to be programmed to incorporate the knowledge acquired from the analysis. In this phase only the possibilities of the game environment were explored. Small features were implemented to create a low-fidelity prototype to be presented in scenarios for the next phase. The assumption was made that two interfaces were needed: (1) the patient interface and (2) the therapist interface. The therapist could both help the patient using his or her own computer and organize a session better as the application stores and displays relevant session data.

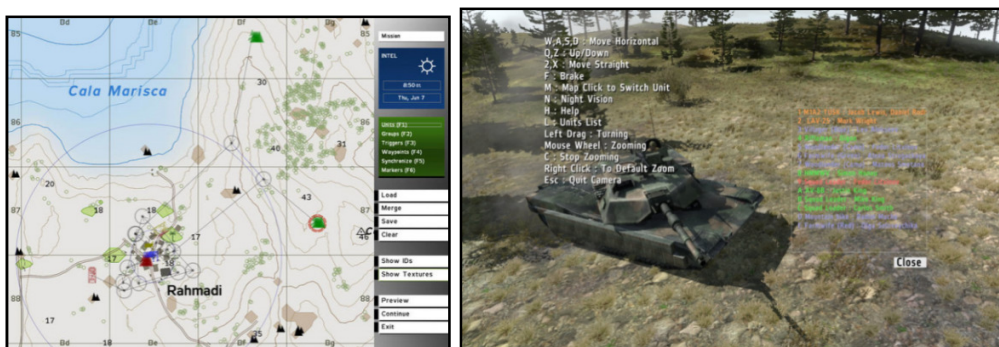


Figure 2-8: Screenshots of map editor *Armed Assault*

<sup>2</sup> <http://www.armedassault.com/>

For the patient interface only a few buttons would be required: save, reset and add object. Other actions could be assigned to keys on a keyboard. For example, the patient could add an object from a list, press the 'add object button' and drag and drop this with the mouse on a pre-defined template. The therapist would require an interface that will allow him or her to select a patient and keep track of a session (Figure 2-9). Also, because the 3D editor might be difficult to work with, the therapist should be able to help the patient by selecting, for example, the needed object in the therapist interface and passing it on to the patient (Figure 2-10). The therapist should also be able to move the camera, pointing out important actions and looking at the situation from different angles while discussing them with the patient. These preliminary requirements resulted in a low-fidelity prototype which was used in the scenarios that followed. Interactive screenshots were discussed with the psychiatrist from UMC to showcase the functionality of a possible implementation. More screenshots of the low-fidelity prototype used in the discussion can be found in appendix C.

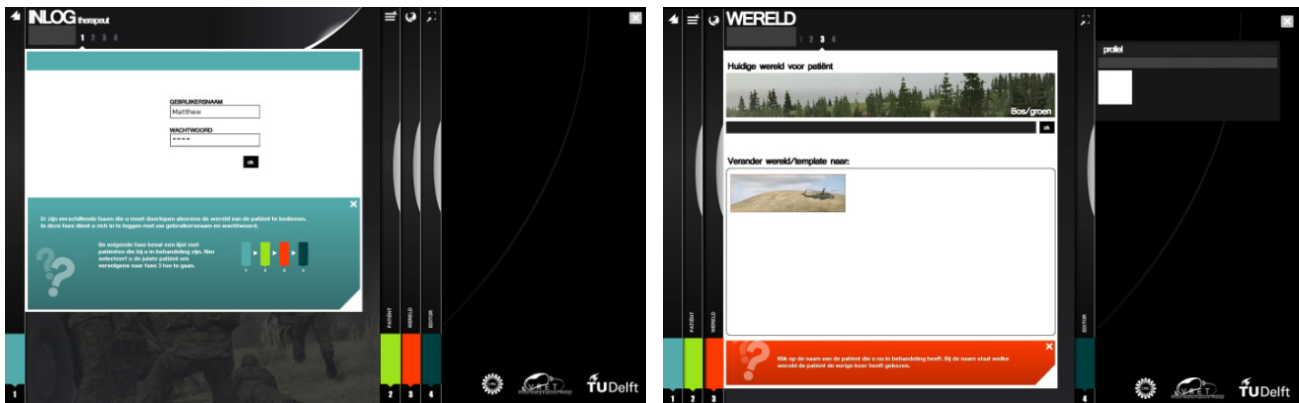


Figure 2-9 and 2-10: Screenshots of early prototype therapist interface



## 3 Scenarios and claims

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### 3.1 Chapter overview

The first phase consisted of a thorough domain analysis of the therapeutic setting and research on currently used theories and treatment methods. The next logical step was to use the data acquired from the PACT analysis and the obtained inventory of operational demands, human factors knowledge and envisioned technology to establish a first requirements baseline. First a set of scenarios (Rosson, Carroll, 2002) were created to describe and discuss possible situations in which the envisioned application was present. By creating these scenarios several assumptions had to be made. The assumptions, or situation features, were linked to possible effects on the involved actors and were therefore important to analyze. A claims analysis was done to categorize the possible effects as either upsides or downsides (Rosson, Carroll, 2002). The idea of using a 3D editor was a new concept and several conversations were needed to refine the list of situation features with their corresponding effects (Rosson, Carroll, 2002). These conversations and the presented scenarios were used to probe the expert's thoughts on possible situations that could occur when the described actors were using the envisioned application. Several actors were described and a low-fidelity prototype of the 3D editor was used to simulate a possible session. To give the expert, in this case the psychiatrist from UMC Utrecht, a better understanding on how things would look like in the therapeutic setting, one of the storyboards was chosen to be visualized as a movie (Pommeranz, et al., 2009). The early use of a prototype, although not fully implemented, allowed the psychiatrist to see (1) an example of a possible setup, (2) the interaction between the therapist, patient and system and (3) possible behavior of all involved actors. Comments were given and the therapist was asked to either support or decline claims associated with the presented scenarios. All feedback on these scenarios resulted in various changes to the early vision of the approach. The use of a 3D world editor looked promising, but the psychiatrist was under the impression that more could be achieved if the option was given to add personal photographs and documents. With this feedback core functions and new claims and scenarios were specified, resulting in a preliminary requirements baseline. This time three movies were recorded, using a newly created low-fidelity prototype, and used in a review with ten therapists. At the start of the in-depth interviews, the films were shown to each therapist separately, followed by an assessment of the underlying claims on the usability and support of the treatment procedure. An overview of all taken steps in this phase is shown in figure 3-1.



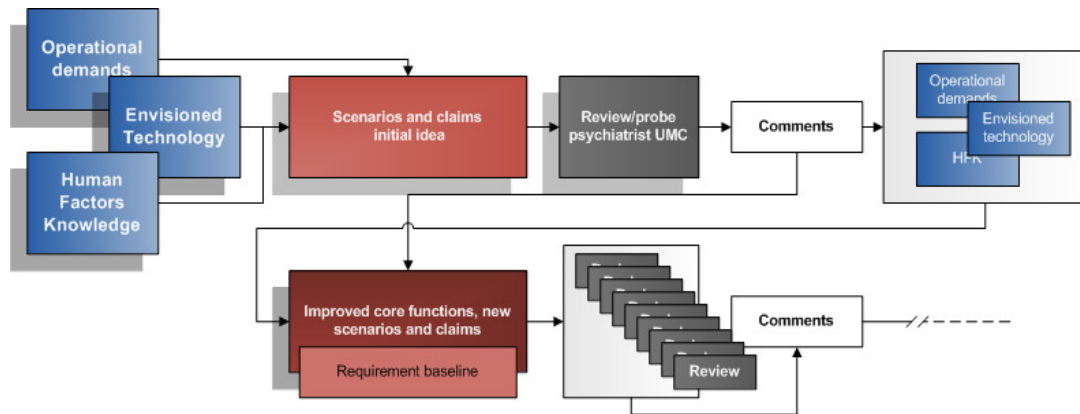


Figure 3-1: Overview of steps taken towards a first requirements baseline

Figure 3-1 shows that in this phase two cycles can be distinguished: (1) the first cycle where scenarios and claims were used to probe the initial idea and (2) the creation and use of revised scenarios to acquire feedback from multiple experts in the field. This chapter starts with the exploration of the first cycle. For this cycle three scenarios were created, each focusing on one particular situation. The therapist commented on these scenarios and supported or rejected the associated claims. During the domain analysis the psychiatrist pointed out that soldiers usually keep photographs, documents and other items or media related to a their deployments save in their home. A brainstorm session was held to see if the use of this material could be incorporated into the system. Unfortunately, adding extra features to the 3D editor would make the application unnecessarily complex. Therefore something new had to be created from scratch, using the knowledge acquired from the work domain analysis and the feedback of the previous idea. This resulted in a new

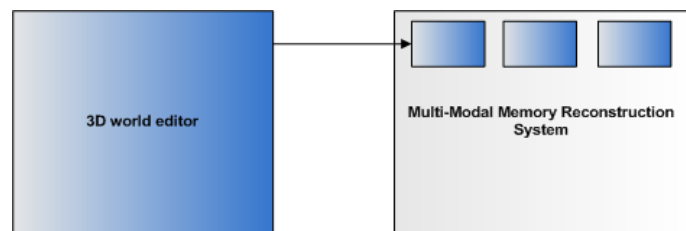


Figure 3-2: 3D editor as a feature

approach which uses a timeline to let patients navigate through a past deployment and lets them link media, including virtual representations of a situation in 3D, to a particular day. The 3D editor was now a feature of a bigger application (Figure 3-2). Paragraph 3.3 describes how this new vision was used in the creation of revised scenarios and claims. Reviews showed that the system could be improved if (1) more resources are given to facilitate memory content, (2) options were given to let the patients personalize the system and (3) features are provided to let patients use keywords to tag or summarize a particular day.

### 3.2 First cycle

The initial set of scenarios was quite different compared to the other sets of scenarios which followed. The most noticeable difference was that the application explored in this scenario was actually a 3D editor, controlled by both patient and therapist. The idea was to allow patients, attending group therapy, to talk and relearn about a past event by letting them build the related area in 3D and sharing these stories with others. Therefore a projector was necessary to display the



output of the computer on a wall. To describe the situation better the low-fidelity prototype, discussed at the end of the previous chapter, was used during the various meetings with the psychiatrist. A demonstration of the interfaces, using interactive screenshots, was used to explain the functionality and the possibilities better. One possible scenario was chosen

Creating scenarios is a necessary step in the creation of the application. Scenarios can be used to acquire feedback from experts and to eventually refine the requirements baseline (Neerinx, Lindenberg, 2008). At this stage the scenarios were primary used to see if the 3D editor was really something the psychiatrist was looking for. Next to the creation of scenarios, several assumptions were made on features that may be needed and how the patient would interact with the system. The effects of these situation features were analyzed using a claims analysis (Rosson, Carroll, 2002).

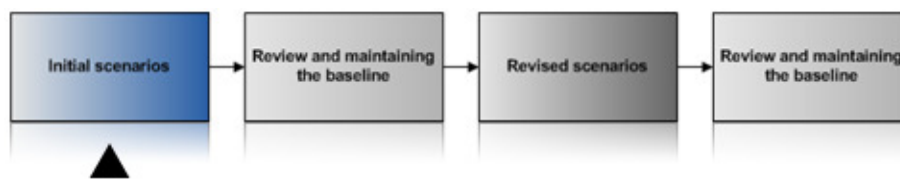


Figure 3-3: First cycle, description of the scenarios

Figure 3-3 shows the first stage of initial cycle; the creation of scenarios and associated claims. Descriptions of the scenarios and claims are given in the following sub-paragraphs. It is important to note that the lists of situation features with corresponding trade-offs were the result of various discussions with the psychiatrist. Of course an initial set of claims were defined while creating the scenarios, but as the concept was new several unthought-of situation features were discussed during the analysis of existing features.

### 3.2.1 The set of scenarios

Using the knowledge acquired from the work domain analysis of the previous phase a preliminary list of specifications was made. The following information was used in the creation of the scenarios: (1) the initial idea to use a world editor to manage memory by recreating a situation in 3D, (2) giving the patient (most) control over the application, (3) patient management by the therapist, (4) using the system in a group therapy session and (5) keeping the interaction between therapist and patient at a maximum. Three separate scripts were written, each of them focusing on one particular situation: (1) letting the patient learn about the application using a tutorial at home, (2) general use of the 3D world editor in a therapeutic setting and (3) the use of the application including an extensive reflection session. The first script was concerned with the possible fact that the patient should follow a tutorial first in order to work with the 3D editor. Although most soldiers are familiar with computers, a 3D editor might still be very complex environment, even if a lot of thought is put into the user interface. The second script describes how a patient uses the basic features of the application. In this situation extra detail was given on the interaction between all actors and the system. Also, likely behavior of both patients and the therapist was described. The last script was actually an alternative to the second script. In the reflection session the idea was to let the therapist move the camera and look at the created virtual situation from different angles. This way the patient

could re-experience, verify and explain a past event. The context of the first script was the situation at a patient's home. The last two scripts were concerned with the therapeutic setting in, for example, a hospital.

Only the second script was chosen to be visualized as a short film (Figure 3-4) as this script contained the most details and at the same time described a possible situation in a therapeutic setting. Two students were asked to play either the therapist or the patient role. The script was written as a film script and thus already contained the necessary sentences and actions for both actors. The therapist was using an early version of the therapist interface (Figure 2-9, 2-10) and the patient was sitting behind a

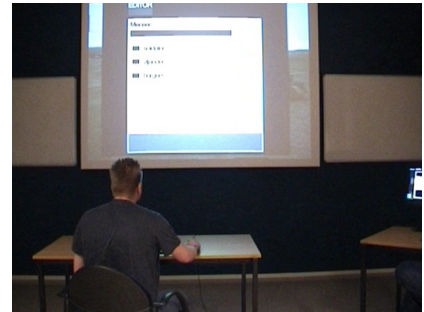


Figure 3-4: Still of recorded scenario 2

PC running a low-fidelity prototype of the 3D world editor. A projector was used to show the PC output on the wall. This film, together with the two remaining scripts, was shown to the psychiatrist at UMC Utrecht. Associated claims were also included in the review session. These, together with the acquired feedback, can be found in the following sub paragraph.

### 3.2.2 Three scripts and associated claims analysis

After the scripts were made and the second scenario was recorded, a review session with the psychiatrist at Utrecht was planned (Figure 3-5). Before the actual meeting took place, all scenarios and initial claims were e-mailed to the psychiatrist first. This way he had the chance to read everything through and come up with a first list of comments. During the meeting the first two scenarios were discussed in detail. The last script, which was concerned with a dedicated review with the patient to discuss what has been said, was rejected by the psychiatrist as it was not necessary. Even if it was required, the tools shown in the second scenario were already sufficient enough to conduct a reviewing session with the patient. After a scenario was discussed, the psychiatrist went through all the associated claims. These claims and their possible effects were discussed and refined. The presented claims in this cycle did not go into details on interface specific elements yet as the scenarios were used to probe the expert's thought on the general idea of using a 3D editor in a therapeutic setting. Only situation features were important at this stage of the study.

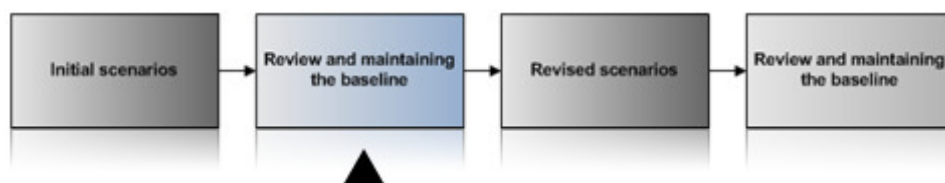


Figure 3-5: First cycle, reviewing phase

#### **Script 1: Letting the patient learn about the application using a tutorial at home**

The first initial scenario was concerned with the patient learning the application. The proposed 3D editor includes various options a new user is not familiar with. This introduces a problem, as there is no time to explain and train the patient during (expensive) therapy sessions. This scenario

described how the patient uses a tutorial disc at home to get acquainted with the system. The patient in the scenario did not get the application on the disc. The assumption was that if the application was put on the disc, the patient may already work on his memory without the supervision of a therapist. The full script can be found in appendix B.

Table 3-1 shows the claims analysis (Rosson, Carroll, 2002) of the two features as a result of the conversation with the psychiatrist. The plus signs in table 3-1 refer to “pros” and the minus signs refer to “cons”.

Situation feature	Trade-offs
Giving the patient a tutorial disc for use at home  <i>It is necessary to give soldiers/patients a small tutorial on how to use the system so they can efficiently work with it in the planned sessions. This tutorial can be watched at home, using a normal desktop pc or laptop. Also small interactive demos should be available.</i>	+ May motivate and prime the patient + Helps the patient learn how to work with the application + No expensive session time used for explanation editor - No direct support or supervision - Effect dependent on assessment patient
Disc contains a general example  <i>It is dangerous if the actual environment associated to the patient's memory is provided on the disc. The patient would be exposed without supervision.</i>	+ Focus on getting to know the application + Not dangerous - May be too general - May be less motivating

Table 3-1: Claims analysis using discussed situation features with corresponding trade-offs (Rosson, Carroll, 2002)

Strongly related to the first assumption listed in table 3-1 is that for some service members a tutorial might not even be needed, as patients can look at someone else’s session. With other group members using the application, patients might pick up the basics by only observing others. This claim was rejected; the psychiatrist thought that doing this might remove some of the controllability. Also, patients can get prepared and maybe motivated to work on their deployment when they get to see a tutorial video at home even if they already know the basics. The patient might also get the chance to actively think about the treatment itself and the way he or she may benefit from it.

Although this scenario did not include many features, it was an important step to see if a tutorial at home was a feasible option. If it was not, it would have resulted in various changes in both the interaction with the application and the corresponding scenario. The psychiatrist, however, supported the idea of a tutorial. He was under the impression that the disc did not only allow the patient to get used to the basics of the system, but also to get the patient primed and motivated.

**Script 2: Using the 3D editor in the therapeutic setting**

For this scenario a short film was created showing all the possibilities the system could offer in a therapeutic environment. The purpose of the movie was to explain the proposed situation better as there were various uncertainties about both the interaction with the system and the behavior of the involved actors. Also, this scenario contained the main features of the approach and was therefore essential in the conversation with the psychiatrist. The script alone (Appendix B) did not provide

sufficient feedback, therefore the idea was to use a movie to discuss the initial assumptions and refine the situation features in more detail.

A small movie showed two actors interacting with the system. In this scenario the therapist logged in and selected a patient from a list (Figure 3-6a). Patients entered the office (Figure 3-6b) and a conversation between the therapist and one of the patients was initialized (Figure 3.6c). The patient then tried to build the area according to his memory by adding and moving 3D objects, such as vehicles and people, on a pre-defined template. The presented movie showed that the patient talks about a particular moment in time, builds the situation using the 3D editor and reviews the whole event in more detail by changing various camera positions together with the therapist. The assumption was that this way the patient learns more about his deployment and maybe sees that some of his or her memory elements are not (sequentially) correct. At the end of the session the patient got emotional and the interaction with the application was paused. This was one of the many uncertainties which had to be discussed in the interview. The interview ended with a list of several important situation features and possible effects. These are listed in table 3-2.

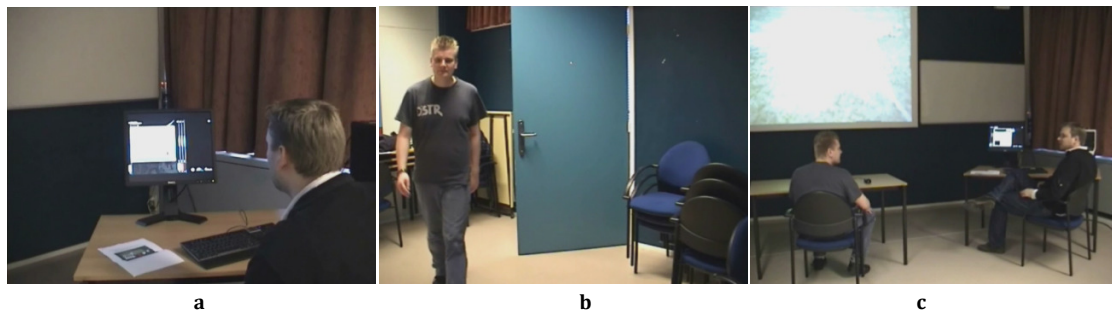


Figure 3-6: Stills of scenario describing the use of the 3D editor in a therapeutic setting

Situation feature	Trade-offs
Options for therapist to add, remove and modify 3D objects  <i>The therapist should be able to help the patient with the more technical aspects of creating the virtual environment, so the patient can focus more on the past event and associated memories.</i>	+ More efficient + Patient concentrates on events instead of technical details + Co-operation might help raising trust and the creation of a bond - Therapist cannot solely focus on the patient now (extra work) - If something goes wrong, therapist might be to blame
Time for reflection and discussion  <i>Looking at a certain situation from different camera angles and discussing the event in more detail are necessary steps to encourage relearning and thinking about a past event.</i>	+ Thinking about time and place, plus sequential order + Possible reappraisal of emotional situation + Chance for the therapist to acquire more details - May require more time and effort - Depends on input of the patient
Session for multiple service members (group therapy)  <i>The approach should provide an effective and efficient way to share stories with other service members.</i>	+ Motivating +Familiar situation, discussing events with fellow service members + Sharing takes place, which may support treatment - Patient might feel uncomfortable - Managing group sessions may be challenging

<p>Managing a session by the therapist</p> <p><i>Tools are required to help the therapist manage a session more efficiently.</i></p>	<ul style="list-style-type: none"> <li>+ Digitally kept, replaces paper folder</li> <li>+ Faster and easier to search for details</li> <li>- No notes during a session, focus should be on the patient</li> <li>- Digital, but can be less secure</li> </ul>
<p>Controls patient</p> <p><i>More details are acquired by giving most of the controls to the patient. They know more about a specific situation and should manipulate the 3D world directly.</i></p>	<ul style="list-style-type: none"> <li>+ Direct creation world</li> <li>+ Patients working on their own recovery</li> <li>+ Patient can focus on other things</li> <li>- May be hard to manage</li> <li>- Less (overall) treatment control therapist</li> </ul>

*Table 3-2: Claims analysis (Rosson, Carroll, 2002) second script*

Two important trade-offs of the first assumption in table 3-2 were concerned with trust. One of the downsides of letting the therapist help is that the therapist can be blamed for what actually is a system error or crash. Although it may not be the fault of the therapist, he or she might still get the blame. However, when both actors work together on a 3D environment, it might also help strengthen the bond. The biggest advantage is that the patient does not have to know every function of the system to create a 3D environment which corresponds to his or her memory.

Another important discussion point was how group therapy may benefit from the envisioned approach. Telling a story by visualizing a past situation on a wall may improve how events are shared with other patients. However, questions arose on what should happen if a patient gets emotional during such a session. This is also a problem with traditional group therapy, but in this scenario an application was present. The psychiatrist responded that the application should be paused until the patient is relaxed. Afterwards the session can be either picked up or another patient can work on his or her story using the 3D editor.

When creating the scenarios it was not certain how much of a deployment should be covered during a session. Also, the creation of an event using the editor might take some time and therefore the amount of sessions might have to change compared to amount of sessions planned for traditional treatment of combat-related PTSD. The psychiatrist responded that more sessions could be arranged if needed. The amount of sessions depends on the patient and cannot be specified beforehand. During these sessions the focus should not be about building the area, but about discussing what happened at that particular moment in time. Therefore, the therapist should continuously ask the patient to tell about what he or she experienced while the area is being built.

The psychiatrist told that the creation of a virtual representation of a certain area itself may already help patients suffering from a combat-related PTSD. Even if the memory elements are sequentially correct. The 3D editor may motivate the patients to continue talking about their past experience, including various details, such as emotions and actions not directly related to the stressor, normally not discussed.

***Script 3: Dedicated reviewing sessions after area is completely built***

The psychiatrist thought that the idea of a dedicated review session (solely a reflection after the 3D world is fully completed) was not necessary. Discussions and reflections are done during every session and they also depend entirely on the patient’s progress. This whole scenario was therefore rejected. The script can be found in appendix B.

### 3.2.3 Conclusions and discussion initial scenarios

The assumptions listed in table 3-1 and table 3-2 had both downsides as well as upsides, but they were, overall, supported by the psychiatrist. Despite the support, the scenarios showed that there were still some difficulties concerning the (1) amount of freedom and control between therapist and patient and (2) the required effort to create a virtual environment. New and more specific scenarios and prototypes were needed to acquire more insights to be used in further discussions with the psychiatrist.

Instead of continuing with the idea of a 3D editor, the psychiatrist saw several other opportunities and provided new insights and ideas which eventually lead to the creation of a different kind of application: (1) the use of a timeline and (2) the use of personal data. According to the psychiatrist, to let the patient restructure and relearn about a past experience, something like a timeline was needed. This timeline is also used in traditional CBT, especially in Trauma-Focused CBT as guidance to tell a story. Related to this timeline, the psychiatrist suggested that the therapist or patient should be able to zoom in on a specific period in time. When a day is selected patients can start elaborating what happened at that time. Not talking only about the events, but also what they felt and what they associated everything with.

The last comment brought up the discussion of personal data. According to the psychiatrist most veterans have obtained a wide range of media and documents related to the deployment over the years. The psychiatrist thought the application lacked the ability to provide personal pictures and text. He thought that these documents should be linked to a specific date on the earlier mentioned timeline. This would add extra modality in the way a story is told, but also lets the patient see that there were other moments throughout the deployment other than the emotional and stressful events. Also, based on studies related to 'imagery rescripting' (Smucker, et al, 1995) the use of imagery can have a more powerful impact on positive emotion compared to narrative elements. This can even be further enhanced by using personal pictures which may trigger memories. 'Imagery rescripting' is not just 'imaginal exposure therapy'; in these sessions the patient also tries to imagine what happened and, as the name suggests, rescript the historical events. Although most taken pictures show events not related to a stressor, some pictures can be painful when exposed to the patient. The psychiatrist suggested that both types of pictures are needed in the application.

As the timeline was the main focus of the brainstorm session which followed after the review, more options were explored. One of the ideas was not to put only the historical moments on the timeline, but also the present time. This way information about the sessions and progress could be monitored. When, for example, the patient starts the application, he will see all progress and changes that has been made, learning more about what he is doing and making sure that he sees that he is really working together with the therapist on the treatment of his disorder.



### 3.3 Second cycle

The suggestions made by the interviewed psychiatrist resulted in the creation of a different type of application to treat patients suffering from a combat-related PTSD. The design and implementation of solely a 3D editor was halted and the newly acquired insights were used to come up with a preliminary requirements baseline for the new approach. For this approach both the (1) timeline and (2) the use of personal data were incorporated, together with the past knowledge of using a 3D editor to help restructure and explain a past situation.

After a preliminary requirements baseline was made, a new set of scenarios had to be created (Figure 3-7). These revised scenarios showed both the behavior of all the involved actors and the interaction with the new envisioned application. Similar to the creation of the scenarios in the first cycle, several assumptions had to be made in order to create the revised scenarios in this cycle. Therefore interviews were needed to acquire feedback and to support or reject the specified claims. This time a total of ten experts were asked for reviewing the scenarios. The creation of the scenarios and the gathered feedback as a result of presenting these scenarios are discussed in this paragraph.

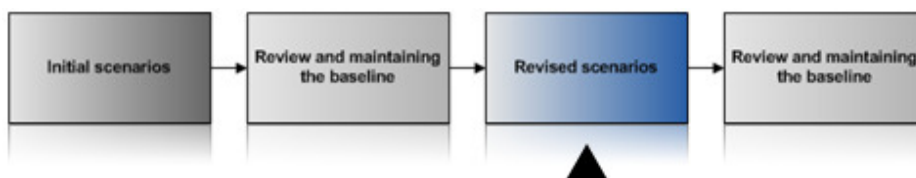


Figure 3-7: Second cycle, creation of the revised scenarios

#### 3.3.1 A preliminary requirements baseline

Just as the first cycle, a new low-fidelity prototype had to be made to explain the new features and possibilities of the application to the people who were going to review it. For the creation of this prototype a set of requirements were needed. Although the requirements at this stage were not as detailed as the requirements discussed in later chapters, they were still useful in the discussions with the experts at this stage. These following requirements and features were later refined as more insights were acquired.

- System should provide different modalities for storytelling. Features are the ability for patients to insert (1) personal pictures, (2) text and 3D virtual worlds using an editor similar to the original approach.
- Patients should be able to organize events and stories. A timeline is needed which also acts as a form of navigation.
- Patient should be able to manage data given at previous sessions. Data can be modified at any given time. Bars and icons are required to indicate which days contain data.

These few requirements formed the base to create a refined low-fidelity prototype (Figure 3-8) which was later transformed to the screenshot shown in figure 3-9.

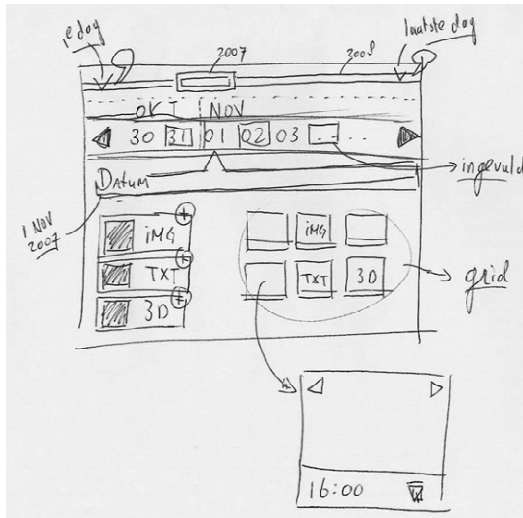


Figure 3-8: Draft low-fidelity prototype



Figure 3-9: Redrawn low-fidelity prototype for use in scenario movies

The screenshots used for the prototype do not go into details on how a user is able to edit text or add images to a timeline. This was on purpose as the set of scenarios were created to acquire as much feedback as possible from therapists and other experts in the field of PTSD, without elaborating about the more technical aspects of the envisioned application. The prototype featured the (1) timeline navigation (Figure 3-10) on top of the application, (2) buttons to insert content and (3) a big field at the bottom of the field containing the media and text of the selected day. The timeline consisted of two components, these are marked in figure 3-10.

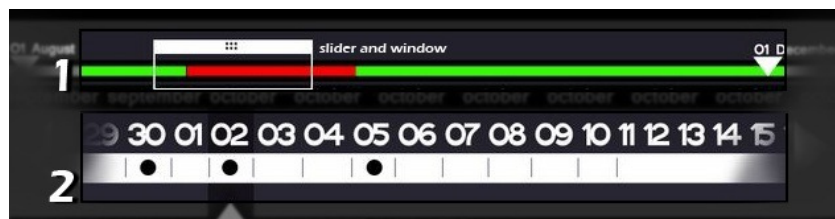


Figure 3-10: timeline navigation consisting of two components

#### Timeline component 1

The first component gives a complete overview of the deployment the patient is currently working on. With the help of a slider the user can quickly zoom in on a specific part of the deployment. The days within the slider window are displayed in component 2. Two colors are used as indication which parts of the timeline needs attention. If a patient keeps adding information, the corresponding parts of the bar will turn green. This way both patient and therapist can keep track of the progress that has been made throughout the therapy.

#### Timeline component 2

The second component displays a small period of about 20 days. As mentioned before, this period is linked to the window of component 1. The sliding mechanism here is used to select a day more precisely; by clicking the buttons on the left and right side of the screen, the whole component will



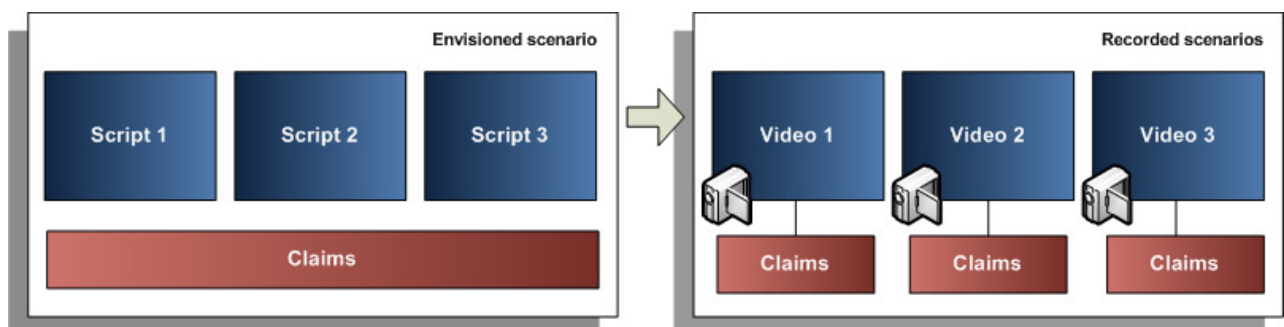
move slightly to the right and left respectively. As seen in figure 3-10 some icons are displayed underneath the numbering of the days. These can be used as extra indicators to inform the patient and therapist if a day has been edited or not. In this low-fidelity prototype only one icon is used, but more icons can be chosen to provide the patients and therapists with more information about a particular day without having to open it. When a day is completed, for example, the patient can mark this day with a specific icon.

#### *Adding media*

The remainder of the screen is devoted to the selection and placement of photographs, text and 3D virtual worlds. This is done by clicking on one of the corresponding buttons. Afterwards a thumbnail of the selected source is displayed in the field located at the bottom half of the screen.

### 3.3.2 Three revised scenarios

After the low-fidelity prototype was made, three new scenarios were created to explain the new features within the revised prototype. First three scripts (Appendix B) were made which described (1) the general use of the system showing all the features in a therapeutic setting, (2) the use of the 3D editor as a feature of the system and (3) modifying a data related to an event discussed in a previous session. By creating these scripts several claims were made. Each claim was linked to one of the three scripts. Afterwards short films were created (Figure 3-11) of all three scripts which were later presented to various experts in the field.



*Figure 3-11: Visualizing scripts to three short films*

#### ***Scenario A: Start of a session and general use of the application***

This first scenario, which can also be seen as the main scenario, described a series of general events which can occur while using the application. In this scenario the therapist welcomes all group members (Figure 3-12b) to his room after talking to another therapist who is involved with the more technical aspects of the system (Figure 3-12a). From here, the therapist looks at the patient's file using his own separate computer, while the patient takes a seat behind the keyboard and mouse controlling the actual application (Figure 3-12c).

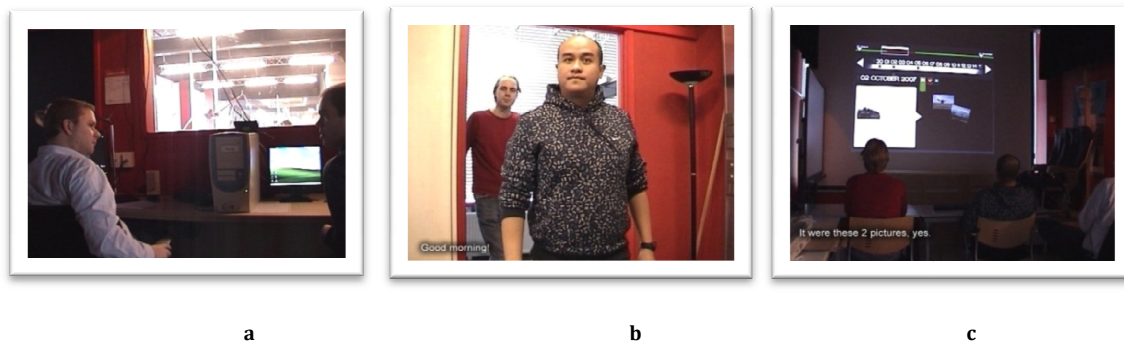


Figure 3-12: Stills of the scenario describing the general use of the application

The patient, who is going to share his story, first picks a date on the timeline. From here, the patient explains what he has witnessed during the time of deployment by placing and moving a variety of multimedia elements on a so-called 'workspace'. This 'workspace' is linked to a particular date of the patient's dispatch and can be opened, changed and tagged with keywords at any time. During the entire scenario the therapist guides the patient and motivates him to continue with his story. Occasionally the therapist gathers information concerning the emotional state related to the stressor or event.

The scenario was not only concerned with how patients can facilitate their memory by using the main features available within the application, but it also gave an example of how the actors behave and interact during a session. Besides this, several other aspects were covered in this short movie and associated claims:

- *Personalization*  
Patients must feel that they are working on *their* story, by using a wide range of tools in combination with their *own personal* photographs and documents in a trusted, customizable, environment. But is this important? If so, how can the application or setup be improved?
- *Timeline usage*  
The timeline is used as main means of navigation. The scenario shows how the patient picks a date by zooming in on the timeline. However, do patients know the exact dates of certain events, or does it not matter?
- *Progress bar and motivation*  
A progress bar is needed to keep track of the events which have been added or deleted. But can a progress bar also act as a way of keeping the patient motivated to continue with the story?

The claims linked to this scenario were:

- The features shown in the video, such as adding personal photographs and text, are sufficient enough for a patient to restructure and relearn a past deployment.
- The usage of the timeline will help the patient to organize various memory elements.
- The progress bar guides both patient and therapist.
- The progress bar also motivates the patient to continue and fill in the days containing no details.

### **Scenario B: Using the 3D editor**

One of the features which may support patients in describing what they have seen and felt during their deployment is the 3D editor. This editor is actually the same as the editor described in paragraph 3.2. This time the editor is one of the features of the system which allows the patient to build a particular area related to a past event or stressor by adding and moving 3D objects, such as houses, people and vehicles, on one of the pre-defined templates. The patient in this scenario did not require any help of the therapist as the editor was simplified and only featured basic functions to create a simple 3D area (Figure 3-13a). The therapist was solely focused on the patient and his story (Figure 3-13b).



Figure 3-13: Stills of the scenario describing the 3D editor

Other aspects explored with this scenario were:

- *Input of fellow group members*  
While one patient explains what he has experienced, the other members of the group get a better picture of what happened during that time. These group members can, in turn, ask questions related to the story.
- *Patient gets emotional*  
Questions regarding what the therapist should do and what the role of the application should be when the patient gets emotional arose throughout the entire study. An example, solely created for the acquisition of comments and feedback, is given in this scenario.

The claims linked to this scenario were:

- To prevent a patient to move away from a specific event, the application should be paused, not closed, when the patient gets emotional.
- Group members are allowed to interrupt and talk to the patient. This does not interrupt the actual treatment and may encourage the patient to explain everything in more detail.
- The patient does not mind sharing all details with the other group members, i.e. everyone is able to see all elements placed by the (active) patient.
- The patient does not need the therapist to help him or her control the 3D editor. He is able to handle the workload without any problems.

### Scenario C: Returning to a previously edited day

During one therapy session the therapist does not expect to hear every detail of the events the patient is currently working on. The most logical explanation is related to the patient's memory; the patient might not remember everything at once while restructuring his or her deployment. Another possibility is that the emotional load of the event is too heavy, making the patient avoid the entire subject on purpose. However, it is possible that the patient remembers, or is encouraged to talk about, these specific events at a later date. In this scenario the patient selects a previously discussed day on the timeline (Figure 3-14a) and opens the 3D editor to explain what really happened that day (Figure 3-14b).



Figure 3-14: Stills of the scenario describing the modification of a previously discussed day

## 3.4 Reviewing the revised scenarios

The scenarios described in the previous paragraph were presented to a total of ten experts (Figure 3-15). All experts were asked to give feedback on the proposed scenarios separately in an attempt to acquire new insights regarding the interaction with the system and the way a therapy session is managed (Figure 3-16). The ten experts who reviewed the set of scenarios all had a background related to (combat-related) PTSD or traumatic memory. Some of them also had experience in treating actual patients. Although the backgrounds are all linked to the same subject, some experts follow one specific practice such as EMDR or solely exposure therapy, to treat patients suffering from a PTSD.

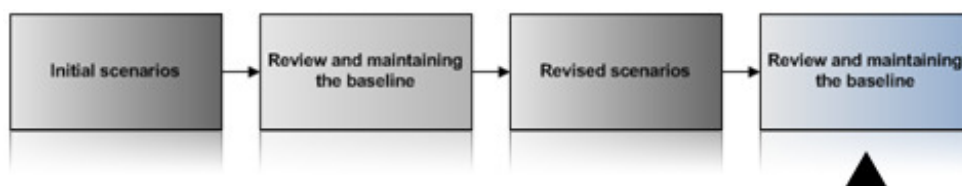


Figure 3-15: Second cycle, reviewing and maintaining the baseline

First the general idea of the approach was explained, together with presenting the three scenario movie clips. Afterwards an open discussion took place to talk about possible improvements and limitations. All feedback and impressions were written down for further analysis. Six of the experts were attendants of the NATO Advanced research workshop 'Wounds of War II' in Austria and were

reviewed by Willem-Paul Brinkman. The same procedure was used in acquiring the necessary feedback.

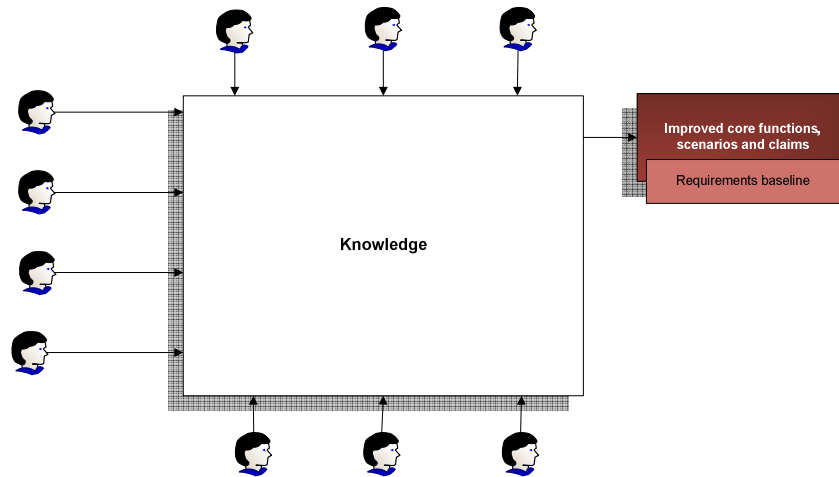


Figure 3-16: Knowledge gathering to refine the preliminary requirements baseline

### 3.4.1 Involved experts

The list of experts who participated in the reviewing phase was as follows:

- **A & B:** Two experts from UMC Utrecht (these two experts have experience in treating veterans suffering from a combat-related PTSD both in a patient-therapist setting and a group therapy setting).
- **C:** Assistant professor at the department of Clinical Psychology (at the University of Amsterdam). Specialized in treatment regarding grief and war-related traumatic experiences.
- **D:** Assistant professor at the department of Clinical Psychology (at the University of Rotterdam). Specialized in scientific research on traumatic memory, post-traumatic stress disorder and forensic psychology.

The other six experts were attendants of the NATO Advanced research workshop 'Wounds of War II' in Austria:

- **E:** A psychiatrist and professor from the Regional Psycho trauma Center Rijeka located in Croatia. The expert's background is not directly related to CBT but to psycho-dynamics.
- **F:** A psychiatrist active at the Split University Hospital located in Croatia, specialized in group therapy (trauma-focus groups, social groups and psycho-education groups).
- **G:** A PhD student, but experienced treating patients. This student uses imaginary exposure to treat individuals suffering from PTSD.
- **H:** Colonel and army psychiatrist working for the US Army, specialized in disaster and trauma response.

- **I:** Psychiatrist active at the Virtual Reality Medical Center in the USA. This expert does not only treat patients, but also trains therapists who use VR Exposure therapy in their sessions. Specialized in VRET and the combination of PTSD and VRET.
- **J:** Psychologist at the Military Institute of Health Services, Poland. Runs group sessions and is familiar with VRET.

### 3.4.2 Acquired feedback

Comments were not only given on the application itself, but also on the way the room is set up, about group therapy in general (and in this particular setting) and the way the patient can benefit by restructuring his or her memory using, for example, photographs and other media. The overall feedback was positive and the general idea behind the envisioned approach was supported. Feedback was mainly concerned with additional features which could improve the system such as additional options to facilitate memory content. Other suggestions, which also caused refinements to the requirements baseline, were (1) the possibilities to personalize the application, (2) the use of keywords to tag or summarize a specific day and (3) methods to manage and store data and session information. Because of the variety in backgrounds, some therapists supported several assumptions, such as the 3D editor, while others were more careful.

Other feedback was useful to get a better understand on what is important during a session and how a session should be managed with the envisioned application. Comments regarding the setup, the interaction and possible behavior were important to create core functions and associated claims needed for the next phase of the study. With all the acquired feedback several categories could be distinguished. The categories, including the various comments, are discussed in the remainder of this paragraph. For easy reading, the letters A-J are used to refer to the corresponding experts (see paragraph 3.4.1).

#### *Features to facilitate memory content*

Many experts liked the idea of adding personal data to a timeline, resulting in an archive containing all the patient's memories of a specific deployment. Experts came with additional options and suggestions to facilitate memory content. Expert F suggested that details about the weather, the smell and what they felt are also important. The system should therefore not be used for the input of only basic facts about what happened during the time of deployment. The text feature could be used to write about these experiences. Pictures and maps can be added to let the patients express themselves more. Furthermore, expert E mentioned the use of numbers, letters and colors, which can have a symbolic meaning to the patient. This is also an alternative way to let patients express themselves. For the system, images with these symbols could be loaded to accomplish this feature.

An option not possible with the presented prototype was the use of geographic maps. Expert J mentioned that he does not ask his patients to bring personal photographs and other related documents to a session, but he does ask his patients to picture a map of the area in their head and elaborate about it. A maps feature might be a helpful option, allowing patients to search the area the events took place and place a screenshot of the map on the timeline.

Both experts A and B said they make use of a flap-over during a session, allowing the patient to draw areas related to a certain stressor. A similar option might be needed in the application. Also,



some photographs need to be scanned first in order to load them onto the timeline, as not every patient has digital photo's related to the problematic deployment.

Experts A and B also mentioned the use of keywords to characterize one specific day. The patient might not want to add text and data to the timeline if it is related to an event that he or she rather not wants to talk about. The patient does not always have to be the victim of, for example, an accident. Some patients have caused harm to someone else and are now having difficulties to cope with what happened at that time. Expert A thought that these patients might not want to put data related to these events on the timeline as they might be scared of the consequences if others find out about it. Instead, code words can be used which are shared between the patient and therapist. This way only the therapist and patient would know what happened at that day.

### ***Controlling the application***

The idea of letting the patient use the application, instead of the therapist, was well received. However, how much power should the patient have?

Expert J stated that the patient should have full control of the application, or at least full control of the 3D editor. When the patient gets too emotional or when he or she thinks the exposure reaches a certain level, the patient should be able to quit the program or disable everything displayed on the screen. Most patients see themselves as a victim, not allowing them to quit at any time might put them in the victim role again. Expert C on the other hand was afraid that patients might stop the application because they know that they might get very emotional if they let the session continue. The Subjective Unit of Discomfort (SUD) score might never reach a certain desired level and he was afraid that by allowing the patient to quit the application hardly any progress would be made.

Everyone agreed that it is essential to let the patient return to a previously edited session. Patients might not remember everything during a previous session and are now given the ability to add or modify data to make everything right. Another reason, as described in chapter 2, is that veterans might not want to share emotional or sensitive data the first time. Later they may realize that sharing and discussing the stories might help with their recovery.

### ***The use of the 3D editor***

Not everyone supported the use of the 3D editor. Experts E and F thought that it is difficult for the therapist to take control of the situation when the patient gets exposed to a stressor or stimuli by using and creating virtual worlds. They mentioned it might even be dangerous. It is important to note that both experts might not have been open enough for anything related to exposure. This was also hinted by looking at their backgrounds (psychodynamics and group therapy without exposure).

However, others, like expert G, did sound positive. A suggestion to reduce the exposure level was to use less-detailed 3D objects, or maybe even basic building blocks. Expert G did also mention that exposure was used to reduce anxiety, not feelings of guilt. Thus, it may not even be needed to use very detailed objects for the editor.

### ***Data storage and management***

Although not mentioned directly in the set of scenarios, the topic 'data storage' was mentioned multiple times. Expert H believes that most soldiers do not seek treatment because of the fear of

stigma and the eventual consequences. Therefore the storage of used data should be well implemented.

#### ***The setup***

Expert J commented that during his group sessions the tables were placed in a circle, where the therapist is able to see all patients. Not only can he, as a therapist, look at the patient's face, but he can also observe the patient's non-verbal communication signals. He also thought that the circle creates the feeling of a 'safe zone'; everything discussed during a session "stays" within this circle. Expert A and I also mentioned this 'safe zone', but he thought only the chairs should be situated in the shape of a circle, or the letter 'U', because tables are not necessary for the other group members.

Experts A, B and F agreed on the 5-6 persons present within a group. Expert F thought that all members should have the same kind of trauma. Due to difficulties creating groups with people who were dispatched to the same areas, groups may be formed with patients suffering from combat-related PTSD from various different deployments. According to experts A and B, this was not a problem.

#### ***Other comments***

Expert A thought that it would be good idea to have a log in screen for the patient, together with a profile page to give the application more credibility. This profile page would act as the personal home of the patient where he can set all kinds of options. Afterwards the patient should be greeted by a list of deployments. Expert A also mentioned the use of session summaries which could be added to the timeline showing the current time period. This would make the patient be more aware of the treatment and his or her progress. Also, he thought that sessions would be easier to manage as the therapist can read the summaries of the past sessions before a session starts.





## 4 Design

### 4.1 Chapter overview

This chapter describes the process of building and evaluating prototypes to verify and refine the preliminary requirements baseline. First the comments of the second cycle of scenarios had to be analyzed further. By doing this several core functions were defined, together with a set of requirements which were later used for the creation of the first high-fidelity prototype. The general idea of how a system could support treatment during a session was covered in the previous phase, therefore, the focus in this phase was more on the design and usability of the system. A heuristic evaluation (Nielsen, 1990) was conducted to either support or reject early usability assumptions. The evaluation pointed out several problems concerning the (1) timeline navigation, (2) system status and (3) availability of the hardware. These problems were addressed and a new prototype was built. A formative evaluation approach was chosen to regularly obtain feedback from a small group of experts at the University, making it possible to continuously improve the prototype or rapidly create new iterations of the system when needed. Several additional meetings with the psychiatrist from UMC Utrecht took place to obtain additional feedback from a therapeutic point of view. This way an expert from the clinical field was also kept in the loop. Figure 4-1 shows that prototypes were both evaluated and reviewed, resulting in two kinds of refinements: (1) usability related refinements and (2) implementation of additional features or changes to existing features. Because of these two flows, the (formative) usability evaluation was sometimes halted until feedback from the therapist was incorporated into a new iteration of the prototype.

This chapter starts by describing all core functions and rationales, requirements and associated features for the system, followed by a brief description of a possible setup in a therapeutic setting. The high-fidelity prototype is discussed in detail in paragraph 4-4. Two evaluations, a heuristic evaluation and an extensive review going through all principal design principles of interaction (Tognazzini, 2003), are described in paragraph 4-5. Afterwards several changes as a result of the formative evaluation are discussed, together with the associated refinements to the requirements baseline.

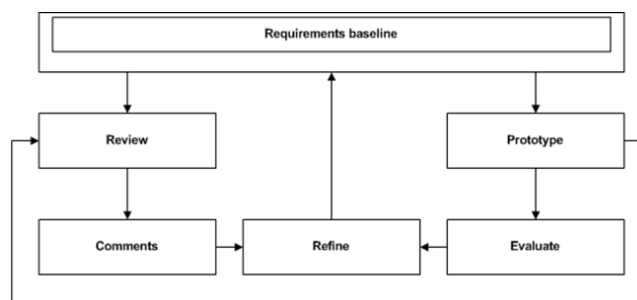


Figure 4-1: Prototypes to verify and refine the baseline (Neerincx, Lindenberg, 2008)

### 4.2 Refined requirements baseline

The preliminary requirements baseline of the previous chapter had to be refined as more knowledge was acquired from presenting the scenarios to ten experts in the field. The following

core functions (Table 4-1) are the result of analyzing this feedback and the previous acquired inventory of operational demands, human factors knowledge and envisioned technology (Neerincx, Lindenberg, 2008). This table also includes two additional core functions; (1) providing a personal approach and (2) preventing unexpected exposure. These are the result of reviewing and evaluating the prototypes created throughout this phase.

Core function	Rationale
<b>Provide a flexible way of storytelling (§4.2.1)</b>	Restructuring and relearning about a past deployment can have a positive effect in traditional treatment. Only the patient has access to the various memory elements related to the events and stressors at that time. More efficient and effective results may be achieved by allowing the patient itself to facilitate memory content in a flexible and motivating way.
<b>Provide a structured way of storytelling (§4.2.2)</b>	Deployments usually cover multiple months. Within these months various events occur. Next to giving the patient the tools to flexibly add and edit memory elements, it might also be important to do this in a more structured environment.
<b>Prevent losing track of changed and added events (§4.2.3)</b>	Currently a physical folder is kept of every patient, containing notes, drawings and other deployment related information. These files can get rather large and it is difficult to keep track of the continuous changes which may occur. Especially if a therapist works with multiple different patients every week.
<b>Ensure trust (§4.2.4)</b>	Deployment related stories can contain very sensitive information. This data should therefore be stored securely. Trust might be another problem if the storage of private data is not properly implemented. The look and feel of the system can also be important when ensuring trust.
<b>Ensure usage for therapists with different backgrounds (§4.2.5)</b>	There are many ways to treat patients suffering from a combat-related PTSD. If the system does not force the patients to follow one specific procedure, while providing several tools to facilitate memory, the system might be interesting for a variety of different therapists.
<b>Ensuring awareness of treatment (§4.2.6)</b>	Next to the restructuring and relearning element, a psycho-educational element can be introduced to give the patient more insights about the treatment in general. Details of sessions, including information about recent changes, future goals and accomplished goals may help patients learn and cope with their disorder.
<b>Provide a personal approach (§4.2.7)</b>	The patient should feel comfortable using the application. Personal preferences should be respected, making the application look and feel like a helpful companion throughout the treatment.
<b>Prevent unexpected exposure to emotional material (§4.2.7)</b>	During the first review with an actual patient, one of the suggestions was to implement an option to 'tag' photographs that are linked to very emotional situations. Patient may not like the idea of being greeted with a very emotional memory when starting the application or navigating through the timeline.
<b>Ensure appealing and motivating approach throughout the therapy (§4.2.8)</b>	One of the problems with current treatment is the high drop-out rates. Keeping the patient motivated and aware of the progress may prevent the patient to quit the therapy too early.

*Table 4-1: Core functions and rationales*

All functions are described in more detail in the upcoming paragraphs. The associated statements listed in these paragraphs are actually supported by experts in the field. They are the result of

continuous discussions the psychiatrist from Utrecht and his colleagues. They were, just like the core functions, based on the knowledge acquired in the previous phases. For each of these claims various cons and pros are listed (Rosson, Carroll, 2002), marked with a minus and plus sign respectively.

Several listed system features and statements described in these paragraphs are the result of evaluations of several prototypes and discussions with the psychiatrist as the design was continuously exposed to new insights acquired along the way. These features were therefore not present right before the creation of the first high-fidelity prototype. The core functions and associated statements and features described in the following paragraphs can therefore be seen as the end result of the verification and evaluation phases.

#### 4.2.1 Provide a flexible way of storytelling

During the first review stage it became clear that the many veterans have personal photographs, letters and other deployment-related data stacked away somewhere in their house. A feasible option is to let patients combine this data with other elements of the system and link the data to a specific moment in time. This not only allows patients to rearrange memory elements in a more effective, and perhaps motivating, way, it also transforms the application in a more personal environment containing all stories, pictures and goals of the patient. In order to accomplish this, several related requirements must be met. These requirements are given below, together with several features for the prototype. In addition to the requirements and features, several statements are also associated with this core function. These are listed in table 4-2. The first statement in this table is actually a combined one; enhancing a story involves (1) adding more details to a story and (2) thinking about these details. These two are both concerned with the re-experiencing, relearning and possible reappraising of past events. The second statement is concerned with the focus of the therapist and who is controlling the application. Another associated statement is concerned with the actual placing and archiving of media.

Statements and trade-offs
<p><b>Using media enhances the way a story is told</b></p> <ul style="list-style-type: none"> <li>+ Can encourage the patient to add more details as it might be more appealing compared to face-to-face talk</li> <li>+ Use of personal material makes working on the application more personal</li> <li>+ Patient can reappraise an event or deployment if material is used related to positive memories</li> <li>+ More modalities to explain what happened</li> <li>+ Can trigger (hidden) memories related to a stressor</li> <li>+/- Exposure to bad memories</li> <li>- Treatment might take longer as non-relevant material is discussed</li> <li>- Requires effort from both therapist and patient (sorting media, organizing, planning, typing, etc.)</li> </ul>
<p><b>Focus therapist → patient remains the same if only the patient interacts directly with the system</b></p> <ul style="list-style-type: none"> <li>+ Therapist can focus solely on the patient and the events he or she is telling</li> <li>+ Patients feel more committed when they know they are working on their own digital memory archive</li> <li>+ Quicker to organize memory, as the patient knows more about his or her past</li> <li>- Harder for therapist to control actual session</li> </ul>
<p><b>Placing media on a particular day is an effective and efficient way to tell a story</b></p> <ul style="list-style-type: none"> <li>+ Can group related media and text together</li> <li>+ Pictures and maps may contain more details than just text</li> <li>+ Quick overview of a day with thumbnails and text previews</li> <li>+ Creation of a memory archive</li> <li>+ Way to share a story with others</li> </ul>

- Media needs to be resized. Otherwise it would not fit on the screen. This requires extra interface options.
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*Table 4-2: Statements and trade-offs 'flexible way of storytelling'*

To accomplish a flexible way of storytelling, or any other core function, one or more requirements are needed. These requirements are essential for the implementation of the system. In these paragraphs not only the requirements are listed, but also the corresponding features and details. For a flexible way of storytelling the placement of media, 3D environments and text is essential. These elements allow the patient to explain what has happened and to think about the events in more detail. For this function seven requirements are given below.

**Requirement 1: placing data elements to help patients tell their story**

The patient should be able to select, add and manage various multimedia elements. Because the data should be clearly visible by all group members, solutions like textual lists and data folders are not an option. All elements should therefore be displayed directly on the screen. The patient should also have the ability to group certain elements together, making the way a story is told more flexible.

Features for the prototype
An empty field is needed for patients to put data in (Figure 4-2)
Patients should select elements from a menu (Figure 4-2)
Ability to drag elements on the field
A small preview is available directly, with an option to see everything
General deployment workspace to load data on, data not yet linked to a date

**Requirement 2: easy input of personal data**

It should be easy for patients to put personal data into the system. Patients can bring their own personal data from home to a session. Be it digital or not. Also, the patient should be able to load this data at any time during a session. Patients should be able to quickly insert these documents while they tell their story.

Features for the prototype
Option to use the webcam to make snapshots (can be used for anything)
Option to load media from hard disk, CD and/or USB-stick

**Requirement 3: other features to facilitate memory content**

During traditional treatment veterans often draw and build areas related to a certain stressor. An option to screen capture notes, drawings and miniature representations of the environment is an essential feature which should be added to the system. Displaying geographical data is also an option which can help veterans facilitate detailed memory elements related to a specific area. Next to these features, an option to add text is needed to put narrative elements on the screen. Although all these features may help facilitate memory, some patients might not want to add sensitive data to a specific day. The system should therefore provide a way to link a codeword or keyword to a particular day. This way the patient and therapist recognize what happened during that time without storing sensitive data.

Features for the prototype
Google earth maps should be loaded and placed within the application
Option to insert text elements for notes or stories
Option to add code- or keywords to a specific day

**Requirement 4: the patient should not get distracted or lose focus**

During treatment, the amount of notifications or pop-ups should be kept a minimum or should not exist at all. Otherwise the patient may lose focus on what he or she is currently doing. The workspace is small and must contain thumbnails of images and previews of text elements. The patient can edit or resize these elements, but he or she must still be aware of the running application underneath.

Features for the prototype
Not many options immediately on screen
Current workspace should still be visible when editing text or watching a full image

**Requirement 5: patient in control of the system**

The user interface should not be too difficult to understand. The patient should, without additional required knowledge, be able to quickly manage their memory elements. Interaction takes place mainly between patient and system. However, narrative elements should be typed by either the therapist or a group member. This allows the active patient to read what he or she is currently saying. Of course, a therapist still takes control of the overall session. He or she manages the treatment and gives the patients directions on what to tell.

**Requirement 6: multiple deployments of a patient should be available**

Many veterans have returned from more than one deployment. According to the psychiatrist it is good that each deployment is linked to a memory. A picture or military code used for the deployment can be used, for example. The system should provide a way to select one of the deployments. Afterwards the system should redirect the patient to that certain time period.

Features for the prototype
A list of deployments is available at the start, all selectable and linked to a region on the time line (Figure 4-3)
Next to each deployment the date, picture and military code are displayed
Deployments must also be visible on the main time line

**Requirement 7: construct an area with the help of a 3D editor**

Sometimes the patient does not have any material to describe a certain situation. In that case the patient can make use of drawings and notes. Another option is to allow the patient to construct the situation using 3D models. Using different camera angles to look at a certain situation may result in further restructuring and relearning.

Features for the prototype
Camera controls to view area from different angles
Controls to select, delete and move objects

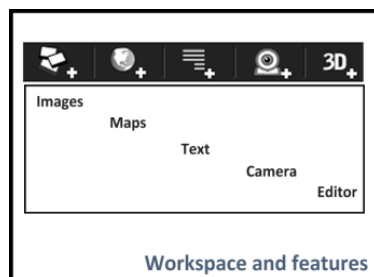


Figure 4-2: Workspace



Figure 4-3: Deployment list

### 4.2.2 Provide a structured way of storytelling

Time is an important aspect to consider when telling a story. For the second cycle of scenarios a timeline was used for navigating through days within a deployment. This timeline, combined with the use of icons and notification dialogs can provide a more structured way of storytelling. Patients now have to think about a specific date (or period) and the related events which happened back then. The two main statements in table 4-3 are concerned with specific details about both time and events that took place. The system should encourage and provide a way to let the patient talk about specific actions and experiences instead of general events, such as 'going to a town', or, 'heading back home'. The third claim is concerned with the timeline used for both indicator and navigation method.

Statements and trade-offs
<p><b>Patients will be more specific about time</b></p> <ul style="list-style-type: none"> <li>+ Patients get a better understanding about their deployment</li> <li>+ Allows them to organize and restructure past events</li> <li>- Can be frustrating if the date is not known, especially when restructuring events</li> </ul>
<p><b>Patients will be more specific about events which happened back then</b></p> <ul style="list-style-type: none"> <li>+ Patients may add more detailed information to one day, instead of more general descriptions of events</li> <li>+ May trigger hidden or memories or memories associated with a stressor</li> <li>+/- Discussion of both relevant as non-relevant events</li> </ul>
<p><b>Timeline provides easy (and quick) navigation</b></p> <ul style="list-style-type: none"> <li>+ Always present and can be used as date indicator</li> <li>+ Can be combined with icons for a better overview</li> <li>- Takes a large amount of space</li> </ul>

Table 4-3: Claims 'provide patient with a structured way of storytelling'

#### **Requirement 1: there should be an ability to zoom in to a specific moment in time**

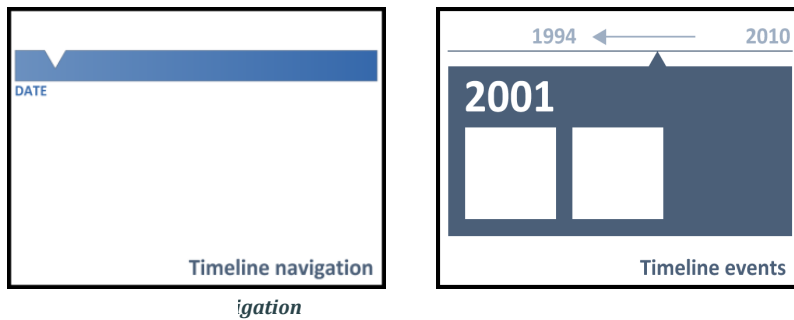
Patients should be able to specify the month, day and the year of the day he or she wants to work with (Figure 4-4). The navigation should be quick and easy to use, as the timeline is the main method of navigation. In addition to navigating, the timeline should also indicate which day is selected.

Features for the prototype
Time line has 3 layers (year, month, day), each with its own controls
When moving one layer (years for example), the rest of the time line should move automatically

#### **Requirement 2: make it clear that contact with the possible stressors took place a long time ago**

A clear separation should exist between the time of deployment and the 'here and now'. One option is to let the system show a set of personal photographs while moving to the desired time period. Two additional advantages are gained by doing this. First, it makes the application more personal and second, it points out other, maybe more, important events in the patient's life.

Features for the prototype
Using the time line, add animations showing personal photographs associated with a year (Figure 4-5)



### 4.2.3 Prevent losing track of changed and added events

The way a story is told does not always follow a logical, sequential order. This means that it may be essential to capture which parts of a deployment have been worked out and which other parts need more attention. There might always be a chance that previously discussed items are forgotten, despite the fact that they are stored in the patient's file. Although the statement in table 4-4 shows more advantages than disadvantages, the effort and amount of time it takes to insert the required data might discourage the therapist to write a detailed summary. A suggestion was to let the system generate this data automatically.

#### Statements and trade-offs

##### Managing a session will be more efficient

- + Therapist can easier pick up a past session by reading the summary
- + Gives a better overview
- + Provides material for a reflection
- Takes a lot of effort if not done automatically

Table 4-4: Claim 'prevent losing track of events'

#### **Requirement 1: both patient and therapist should be given a general overview of the treatment**

To provide the veterans with an overview, progress bars and icons (Figure 4-6) can be implemented and shown on the screen. The use of a progress bar does not only provide a good overview of a selected deployment, it can also act as a method to encourage the patient to continuously work on a story. This can be achieved by automatically filling the progress bar as soon as the patient is finished filling out a specific part of the timeline.

#### **Requirement 2: summaries of previous sessions should be provided**

To prevent loss of previously discussed items, summaries of a session should be kept and immediately linked to the day the session took place (Figure 4-7). An idea is to make this automated; the system should keep a log of past edited events and automatically create a summary. When the patient logs in, all summaries of the past sessions will be displayed on the timeline showing the current time period.

#### Features for the prototype

On the start screen the patient can select days in the current timeline. A summary is given of the session when a day is selected





Figure 4-6: Icons and progress bar

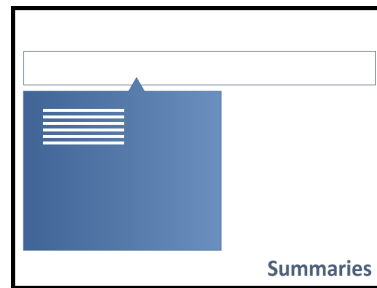


Figure 4-7: Summaries of past sessions

#### 4.2.4 Ensure trust

Data added to the system should be stored using a cryptographic algorithm. Additional to this, all data should be stored on the patient's personal USB-storage device. According to the psychiatrist at UMC Utrecht, the option to let patients carry all personal data with them may have a positive effect on the way the patient thinks about the system. All data is kept by the patient and the patient is in control of all the data, instead of an organization or hospital. In addition to data storage, the system should also look and feel trustworthy. Trustworthiness is one of the key components of credibility (Fogg, Tseng, 1999) and is an important aspect of how the patient perceives the application. Inconsistent interfaces, typographical errors, and hard to use interfaces should therefore be avoided. Although the application will be used in the therapeutic environment which hints that it has been approved, it may also be important to emphasize that the corresponding hospital or clinic really supports the use of the application. This can be done by, for example, adding a logo of the hospital on the startup screen.

##### Features for the prototype

Log-in screen which requires a username and password
Possibility to put a logo on startup screen

#### 4.2.5 Ensure usage for therapists with different backgrounds

There are various methods to treat patients suffering from a combat-related PTSD. Some claim that exposure is the best way of treatment, while others concentrate on methods such as EMDR and psychodynamics. Ensuring usage for therapists with different backgrounds can be accomplished by not forcing one specific procedure. The system should therefore give the therapist enough freedom to tell or encourage the patient to pick certain tools during a session. This way the therapist decides where the focus should be on and not the application.

The webcam feature can be used for a variety of things; the therapist can, for example, decide to capture drawn symbols, personal pictures or physical objects. And, of course, the therapist can decide not to let the patient work with, for example, the 3D editor or the 'google maps' feature. The use of the timeline cannot be avoided, as it is the main method of navigation.

#### 4.2.6 Provide a psycho-educational element within the application

Following the first interview several options were discussed to incorporate traditional treatment options into the application. The timeline was initially designed to enable the patient to navigate to

a specific period of time. However, the timeline can also be used to display the current time period. Using this part of the timeline therapy session information can be added, allowing the patient to be more aware of their treatment. Table 4-4 lists the positive and negative aspects of the treatment awareness claim associated with this core function.

Statement and trade-offs
<p><b>Patients will be more aware of their treatment</b></p> <ul style="list-style-type: none"> <li>+ Patients get a better understanding about their disorder</li> <li>+ Patients will see progress or changes throughout the therapy by using the (current) timeline</li> <li>+ Patients may become more committed</li> <li>- Takes a lot of effort and time to create summaries</li> </ul>

Table 4-4: Claim 'provide a psycho-educational element within the application'

#### Requirement 1: Therapy session information

Icons should be used to indicate that a session took place (Figure 4-8). These icons should be attached to dates on the timeline within the application, so the patient knows what happened on that day. Not only information about previous sessions should be included, also future sessions should be added to the timeline. This kind of overview will add to the treatment awareness.

Features for the prototype
Additional icon to indicate a session
Option to add text to days on the current timeline period

#### Requirement 2: Adding goals

Another discussed feature is to let the patient, together with the therapist, insert goals and link them to future dates (Figure 4-9). Small descriptions of deployment related events the patients want to cover can be described, but also goals related to activities in the current time period, such as fixing a car, preparing a wedding, etc. Patients can insert pictures and narrative elements of what they are currently doing. This feature will let the patient think more about the present instead of the past.

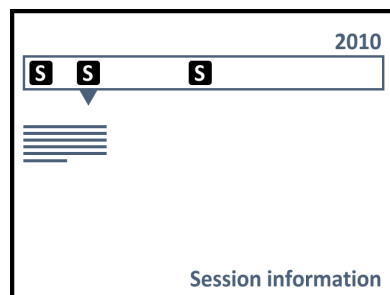


Figure 4-8: Session information

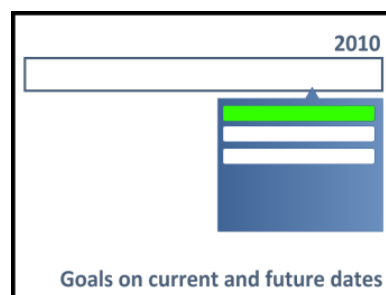


Figure 4-9: Adding goals

#### 4.2.7 Personal approach and preventing unexpected exposure

One way to accomplish a more personal approach is by adding options for the patient to set several preferences. Also a personal log in screen before the actual application starts may give the patient the feeling he is working in his own, personalized, environment. To prevent unexpected exposure, an easy to use option should be available to hide and unhide photographs. This way every

photograph can be sorted into two separate categories, depending on the emotional load the image carries.

Statement and trade-offs
<p><b>Adding a log-in screen and allowing custom preferences adds to a personal approach</b></p> <ul style="list-style-type: none"> <li>+ Patients may feel more comfortable using the application</li> <li>+ May be more enjoyable</li> <li>+ Working on their own deployment in their own application environment</li> <li>- Small part of the session is used for setting technical preferences and is not about therapy</li> </ul>

*Table 4-5: Claim 'personal approach'*

Features for the prototype
Screen where user can set preferences
Option to hide and unhide content to prevent unexpected exposure

#### 4.2.8 Ensure appealing and motivating approach throughout the therapy

Although the multimedia features may already appeal and motivate the patient, the user interface itself should also add to both an appealing and motivating approach. Various decisions have to be made concerning the (1) color scheme, (2) placement of UI components and panels, (3) use of animations and (4) 2D graphics.

### 4.3 Setup and environment

The setup pictured in figure 4-10 shows a possible situation of a group therapy session used together with the computer assisted technology in a therapeutic environment. In this situation it is possible for a patient to both discuss the various deployment related events with the therapist as well as sharing these stories with other members of the group. The application is designed to run on a personal computer, displayed near the desk in figure 4-10, which can be controlled by the patient currently restructuring his or her memory. The patient can add and rearrange elements, such as, personal photographs, geographical maps and 3D worlds, by using a standard keyboard and mouse. The therapist is able to monitor the entire progress of the treatment by looking at the display screen placed on the desk. An extra keyboard is required to let the therapist type and add the narrative elements of the patient's story. Finally a projector is used to display the computer screen on the wall for all group members to see.

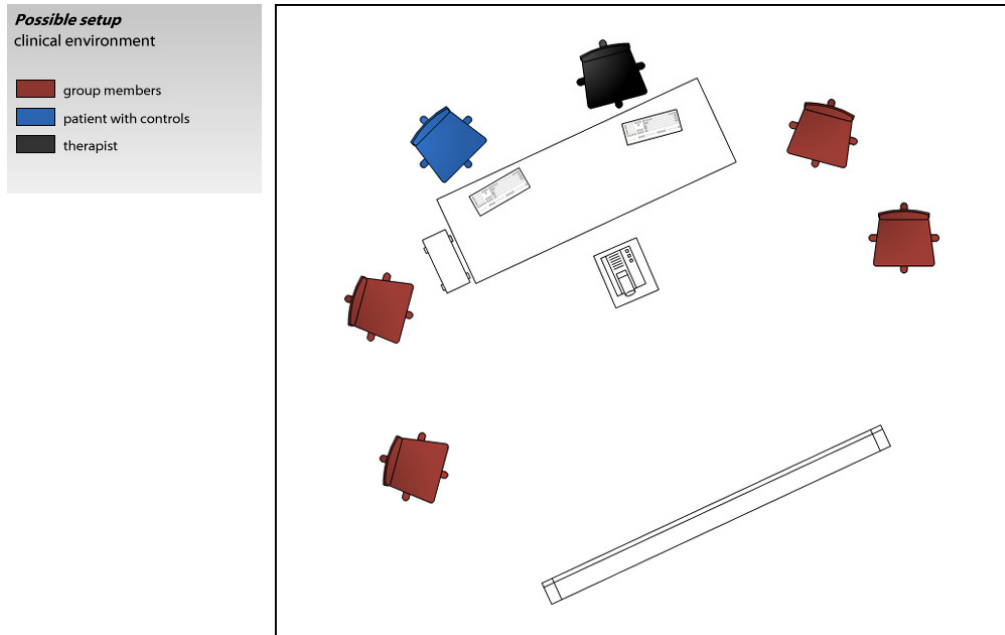


Figure 4-10: Possible setup therapeutic setting

Together with the circle shaped chair placement, this particular setup creates a safe zone, in which direct eye contact among members can be avoided. Some patients may not like to be stared at during their exposure, and others do not want to look at someone in a potentially distressing state. However, the option to look at other members of the group is still open; in case other methods are used to facilitate memory content, such as the use of a flap-over or the creation of physical maps and sceneries.

#### 4.4 High-fidelity prototype

With the refined requirements baseline, a first attempt was made to create a prototype with sufficient features to be used in the heuristic evaluation (Figure 4-11). The prototype resembles the previous, low-fidelity, prototype, but also incorporates the feedback from the second cycle of scenarios. The most noticeable difference is that the timeline is used for both activities in the current time period (Figure 4-13) and activities from past deployments (Figure 4-14). The current time period resembles the time when treatment takes place. Therefore, this part of the timeline contains information or summaries of past and future sessions. More screenshots can be found in appendix C.

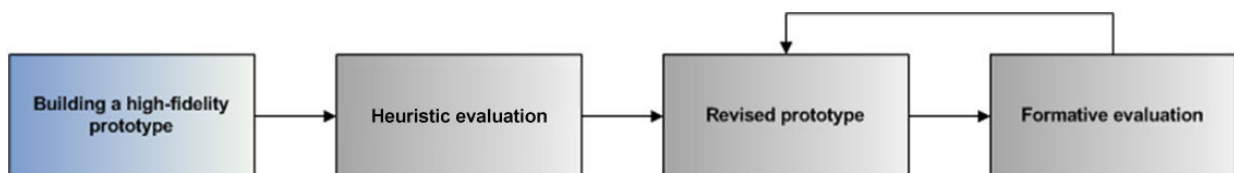


Figure 4-11: First phase

The prototype consists of three main components: (1) a timeline navigation panel, (2) a content panel and (3) an overview panel (Figure 4-12). This paragraph gives a short description of some of the main elements present in these three components, together with several initial assumptions. Although some of the features were not fully implemented, the prototype had sufficient functionality to be used in the heuristic evaluation which followed. This paragraph does not yet cover any details about the 3D world editor. For this prototype and the corresponding heuristic evaluation the standard 3D editor of 'Armed Assault', as described in chapter 2, was used. Later, an easy to use 3D editor was built for both the experiments and case study.

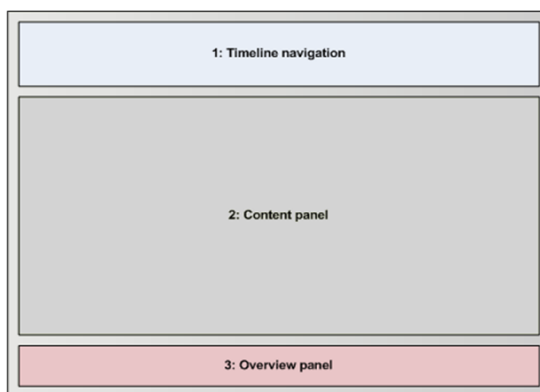


Figure 4-12: Three main components

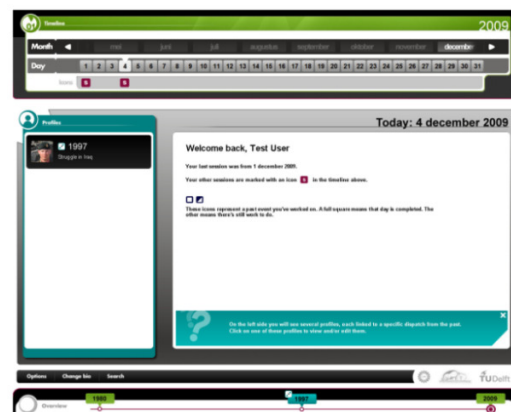


Figure 4-13: Current time period

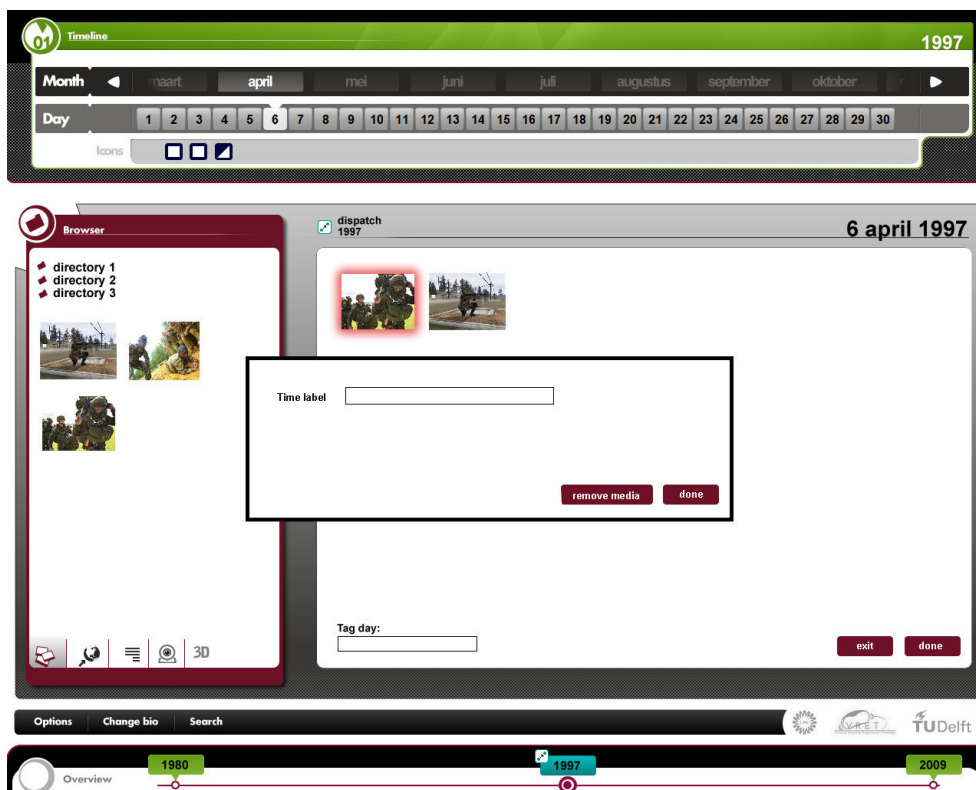


Figure 4-14: Past time period

### Component 1: The timeline navigation

As patients can go back to previously edited days at a later time, it should be clear which days are completed and which days still need attention. The system constantly saves data to XML-files when changes occur. If the patient does not specify a day as 'completed', the system assumes that more editing is needed and marks the day with the 'incomplete' icon. In this prototype three icons (Figure 4-15) were used to make clear what is linked to a specific day displayed on the timeline. The 'S' icon corresponds to session information, such as summaries or goals. This type of icon is therefore only used on the timeline displaying the current time period. The timeline consists of two separate bars; one for selecting a month and one for selecting a day within this particular month.



Figure 4-15: Icons

### Component 2: The content panel

Help panels are present during every phase of the application. These help panels contain information to help the patient with the options presented on the current screen. These help panels can be closed at any time and only provide the basic knowledge to work with the application.

#### Current time period

When the application starts, the panel displays data related to the current time period, i.e. summaries about past and future sessions. One of the comments which followed after the reviewing phase was to include keywords or codes and a photo of the soldier during that time. The new prototype accepts this data and uses this data to create a clickable panel. This panel is then placed in the deployment list, located on the left of the screen (Figure 4-17). When this panel is clicked, the timeline will move to the selected time period.

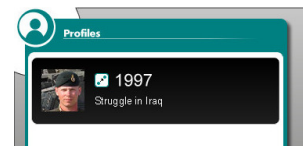


Figure 4-17: Profile

#### Switching from time periods

A clear distinction between the 'here and now' and the 'there and then' must be made. Adding (personal) photographs to specific places on the timeline and watching a few of these pictures pass by while "warping" to the selected deployment can make the patient realize the deployment took place a long time ago (Figure 4-18). All paths to the images, together with the corresponding time IDs, are saved in the patient's personal XML file.

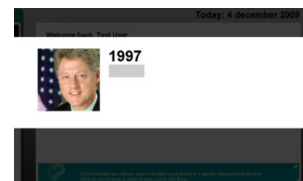


Figure 4-18: Switching years

#### Past time period

Two additional storytelling features were added in this prototype. An internal html-viewer was created to allow the patient to open up Google maps, search a specific location and make a screen dump. The dump is then placed on the field of that particular day, together with all the other (media) elements which can be put there. Similar to this, a webcam feature was added. This feature can be used to make quick snapshots of documents, physical objects or drawings (Figure 4-19).



Figure 4-19: Maps and webcam feature

All media elements can be managed by double-clicking them. A pop-up appears where the patient can rearrange, delete and tag the media placed in the grid as seen in figure 4-14. When the patient fills in a time, the application automatically sorts all media within that grid. Adding images is done by selecting an image in the browser panel on the left (Figure 4-14). This is similar to the way 'windows explorer' works. For the maps a small panel appears where it is possible to type in the desired country or city and make a snapshot.

An option was added to tag an entire day with several keywords (figure 4-20). Keywords will be displayed when the patient hovers the mouse pointer over buttons on the timeline. The actual reason behind this addition is that some days might contain very sensitive data. Patients can still mark a day without adding too much content to the system. Tagged days can later be found by searching the corresponding keywords.



Figure 4-20: Tag a day

**Component 3: The overview panel**

Every added deployment is also viewable on the overview panel. The overview panel shows a lifeline which starts with the patient's day of birth and ends with the current date. Although most space of this timeline is of no importance, as only deployments are displayed, it does give the patient an idea that the problematic events only take up a small section of the lifeline. Using the circles beneath the labels, the patient can also see where on the lifeline he or she currently is.

**4.5 Heuristic evaluation and group discussion**

Ten principles for user interface design (Nielsen, 1990), also known as the ten heuristics, were used to obtain feedback on the high-fidelity prototype discussed in the previous paragraph (Figure 4-21). By creating the prototype discussed in the previous paragraph, various assumptions were made regarding the usability of the system. These assumptions can be found in table 4-6. During the inspection of the ten usability aspects, these assumptions were either accepted or rejected. Next to a heuristic evaluation of the prototype, a group discussion was held to discuss the design principles of interaction (Tognazzini, 2003).

User interface assumptions
It is clear that the timeline contains clickable buttons (both months and days)
It is clear which day the timeline is currently pointing to
Users are not confused when profiles window (current time period) changes to a browser window (past time period)
Users know that they have to load a profile first to start working on a past deployment
The overview panel provides sufficient information
Small help dialogs help beginners to get used to the application
Sorting media by editing the time (in an edit window) is easy

Table 4-6: User interface assumptions

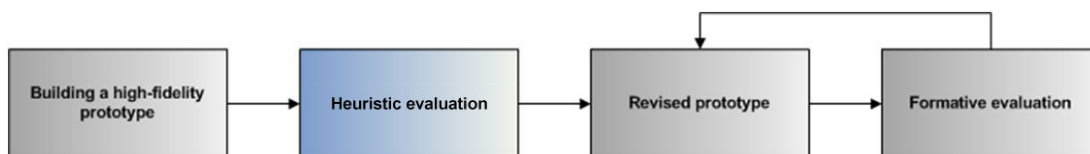


Figure 4-21: Second phase

#### 4.5.1 Materials, procedure and participants

Six students, experienced in the field of human-machine interaction, were asked to visit a website containing all the necessary information to participate in the evaluation. The evaluation method used screenshots and detailed descriptions of the prototype to explain the possibilities provided by the prototype. At that point the prototype was not yet stable enough to let the participants directly interact with it. Instead a paper prototype was used, together with movies and a thorough explanation of the features for the heuristic evaluation. Later, a part of this group (five participants) was asked to participate in the follow-up evaluation. This follow-up was a group discussion, going through all design principles of interaction. For this last phase the actual high-fidelity prototype was used and interaction was possible. The computer output was shown on the wall with the help of a projector, so everyone could comment on it. The left part of figure 4-22 shows the two separate evaluation phases. After the evaluation phases were finished, all comments were gathered and the requirements baseline was refined and a new prototype was created.

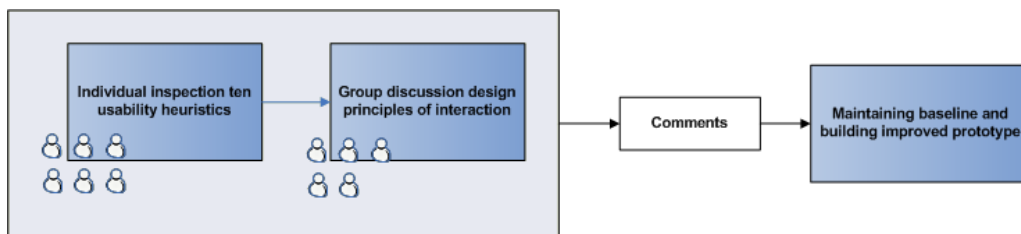


Figure 4-22: First usability evaluations

For the heuristic evaluation, the participants were asked to go to a website<sup>3</sup> and follow the necessary steps in order to evaluate the prototype. The website featured details about the prototype, explaining the various elements and their functions. All participants were asked to fill out a form. This form (Appendix D) contained questions regarding all ten heuristics. Not only did the individual inspection contain valuable feedback, it also prepared the participants for the follow-up evaluation. Thus, prior to the group discussion which followed, everyone already had a small list of improvements and suggestions. These points were used during the meeting, resulting in additional feedback.

#### 4.5.2 Discussion results of individual inspections

All usability problems and findings are listed in table 4-7. Most of these issues were concerned with the visibility of the system status. For example, the system did not highlight the current selected day and it was not clear which deployment was loaded. Sometimes the status of the system was shown at multiple places at the same time, which is of course not necessary. Several assumptions related to the timeline and overview panel were also rejected. It was not clear which day was selected and the overview panel was not properly linked to the timeline. Although different colors were used to indicate which part was currently selected or active, various participants did not see this. All other comments were small things that could easily be fixed in a short amount of time. Therefore, at this stage, no severity rating was needed to select which issues needed to be addressed and which not.

<sup>3</sup> <http://www.parasite-eve.net/heuristic/>



Heuristic evaluation results
Not sure which profile is loaded
No clear link between the month buttons and day buttons
Overview panel does not indicate the selected year
The majority was confused with the icons used for the interface
Dutch and English language, not consistent
State of the system not clear
The 'done button' should be renamed. It was not clear what was "done" when clicking it.
Browsing photos did not follow a OS standard (i.e. Windows or Unix)
No save, undo and re-do buttons

Table 4-7: Results heuristic evaluation

#### 4.5.3 Discussion results of the follow-up evaluation

Additional issues and findings can be found in table 4-8. The most problematic finding was the limitation of the projector. For the planned case study only a projector with a maximum resolution of 1024x768 was available. The application, on the other hand, was designed for resolutions of 1280x1024 and higher. This meant that the whole application had to be redesigned. Another find was concerned with notifications, help windows and pop-ups. Even though the design principles encourage the use of documentation and help windows in the interface, it was not recommended for this application as the patient should not be distracted while telling his or her story. The suggested grid to place media on was also seen as something that may cause usability problems, especially when sorting and rearranging media. Other comments were concerned with the timeline navigation and overview panel. However, most of these were already discussed in the individual heuristic evaluations.

Design principles results
No need for help panels
Status icons not clear, what do they mean?
Icons in the overview panel need to be changed, so it is known which indicator icon is active
Resolution needs to be 1024x768 or lower
Readability. Some text was too small.

Table 4-8: Results design principles group discussion

## 4.6 Formative evaluation and expert reviews

Introducing a redesign can also introduce usability issues, even if an attempt is made to fix the previous findings addressed in the heuristic evaluation. This was the case when creating a new prototype to address the usability issues discussed in the previous paragraph. A formative evaluation approach was chosen to continuously acquire feedback of rapidly generated prototypes in a period of three to four weeks (Figure 4-23). During this phase various elements of each prototype were inspected by students and experts with a background in Human-Computer Interaction. During this time meetings with the psychiatrist took place to discuss the progress and eventual changes made to the requirements baseline. In addition to the reviews, a small interview took place with a patient suffering from combat-related PTSD. The reviews and small interview resulted in two core functions (1) providing a personal approach and (2) preventing unexpected exposure (Table 4-1). Eventually the list of usability issues reached a point that further improvements were not found anymore. As seen in figure 4-23, this last prototype is referred to as the 'final prototype'. Final, as in, the prototype contained sufficient features to be used in both an experiment and a small case study with a veteran.

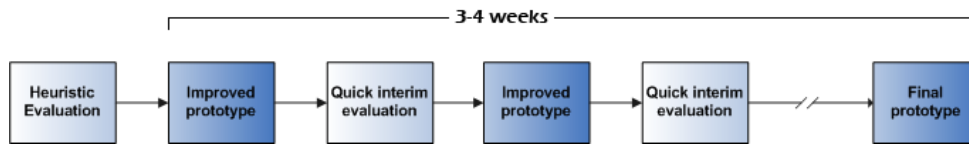


Figure 4-23: Formative evaluation

#### 4.6.1 Prototype refinements

A refined prototype (Figure 4-24) was made as a first attempt to address the issues described in tables 4-6 to 4-8. Also, the feature to use 3D objects to facilitate memory had changed. The ‘Armed Assault’ editor was not found to be an efficient tool to be used during treatment as it would (1) require much effort to create something simple, (2) switch the focus to more (irrelevant) technical aspects and (3) require time to learn how to work with the editor. Instead of scripting an entire different user interface to make the application less complex, the decision was made to create a new 3D world editor from scratch. Prior to the formative evaluation started, a first version (figure 4-25) was built. Therefore, during the evaluation, feedback was acquired of both the main application and the newly introduced 3D editor.

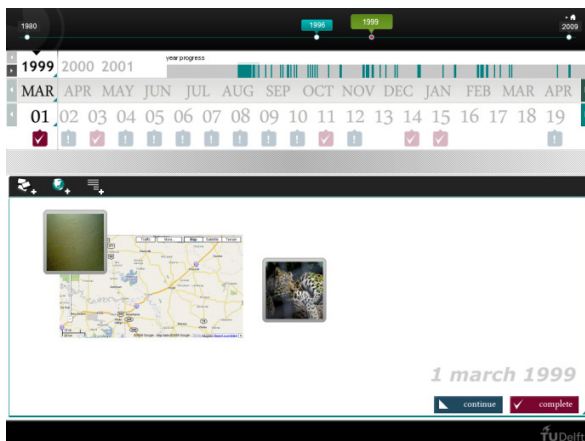


Figure 4-24: Refined prototype

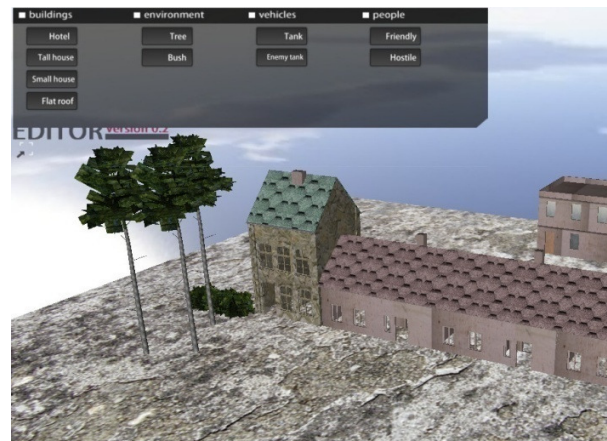


Figure 4-25: The new 3D world editor

Due to the resolution restriction and the problems concerning the grid, a new way of placing media was implemented. Patients were now able to add media and drag the data anywhere on the content panel (Figure 4-26). This not only allows the patient to sort media easier, but it also allows the patient to group certain elements together. Other problems were involved with the timeline and overview panel. Although new icons were used, together with a redesigned timeline navigation panel, several problems still persisted. These problems can be found in table 4-9. Not many problems were found with the early prototype of the 3D world editor. The only problems were: (1) it was not clear which object was currently selected and (2) the camera was difficult to control. Issues were addressed by either making small adjustments to a current iteration or by completely redesigning a certain component. The two issues with the 3D world editor were easily solved by (1) putting an arrow above the selected object and (2) switching from mouse to keyboard controls to move the camera.



Figure 4-26: Placing content freely and grouping data elements

Usability issues
Timeline cluttered
Year progress bar not clear, placement was wrong
Pop-ups to save and continue were confusing and annoying

Table 4-9: Persisting problems after redesign

### 4.6.2 Reviews and interview

As stated at the beginning of this chapter, throughout the design phase, several meetings with the psychiatrist from Utrecht took place to obtain additional feedback on the created prototypes and the overall progress. It is important to put an expert or future user in the loop while designing a user interface or validating requirements. This way comments are obtained from a different kind of view. This feedback resulted in an additional core function; providing a personal approach. The psychiatrist suggested that it would be useful if the patient was greeted by a log-in screen where he can enter his or her username and password in order to continue. In addition to a log-in screen, the patient can set certain preferences, such as color, interface font and background picture. The log-in screen used for the final prototype is given in figure 4-27.



Figure 4-27: Log-in screen

Of course it is also important to get a real future user in the loop, in this case a patient suffering from PTSD. A small interview took place with a woman suffering from combat-related PTSD. In this interview a tour of the application was given, explaining all the features that were implemented at that time. The patient reacted skeptic at first as she would not just put all her photographs and personal information into the system. But after explaining that all data would be encrypted and stored at the hospital, she changed her mind. Still, she suggested that some media could be categorized. She did not like the idea that she would suddenly see a photograph which triggers a painful memory by just browsing through the days. This idea resulted in the second additional core function; preventing unexpected exposure (Table 4-1). The patient can be given the option to hide or unhide an image.

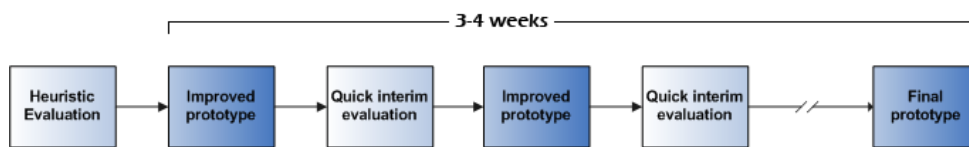


Figure 4-28: Towards a final prototype

Figure 4-28 shows that at the end of the formative evaluation a final prototype was created. At this time all issues, both new and old, were addressed and the prototype was ready for the experiment and planned case study. Several screenshots of this prototype are given in figure 4-29. Figure 4-29a shows an edited day containing a map, personal pictures and text. The timeline and progress bar show that only a small part of the deployment has been covered. Figure 4-29b is the screen the patient sees after logging into the system. Here the patient is presented with a list of past deployments. The patient can also obtain session information by selecting a day on the timeline showing the current time period. The last screen shows the 3D world editor with a small user interface at the top of the screen. More details and screenshots can be found in the next chapter and appendix E.

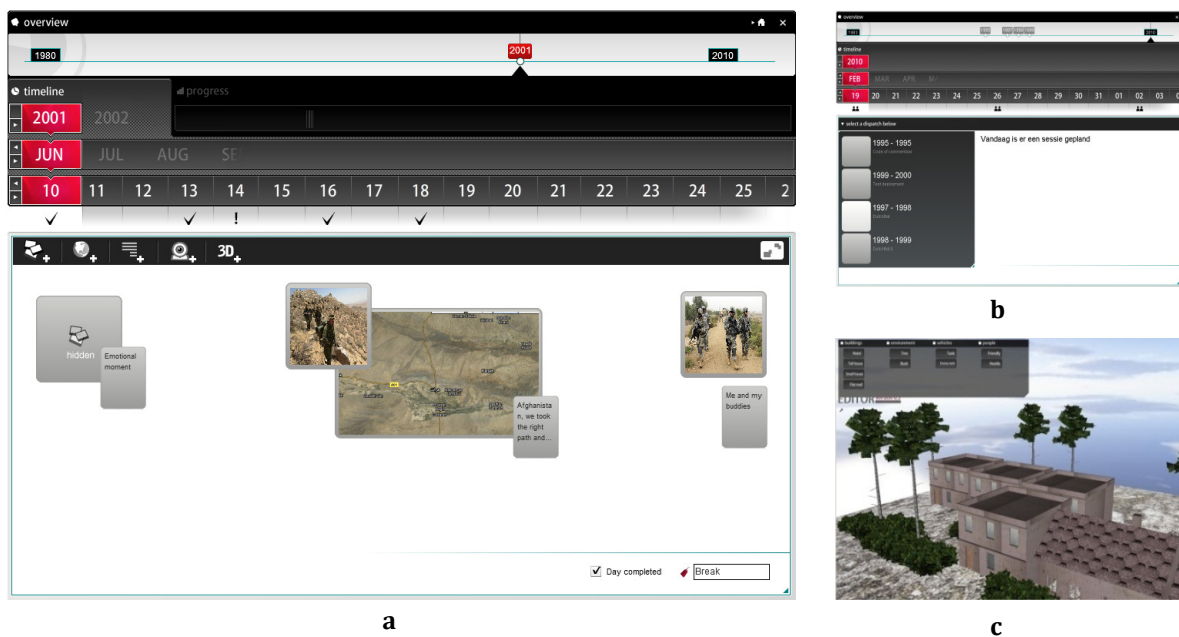
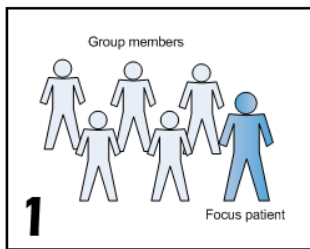


Figure 4-29: Screenshots final prototype

## 4.7 Storyboard

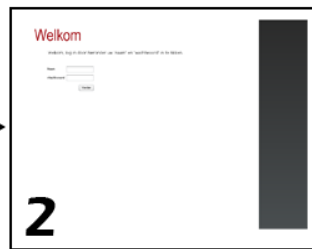
As the requirements baseline was exposed to changes, so were the scenarios. Figure 4-30 shows the final storyboard with all possibilities provided by the system. It is important to note that this storyboard also includes the refinements as a result of the insights acquired from the experiments and case study discussed in chapter 6.

Step 1 describes the log-in procedure. Before the actual therapy begins, the patient must first log in to the system by using a personal username and password. Step 3 states the patient is greeted by a screen where he or she can adjust settings and add or remove deployments attached to his or her account. The following steps are similar to the previous scenario phase. Step 7 however mentions a 'deployment overview'. The case study showed that the patient wanted to gather all media related to a deployment first and put them on the timeline later. This allows the patient to select a huge selection of media and, temporarily, put them on this so-called 'clipboard'. The user can show the contents of the clipboard at any given time and is able to copy and paste media from clipboard to the day that is selected (and vice versa). When adding pictures, thumbnails of the original source are displayed at the bottom part of the screen. The patient can always view a bigger version of the image by double-clicking it. This is useful if the patient wants to explain something which cannot be seen by looking at the thumbnail. If the patient decides to add text, he or she needs to edit the element first. By doing this a small text editor pops up. When this editor is closed, the text is saved and a preview is displayed on the workspace. The storyboard does not mention the presence of notifications, dialog windows and other messages. This is done on purpose as the patient should not be interfered with system-related information while telling about his or her experiences. All data is therefore saved automatically.



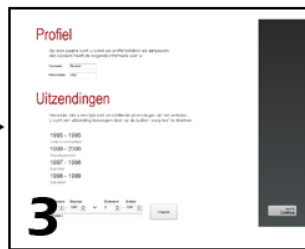
**1**

**Start**  
Group enters the room. One patient (the focus patient) takes the seat behind the mouse and keyboard.



**2**

**Logging in**  
The patient logs in using his/her username and password.



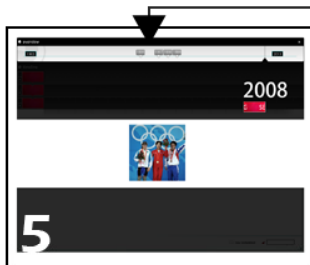
**3**

**Profile Home**  
Patient is greeted with his/her profile information. Preferences can be set and deployments can be added.



**4**

**Timeline: Current time period**  
Patient can see information about future/past sessions. (Optional: goals can be set) Afterwards a deployment can be selected.



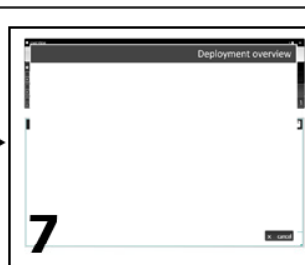
**5**

**Warp animation**  
Patient "warps" to the selected time period. Various (personal) photos are displayed related to events that occurred between 'now' and 'then'.



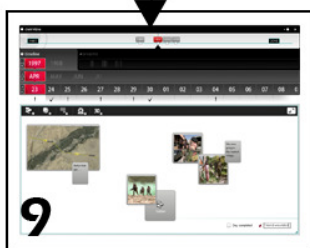
**6**

**Timeline: Deployment period**  
Patient can select a day here and start telling his/her story by adding media elements. Various indicators are displayed to show which days need attention.



**7**

**Deployment workspace**  
Optional, but shown useful after the case study was analyzed. Patient can put media related to a deployment here, without yet linking it to a date. During the first sessions the patient does not have to worry about the timeline, but can give the therapist and group members a summary of what happened. Later the patient can link every element to the correct dates. Can also be used as a "clipboard".



**9**

**Modify days of previous session(s)**  
Patient has the option to add or modify data on a previously edited day from a past session.

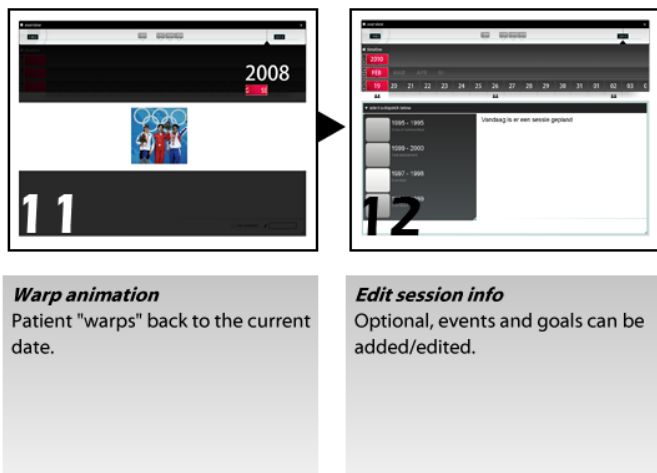


**10**

**Adding or modifying data**  
Using a set of tools, the patient can add (personal) photos, geographical maps, narrative elements and 3D virtual worlds to explain what he/she has experienced.





**Warp animation**

Patient "warps" back to the current date.

**Edit session info**

Optional, events and goals can be added/edited.

Figure 4-30: The "final" storyboard

## 4.8 Metaphors

Throughout the entire study a wide range of metaphors, such as 'diary', 'workspace' and 'lifeline' were introduced. These metaphors are the result of the different discussions and reviews that took place with the psychiatrist at UMC Utrecht and with several other experts in the field. The use of these metaphors made conversations easier to understand for all involved parties during the development of the application, without the unnecessary use of either technical or psychological terms. The application itself can be seen as media archive, or diary. A patient can manage this archive by adding and modifying information with the help of the timeline. A sorting machine is also applicable. The data goes through several sorting phases. First the patient gathers all relevant photographs and documents from home. Afterwards the material is loaded into the system, without putting everything on the correct dates yet. And finally the real sorting starts by placing everything on the timeline.





## 5 Final prototype

### 5.1 Chapter overview

This chapter describes the implementation of the final prototype. A general description is given first, elaborating on what was used for the creation of the system. As explained in the previous chapter, the system went through several phases as new insights were acquired throughout the design process. During those phases features were added while others were slightly modified. All these components are described in detail in paragraphs 5.3 to 5.9. An overview of all the implemented components is given in table 5-1. At the end of this chapter several additional options for future iterations are discussed, these are also listed in table 5-1.

Implemented components
Timeline navigation
Data management (saving/loading)
Progress bars
Content elements (pictures, 3D worlds, text, webcam and maps) and placement
Session information (current time period)
Deployment list
Use of personal pictures for timeline animations
Log-in screen and options to set preferences
Additional features for future iterations
Creating session summaries and adding goals to the current time period
Clipboard to temporary store and place content
Content element audio and/or movie clips

Table 5-1: List of implemented components and additional features

### 5.2 General description

For programming the system two development packages were used; (1) Adobe Integrated Runtime<sup>4</sup> (AIR) for the main application and (2) Vizard<sup>5</sup> for the 3D world editor feature. Almost all requirements discussed in chapter 4 were made using AIR, with the exception of the editor. The editor had to use a 3D environment and Vizard was one of the available options the University offered. Vizard is a toolkit that is designed to create 3D virtual environments using Python as programming language. The toolkit offers a wide range of VR-related functions, such as support for Head-Mounted Displays (HMDs) and the ability to interact with objects placed in a virtual environment. Most of these functions were not necessary for the implementation of the world editor. However, the functions to interact with virtual objects played an important role in the decision to use Vizard. With the help of the provided functionality, more attention could be given to the usability of the system. The only thing that was needed, besides the user interface, were 3D models. These models (Figure 5-1) were created using 3D Studio Max. The choice to use AIR for the main application was simple; by using AIR it is possible to rapidly create prototypes and quickly redesign parts of the interface without touching the code. When properly designed, it is possible to separate the interface from the actual code. Therefore, usability issues can be addressed in a small amount of time by only editing a couple of UI elements or graphics. AIR also allows the use of Flash

<sup>4</sup> <http://www.adobe.com/products/air/>

<sup>5</sup> <http://www.worldviz.com/>

components to insert animations, graphics and sound to make the user interface appealing and more flexible to work with. Although the environment offers standard UI elements, such as buttons and sliders, the choice was made to design and implement the components from scratch so they could match the colors and style of the desired layout. Graphics, textures and UI elements were drawn with applications such as Illustrator and Photoshop.



Figure 5-1: 3Dmax objects

### 5.3 Data management

All data is loaded from and saved to separate XML-files stored on either the hard disk or the patient's USB storage device. For this prototype classes based on 'E4X' (ECMAScript for XML) were used to query the XML data. These queries make it possible to quickly modify or obtain certain XML strings or variables. Another possibility is to add or remove XML strings, which is needed when the patient creates or modifies data inside the content window. An example of a query is: `"var mapsOfSelectedDay:XMLList = workXML..DAY.(@nr == selectedDay).MAP"`, which will put all map strings of a certain day in a temporary XML list. A variable of one such string within this list can be obtained by, for example, the following code: `"mapsOfSelectedDay[2].@variable"`.

The file needs to be read and loaded into memory first before the data can be queried. When the source file is read, the application will take care of the creation of buttons, thumbnails and other elements that need to be presented on the screen. The user can now delete or modify these elements or the user can add new information by adding, for example, an image or geographic map. The only thing that needs to be done now is to save these changes to the hard disk as manipulations are only done inside the system memory. Saving is done automatically using a save function which stores the XML data to the hard disk. System performance may decrease dramatically if this function is constantly executed. Therefore the application only saves when (1) the patient switches days, months or years and (2) right before the patient closes the application. This is only done when the system actually detects an event, such as moving, deleting or adding data. If this is not the case, there is no need to access the hard disk.

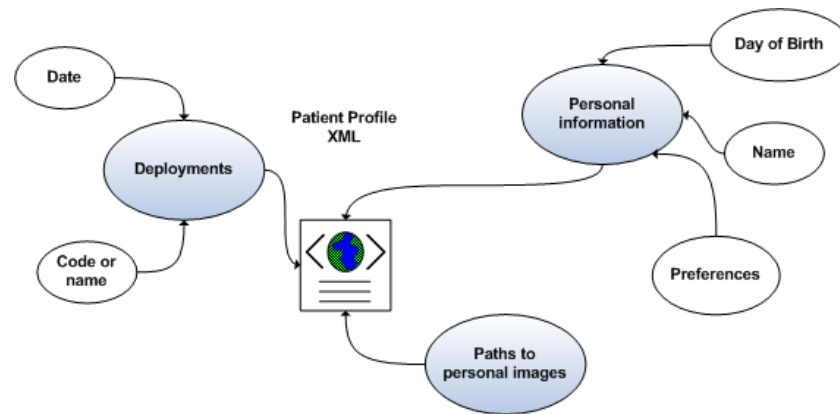


Figure 5-2: Patient's personal profile settings stored in a XML file

For each patient a profile file exists, together with several deployment files. The profile file is loaded when the application starts and a deployment file is only loaded into memory when the related deployment button is clicked. The first file that is loaded in memory is the patient's personal XML-file, containing details such as (1) date of birth, (2) preferences, (3) path to personal images used for timeline redirections and (4) dates of past deployments (Figure 5-2). An example of such a file is given in Appendix F. With this data all kinds of variables are set during the initialization phase of the application. Data such as the date of birth and the dates of deployments are used to create the patient's 'lifeline'; the overview panel located on top of the application. Deployment data is also used to create buttons (Figure 5-3), which are linked to other XML-files. The patient can also set a personal image to a particular year. These images are shown after a deployment is selected. An animation will start going through events which happened during the time between the selected deployment and the current year (Figure 5-4). Although only one template was created for this prototype, patients have the ability to set a default skin or template which is automatically loaded when the XML-file is read.

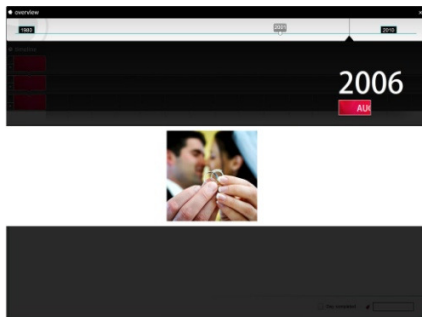


Figure 5-4: Personal photographs

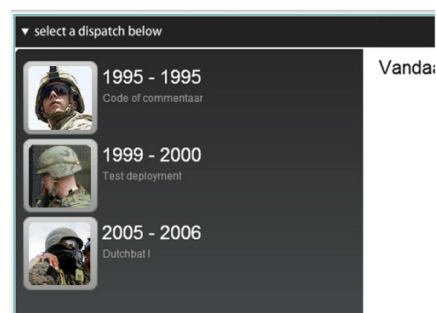


Figure 5-5: Deployment list

After the profile is loaded and the user interface is initialized, the patient can load a deployment by clicking on the corresponding button in the list (Figure 5-5). Now the XML-file related to the selected deployment will be loaded into memory. This file contains story text and paths to media content of all the (partially) completed days covered by the patient (Figure 5-6). An example of such a source file is given in appendix F.

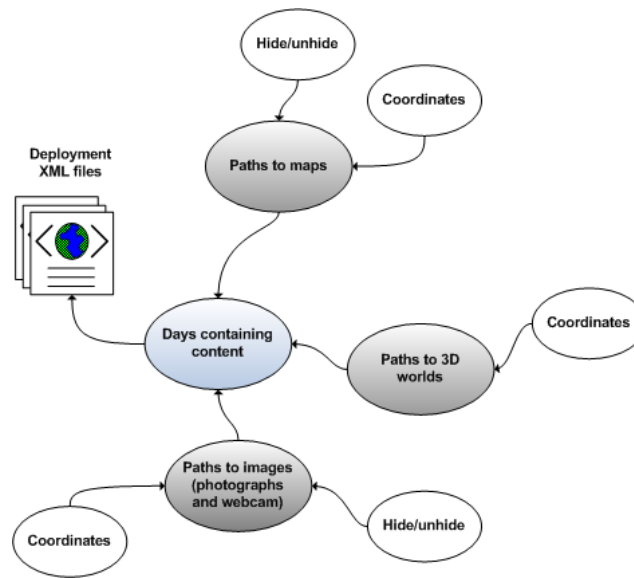


Figure 5-6: Story text and media paths in the deployment XML files

To increase the speed of the application and to decrease memory usage, only content of the selected day is loaded. Deployments can take up many months and loading all images, text and other media of a particular deployment will decrease system performance significantly. When switching to another day on the timeline, the previous presented media is unloaded and a new query is fired to load the media corresponding to the newly selected day. As shown in figure 5-6 only paths to the media are stored in the XML-file. The media itself is stored on a removable storage device or the PC located at the clinic. A content loader function takes these paths and creates thumbnails, previews and links which are placed inside the content panel. As content can be placed freely inside this panel, coordinates of each element need to be saved as well. As mentioned in chapter 4, it is also important to hide images as unexpected exposure should, in some cases, be avoided. All these extra options need to be saved as well, therefore strings inside the XML-file not only contain the paths to the media, but also the x- and y-coordinates and a check whether the images should be hidden or not.

## 5.4 Layout and style

The layout consists of three main components: (1) the overview panel, (2) the timeline and (3) the content panel. The extra element in this iteration is the 'progress meter', which is placed right beneath the overview panel (Figure 5-7). A small bar in this gauge corresponds with a day that contains deployment information. This gives both the patient and the therapist a complete overview of which part of the timeline has been covered and which part has not. As mentioned in chapter 4, the data elements (i.e. pictures and maps) inside the content panel are no longer sorted in a grid. Instead, all elements can be moved around freely (Figure 5-7). One of the reasons behind this was the resolution limitation of 1024x768. A grid-like style would make the placement of content elements difficult and confusing, especially if the patient wants to sort and group certain elements.

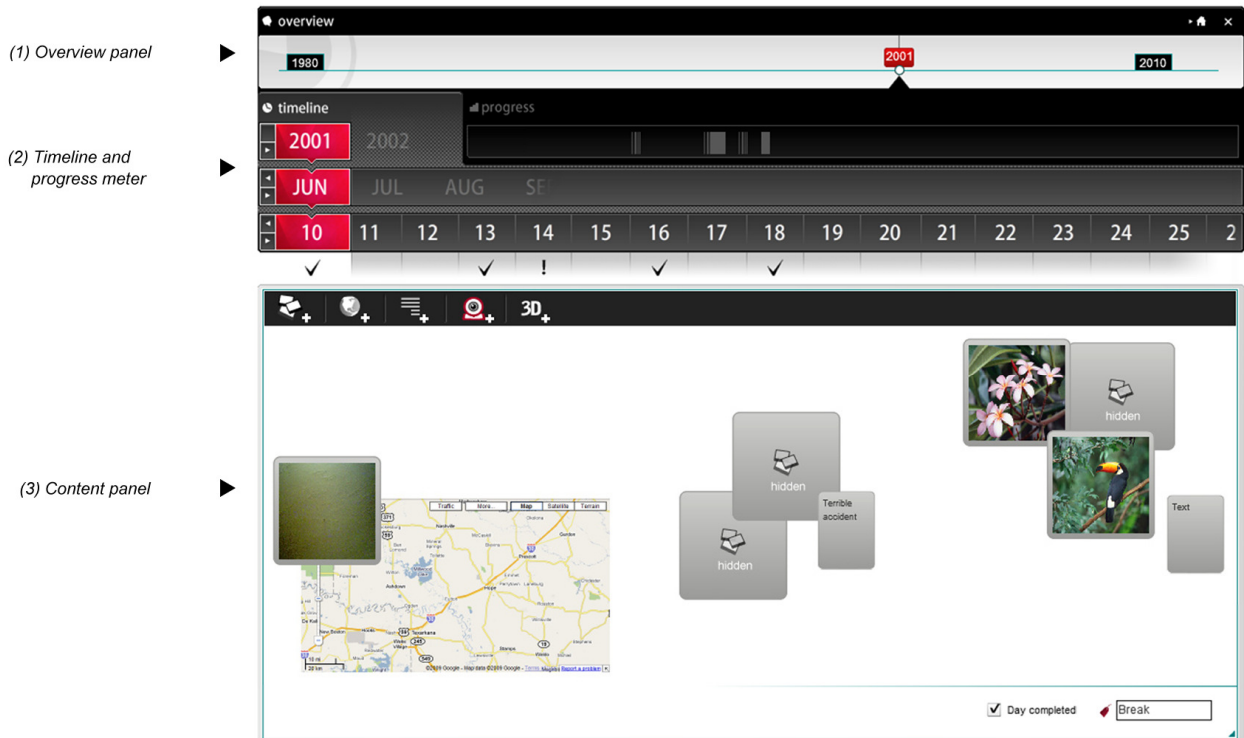
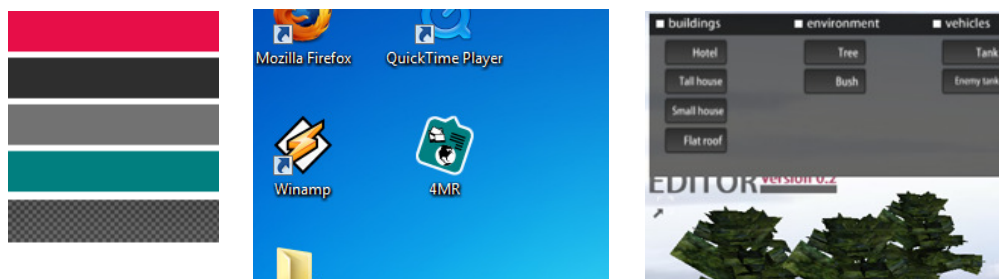


Figure 5-7: Layout of the 3MR system

The first picture in figure 5-8 shows the color scheme used for the system. Some elements are related to the system status and need to catch the patient's attention. For example, the patient needs to know which day, month and year are currently selected. The choice was made to make these elements red as this color is well-known to draw someone's attention. The black and grey tints are used at the top of the screen, while white is used at the bottom of the screen. This causes a clear separation between the timeline and content panel. The assumption was made that this allows the patient to easily switch focus between navigating through the application and placing media on the content panel. Some parts also use a third color, green, which is used for small details, such as borders. Green was chosen as it is the complement of the red color used in this layout, creating a small complement color scheme for only the details present in this style.



esktop shortcut and the 3D editor UI

For an easy installation procedure, an installer was created. With this installer everyone with a Windows PC or Mac can install the application by just clicking the executable. All files will be put in the proper directories and a shortcut icon is created on the desktop (Figure 5-8b).

In an attempt to make the storytelling more appealing, the choice was made to use custom made 2D graphics, icons and animations instead of standard UI elements provided by the programming environment. Buttons, lists and input fields could now match the overall style of the application. Animation actions are used to make the date sliders rotate smoothly when clicking the buttons next to them. Additional animations are programmed for redirecting the patient to a specific period in time. The interface of the 3D editor also used graphics which resembled the style of the main application (Figure 5-8c).

## 5.5 Timeline and overview

The three sliders of the timeline can each be rotated by using the set of buttons located on the left side of each slider (Figure 5-9). The sliders are all dependant on each other. This means that all three sliders will move when, for example, moving the 'days slider' from December 31<sup>st</sup> to January 1<sup>st</sup>. Animations between begin and end state are used to let everything rotate smoothly.

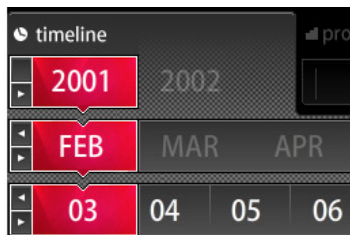


Figure 5-9: Timeline sliders

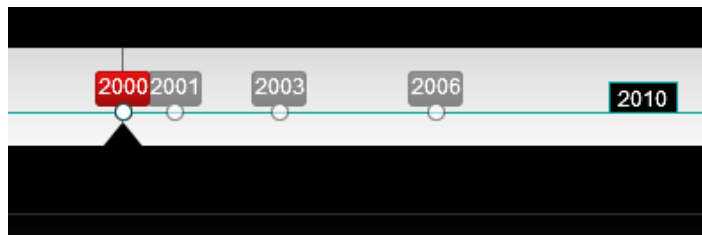


Figure 5-10: Lifeline with deployment 'balloons'

As mentioned earlier, the application does a quick check before the timeline switches days. A flag is set when elements on the content panel are added, deleted or modified. If this is the case, the system calls the save function to quickly save the changes.

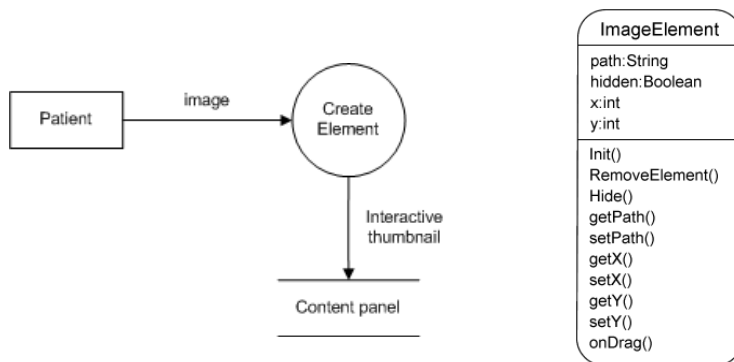
The numbers on the timeline are automatically generated using only the start and end date as stated in the personal XML file. This does not mean that all these days are included in the deployment XML-file. This file only contains the days which actually contain content. These days are also marked with either a 'complete' or 'incomplete' icon. These icons appear right beneath the timeline navigation panel. Completed days need to be marked, otherwise the system thinks the day still needs attention. When a day is set to 'completed', it means that this particular day has been fully covered during a session. This does not mean that the day cannot be edited anymore; information can still be added or modified.

On top of the application is the overview panel. This panel displays the 'lifeline' of the patient (Figure 5-10). This panel not only gives an overview of all the past deployments, it also adds a psycho-educational aspect to the system. For example, it allows the patient to quickly see which part of the timeline is currently being discussed. The 'lifeline' goes from the patient's day of birth to the current year. A lot of this line will remain empty as the deployments normally take up a small

section of the lifeline. Figure 5-10 shows small ‘balloons’ placed on the line. These balloons are linked to deployments; a red balloon is the active deployment that is currently selected and the grey balloons are the other deployments loaded from the patient’s personal XML-file.

## 5.6 Content elements

The system provides five different features to facilitate memory. The patient has the option to add (1) images or photographs, (2) geographic maps using ‘google maps’, (3) story text, (4) webcam shots and (5) virtual representations of a situation using the 3D editor. When the patient adds an image, webcam shot or map, the system creates an interactive thumbnail and puts this thumbnail on the content panel (Figure 5-11). A similar process happens when adding text. However with text a small preview of the story is given (Figure 5-13). An example of the variables and functions of the image element class is shown in figure 5-12. In this example a created image thumbnail object contains the path to the original image source, a flag whether the image should be hidden or not and the x- and y- coordinates stating where in the content panel the element is placed.



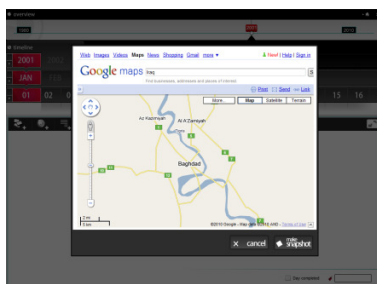
*an image*

*Figure 5-12: ImageElement class*

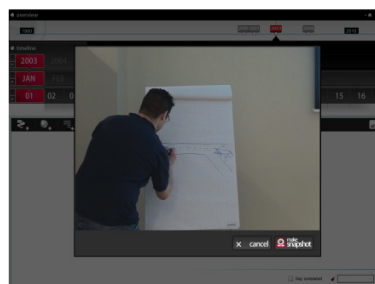


*e 5-13: Text preview and menu*

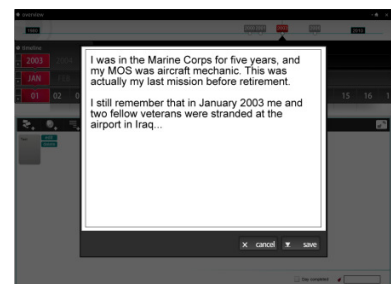
Figure 5-11 shows that the ‘Create Element’ process is not adding any strings to the XML-data. When an object is created, it is only placed in an array and presented on the content panel. Also, when modifying existing elements, changes are only made to the objects and not yet to the XML-file. Changes only occur when the system calls the save function. This automatic function checks all objects within the content panel array and makes the necessary modifications so that the application and the XML-file are fully synced again.



*Figure 5-14: Adding maps*



*Figure 5-15: Adding webcam shots*



*16: Adding story text*



### ***Adding images***

The default Windows browser window pops up, allowing the patient to select one or multiple images from a directory on the hard disk or USB-stick. All selected images are then transformed into interactive thumbnails. These preview images can be made bigger by pressing the right mouse button. This also creates a small menu where the user has the option to either hide or delete the image. Just like the other content elements, the image thumbnail can be dragged and dropped anywhere within the borders of the content panel.

### ***Adding maps and webcam shots***

A small window appears where the patient can search for a particular location using 'google maps'. The window also has the option to create a screenshot (Figure 5-14). When the patient selects this option, a part of the screen will be saved and the bitmap data will be encoded to a PNG-file. This file is then stored in a directory where the executable is found. Adding a webcam shot is very similar to the option to add a map. Again, a small window appears with the ability to make a screen dump to be used in a thumbnail (Figure 5-15). The webcam option only works if a webcam is connected to the computer. If there is no webcam connected, a small dialog appears asking the user to connect either a webcam or camera.

### ***Adding 3D worlds***

Unfortunately the 3D editor could not be fully integrated into the main application. When adding a 3D world, a small icon appears on the content panel. This icon is linked to the Vizard application. The 3D editor will start in a separate window when this icon is double-clicked. For this prototype the state of the 3D editor is not saved. Thus, it is not possible to save a created virtual setting and load it afterwards. For the experiment and case study, this feature was not needed. However, a new iteration must have the ability to save and load a virtual world. The path of the extra save file must then be included in the XML string of the main application.

### ***Adding text***

The patient can also add text. A small editor is created for simple text input (Figure 5-16). This text is later stored directly in the XML-file. Enters, spaces and special characters are all permitted. The created object is a content element with a small preview of the full story. The only options available in the menu are the options to edit and delete the element.

## **5.7 The 3D world editor**

The 3D editor uses the mouse and keyboard to move selected objects in the virtual environment. Most of the code is therefore related to object selection and control. Selection of objects is accomplished by using a Vizard function named 'pick'. This function makes it possible to select an object in the 3D plane. When the object is selected, the user can move it using the up, down, left and right keys. Objects can be deleted by pressing the 'del' key. The object can also be rotated on the z-axis. This is done by using the scroll wheel on the mouse. Although the functionality is limited, the application is easy to control and does not require a tutorial like the first idea mentioned in chapter 2. Next to controlling the objects, the camera can also be controlled. This is done with the 'w', 'a', 's' and 'd' keys.



During start up, an empty template is loaded, together with a simple user interface which is displayed at the top of the screen (Figure 5-17). By clicking one of the buttons, the selected object will appear on the plane. Objects can be persons, buildings and vehicles. All these objects were created using 3D Studio Max. The emphasis was on quickly creating a virtual representation of a past situation to enhance storytelling. Advanced options to manipulate the 3D objects on the template were therefore not needed. Also, advanced options might require more knowledge and effort of both therapist and patient, as seen in the initial created scenarios of chapter 3.



Figure 5-17: 3D editor, empty plane and plane with objects

## 5.8 Additional features for future iterations

The five content elements discussed in this chapter were initially designed to be used to enhance storytelling about past deployments. Some of these elements can also be used to create session summaries or goals which can be placed on the current time period. This adds an additional psycho-educational element to the system as described in chapter 4. Only three of these elements would be useful: (1) text, (2) images or photographs and (3) webcam shots. A therapist or patient can now put together a short summary of a session similar to the way information is added to a past deployment. An alternative option could be an automated process of creating session summaries, pointing out the important events which happened during treatment. With this the system keeps track of all the changes and can list, for example, the days that have been edited and the days that still need some work.

Another possible feature to be added in a future iteration is the so-called clipboard or 'general workspace'. During the case study (Chapter 6) the patient wanted to put all media on a clipboard first before sorting all media to the corresponding days. The clipboard could also be used to quickly copy and paste media from one day to another. Although the feature was not present in the final prototype, it is included in the storyboard of chapter 4.

Other refinements, already discussed in detail throughout this chapter, were: (1) ability to save a 3D world state, (2) additional skins or templates which change the look and feel of the system.

Next to pictures, maps, 3D worlds and text, videos and audio might also be feasible content elements which can be added to the system. The psychiatrist commented that some veterans have both good and bad memories attached to certain songs that played during a deployment. The option to add audio files might therefore be another interesting modality for a future iteration of the prototype.



## 6 Experiment and case study

### 6.1 Chapter overview

The evaluations discussed in chapter 4 lead to several refinements regarding both the usability and the functionality of the system. With the help of this feedback, the discussions with the psychiatrist and a small interview with a real patient, the prototype described in the previous chapter was created. This feedback was, however, not sufficient to verify certain statements described in chapter 4. Also, with all the acquired knowledge and a final prototype, the research question could still not be properly answered.

With the final prototype finished, both an experiment and a case study were conducted (Figure 6-1) to acquire more insights. The aim of the experiment was to (1) acquire more feedback concerning the usability of the application and (2) to see if storytelling could actually be enhanced by using the system. The aim of the case study was to acquire insights into how a patient would use and interact with the system. As figure 6-1 suggests, both evaluations were done simultaneously.

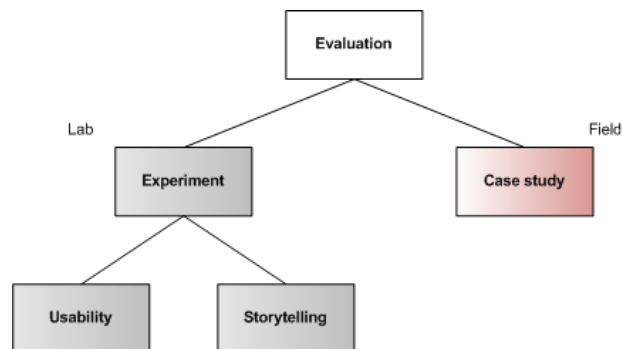


Figure 6-1: Experiment and case study

Figure 6-1 also shows that the lab experiment was divided into two evaluations. A total of 18 people were asked to participate in both activities. First a usability evaluation took place, followed by an experiment where the participant had to tell two stories, one with the application and one without. For the last part of the experiment two sources were used to see if the application had an effect on how a story was told: (1) a questionnaire the user had to fill in after both stories were told and (2) voice recordings that could be used for an additional analysis. This last analysis was concerned in how many times the participant referenced to time, locations and events.

Although experts were kept in the loop during the previous phases of the study, no actual patient suffering from combat-related PTSD was asked to participate in an evaluation. To acquire impressions and insights regarding the interaction between the patient and the created prototype, an initial field study consisting of two sessions was planned. During these sessions a veteran was observed who was using the system to tell a story related to one of his past deployments.

This chapter starts with describing the experiment in more detail, together with the acquired results. Afterwards the case study is presented. During the case study a small discussion took place

with the veteran, resulting in additional feedback. This feedback is described in the last part of this chapter together with several concluding remarks regarding the conducted evaluations.

## 6.2 Experiment method

### 6.2.1 Participants

The sample comprised 18 participants (12 males, 6 females). Due to the personal and private nature of the stories, only friends and family members were asked to participate in the experiment. All people participated in both evaluations of the experiment and none of them suffered from combat-related PTSD. The age varied between 21 and 59 ( $M=36.2$ ,  $SD=15.1$ ). All participants never worked with the final prototype before and none were given instructions beforehand.

### 6.2.2 Measures and materials

#### *Usability evaluation*

Participants filled out a component-based usability questionnaire (Brinkman et al., 2009) consisting of a series of statements which were concerned with the usability of three user interface components of the system. A total of 6 statements were used for every component (Table 6-1). Participants were asked to rate the likelihood of these statements on a 7-point scale. Next to the rating, the questionnaire also had room for additional comments. After the participant completed the ratings of one component, he or she was asked to write additional feedback down in the appropriate boxes on the form before continuing with the next component. The questionnaire can be found in appendix G.

Statements
Learning to operate the [component] would be easy for me.
I would find it easy to get the [component] to do what I want it to do.
My interaction with the [component] would be clear and understandable.
I would find the [component] to be flexible to interact with.
It would be easy for me to become skilful at using the [component].
I would find the [component] easy to use.

Table 6-1: The six statements used for every component

For this evaluation the final prototype as described in chapter 5 was used. In order to fill out the usability questionnaire, all participants had to complete several tasks. Therefore a task list was created which covered every feature the prototype had to offer (Table 6-2).

Tasks
Start with the deployment that happened in the years '2006 – 2007'
Now navigate your way to June 6 <sup>th</sup> 2006.
Add 6 images from the folder 'images' located on the desktop.
Write something about one of the images and place the element near the corresponding 'image'.
Go to July 8 <sup>th</sup> 2006 and add a 'webcam picture'. Also add a 'map picture' of your birthplace.
Now delete these two images and exit the application.
Try to make the following scene in the 3D editor (Figure 6-2)

Table 6-2: Task list

### Storytelling evaluation

For this evaluation, each participant filled out a different evaluation questionnaire (Appendix G). Again, participants were asked to rate several statements. However, this time the focus was not on the usability of the system but on the way a story was told. Participants were asked to rate the likelihood of the seven statements given in table 6-3.

Statements
I prefer a timeline, such as the one in the application, to tell my story.
I found the story telling with the application more enjoyable
I was able to tell everything I wanted (story telling <b>without</b> the application)
I was able to tell everything I wanted (story telling <b>with</b> the application)
I put more details in the story told with the application
By using the application, I was encouraged to add media such as text, maps or webcam pictures to explain things better.
I found that more memories came back with the application

Table 6-3: Statements used in questionnaire of the storytelling evaluation

One story was told with the prototype and one story was told without the application. In both cases participants were allowed to use photographs to support the storytelling. No other material was allowed during the experiment.

### 6.2.3 Procedure

The focus of the first phase was to evaluate the usability of the system. This evaluation also helped the participants to get to know the system before starting the second phase. Using the provided list of tasks each participant selected one specific deployment, navigated through the timeline to pick a date and eventually added, modified and deleted content elements. For the editor the participants had to create a virtual world similar to the situation shown in figure 6-2. These tasks were sufficient to give the participant an idea how the system works and how to interact with all the different features. Every participant received the exact same task list. No additional instructions or help files were given prior to the experiment. When the participant completed all the given tasks, he or she was asked to fill in the evaluation questionnaire.



Figure 6-2: Example scene

Right after filling in the first evaluation questionnaire, the participants were asked to tell two different autobiographic stories of 6 minutes each, one with the help of the 3MR system and one without. The focus of this part of the experiment was to see if there was a difference between how the stories were told. Participants were asked to talk about, for example, past holidays or business trips which had to be over three years old. The order in which the stories were told was counterbalanced; 9 participants started with the oldest story while the others started with the more recent story. Counterbalancing was also used to determine which of the two stories was told with the application. During the storytelling participants were allowed to explain something or express themselves by using photos they brought with them. These photos were selected by the observer right before the evaluation started. Otherwise participants already had a chance to think about what they were going to share. While using the application, participants were allowed to use all the

features offered by the system. After both stories were told, each participant was asked to fill out the second and last evaluation questionnaire.

## 6.3 Usability analysis

### 6.3.1 Analysis of the evaluation questionnaires

As described in the previous paragraph, three user interface components were evaluated using a component-based questionnaire. The three evaluated components were as follows: (1) the timeline navigation, (2) the content manager (the panel, including the placement of elements) and (3) the 3D world editor. The questionnaire elements for all three components obtained acceptable levels of reliability with Cronbach's alpha. All values were above the threshold of 0.7 (Loewenthal, 2001) (Table 6-4), indicating an acceptable level of reliability.

Component	Alpha
Timeline navigation	0.81
Content manager	0.70
3D world editor	0.73

Table 6-4: Cronbach's alpha for each component and the application as a whole

The ratings of all three user interface components, acquired from the filled-in component-based usability questionnaires, were compared with the norm value of 5.29 (Brinkman et al, 2009). Ratings above this norm value suggest that the usability of the component is more similar to the usability of the easy to use components in the norm set. Likewise, ratings with a value below 5.29 suggest that the usability of the component is more similar to the usability of the difficult to use components in this norm set.

To see if the acquired ratings deviated from the norm value, a one-sample t-test was done using the 5.29 as test value (Table 6-5). The analysis of the ratings showed that participants rated the timeline navigation ( $M = 6.37$ ,  $SD = 0.43$ ), content manager ( $M = 6.08$ ,  $SD = 0.45$ ) and 3D world editor ( $M = 5.62$ ,  $SD = 0.57$ ) above the 5.29 norm value ( $p < 0.03$ ). These results are also given in figure 6-3.

One-Sample t-test with test value = 5.29			
Description	t	df	Sig.(2-tailed)
Average score timeline	10.579	17	< 0.001
Average score content manager	7.368	17	< 0.001
Average score 3D world editor	2.436	17	0.026

Table 6-5: Results one-sample t-test

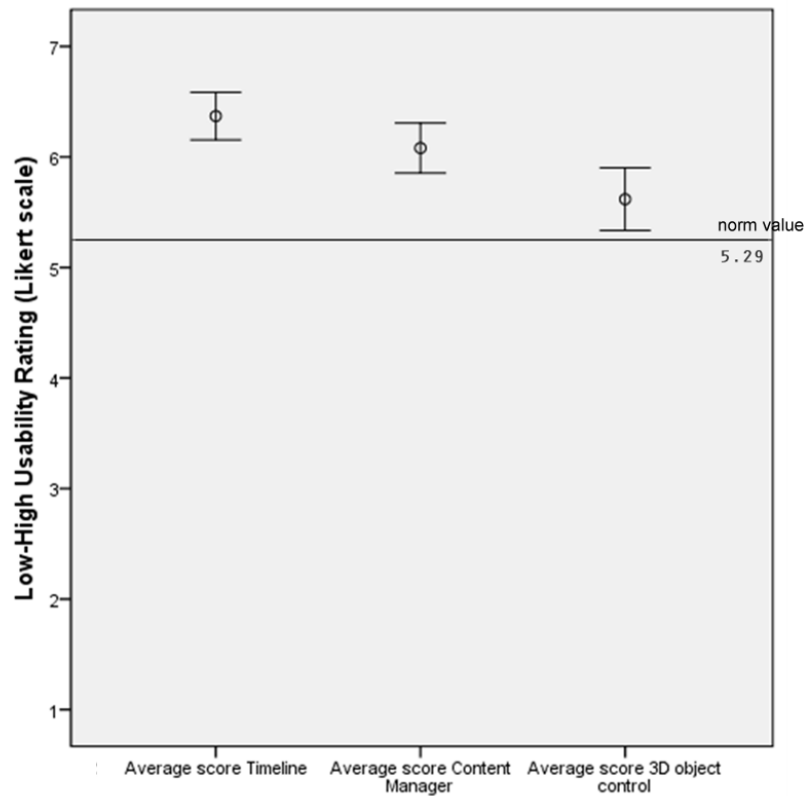


Figure 6-3: Mean-rating of the three main components (95%CI)

### 6.3.2 Analysis of the comments and discussion

The results from the previous analysis suggest that all three user interface components are easy to use. The questionnaires also allowed participants to add additional comments and suggestions. All the results are discussed in this paragraph. A reoccurring issue was that of the 'maps' icon; the task list asked the participant to add a map, however a large amount of people thought the 'maps' icon was actually the icon to open up an internet browser. Because there were not many other options, everyone still managed to add the map, but some found this a bit confusing. Others thought it was convenient that the "internet browser" directly pointed to 'google maps'. Later they were told that this icon was actually not a web browser icon. A suggestion made by multiple participants was to add the ability to drag and drop objects in the 3D world editor. Other, minor, comments and suggestions can be found in table 6-6.

Suggestions and comments
Add the ability to drag the sliders with the mouse.
Double-click and right-click commands should be like those used in Windows OS.
When creating groups of elements, they should be sticky.
Instead of using the option 'edit' on a text element, the text editor should appear when double clicking it

Table 6-6: Other suggestions and comments

No other usability issues were found in this phase of the experiment. All participants also stated they were very pleased with how the application worked. Most of the users thought the interface looked appealing and they liked the way the content is placed on the screen. One of the reasons



might be that the heuristic evaluation and the continuing formative evaluation took care of most usability issues. As mentioned earlier, the 3D editor was not as polished as the main application. However, the participants did not find the used control scheme annoying. One of the participants suggested more functionality, such as stacking and resizing objects. Regarding the timeline, a few participants thought that switching days could take some time. Therefore quickly rotating the slider with the mouse was preferred. Another suggestion related to the timeline was that one participant was missing the names of the days (i.e. Monday, Tuesday) on the timeline. When the participant was telling her story, she did not remember the exact day she was going to the mall, but she did remember that it was on a Wednesday. The prototype only displayed the numbers of the days.

## 6.4 Storytelling analysis

### 6.4.1 Analysis of the evaluation questionnaires

Although the questionnaire used in the second phase contained less statements compared to the questionnaire from the first phase, a similar procedure was done to analyze the acquired data of all 18 participants. First a one-sample t-test was done (Table 6-7) to see which ratings deviated from the median of the 7-point scale ( $H_0: score = 4$ ). The table shows that the statements 'I was able to tell everything I wanted to say (without 3MR)' ( $p > 0.56$ ) and 'I was encouraged to add media with 3MR' ( $p > 0.36$ ) were not found significant. The last score was unexpected. There was no need to use the provided content elements, as most of these were designed specifically for veterans with a PTSD. Another reason could be that the available 6 minutes were too short to allow them to make use of the available features. A plot with all the statements is given in figure 6-5.

The acquired results of the analysis:

- Participants thought the timeline was an essential component in a way a story was told ( $M = 5.50, SD = 1.29$ )
- Participants enjoyed telling a story with 3MR more than telling a story without the application ( $M = 5.28, SD = 1.27$ )
- Participants thought they were able to tell everything they wanted to say with the application ( $M = 5.50, SD = 1.25$ )
- Participants thought they put more details in the story told with the help of 3MR ( $M = 6.00, SD = 0.69$ )
- Comparing the two stories, the participants found more memories came back by using the application ( $M = 5.94, SD = 0.80$ )

One-Sample t-test with test value = 4			
Statement	t	df	Sig.(2-tailed)
I prefer a timeline, such as the one in the application, to tell my story	4.915	17	< 0.001
I found the story telling with the application more enjoyable	4.254	17	0.001
I was able to tell everything I wanted (story telling <b>without</b> the application)	-0.592	17	0.562
I was able to tell everything I wanted (story telling <b>with</b> the application)	5.097	17	< 0.001
I put more details in the story told with the application	12.369	17	< 0.001
I was encouraged to add media such as text, maps or pictures to explain things better	0.923	17	0.369
I found that more memories came back with the application	10.282	17	< 0.001

Table 6-7: Statements and results one-sample t-test

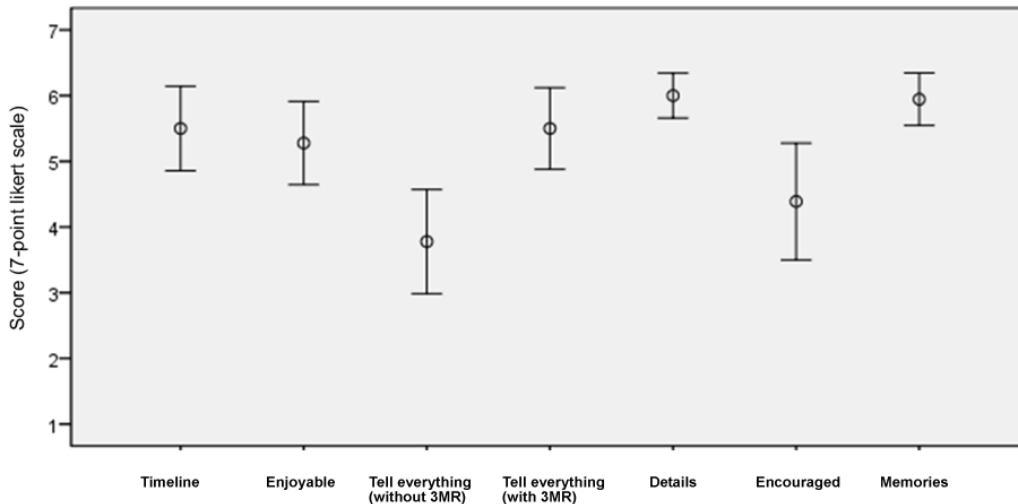


Figure 6-5: Mean-rating (95%CI) second questionnaire

#### 6.4.2 Analysis of voice recordings

During the storytelling of the 18 participants voice recordings were made of both stories, resulting in a total of 36 different audio clips. The analysis of these recordings acted as a second source to see if the tool affected people's storytelling. Each sentence was analyzed to see if it contained any reference to (1) time, (2) an event or (3) a location. A sentence can also contain multiple references. Due to this and the difficulty categorizing the references while listening, every recording had to be checked multiple times. All references in a told story were counted so it could be used for a statistical analysis. A distinction was made between a precise time reference (i.e. 12<sup>th</sup> of March) and a less precise time reference (i.e. the summer holidays). The same was done with events; a distinction was made between more general events, such as 'going on a business trip', 'leaving town', 'taking care of the pets', and more specific events, such as 'buying a cola at the supermarket', 'picking up the phone' and 'getting in the car'. Another aspect which was included in this analysis was the time period the story covered. Only 24 clips were used in this analysis, as 6 people used the text feature to write about their stories without saying what they were typing. These voice recordings did not contain any relevant information and could not be used. For every story the amount of references for each category was counted, these values were used in a Wilcoxon Signed-ranks test.

The Wilcoxon Signed-ranks test indicated that more participants mentioned a precise date with the 3MR system ( $Mdn = 2.50$ ) than without ( $Mdn = 0.00$ ),  $Z = -2.96$ ,  $p = 0.003$ . The opposite was true when participants referred to a less precise time frame,  $3MR-Mdn = 1.5$ ,  $non-3MR-Mdn = 4.0$ ,  $Z = -2.77$ ,  $p = 0.006$ . The application seems to encourage them to think about the time the story and associated events took place. Once they picked the first date, it seemed that they were going to tell more about this day by adding events. Concerning these events, participants were more detailed with the system ( $Mdn = 4.00$ ) than without ( $Mdn = 3.00$ ),  $Z = -2.56$ ,  $p = 0.011$ . Again the opposite was the case when participants referred to more general events,  $3MR-Mdn = 1.5$ ,  $non-3MR-Mdn = 3.0$ ,  $Z = -2.46$ ,  $p = 0.014$ .

Also, stories told with 3MR covered a smaller time period in months ( $Mdn = 0.13$ ) than without ( $Mdn = 0.50$ ),  $Z = -2.43$ ,  $p = 0.015$ . Most participants using the application picked days which were sitting very close to each other. Without the application, this was usually not the case. Some of these stories even covered multiple months. The test indicated that the frequency of location references showed no significant difference ( $p > .05$ ).

Another observation was the difference between what the participants used to tell their story. It is not certain if this was due to the 6 minute time limit they had. Some only used the text feature to write about past events and what they saw, even when they brought a photo book with them containing pictures which may have supported the storytelling. However, others were very dependent on the images and photographs. Two participants even did not mention any events that were not seen on the pictures. As seen earlier in the experiment, most participants enjoyed adding media and text on a timeline to tell a story. Some even suggested it might even be fun for people without a PTSD as they can use the application to keep a diary or to create an interactive photo book. Friends can, for example, place their photos next to the ones someone else made, filling the photo book collaboratively. This archive can later be used to share the stories with others. Of course, telling more serious stories about stressful situations may not be as enjoyable compared to stories about holidays. But it may still be a more appealing way to tell something about a past deployment.

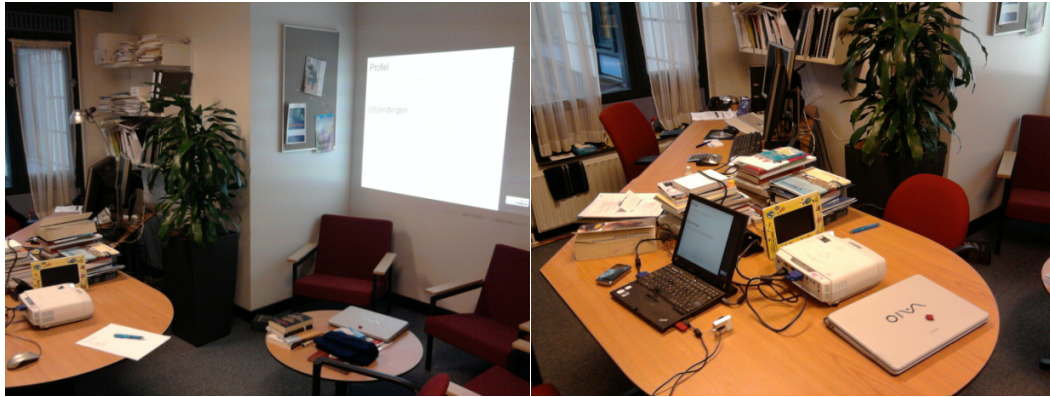
The results hint at a more structured way of storytelling when using the system. In this case the participants did not get any help or directions to tell their story. In a therapeutic setting this is different. The therapist can help the patient to tell the story in a more structured way. But with the help of the application, this may be something that can be done with less effort of the therapist.

## 6.5 Case study with a veteran

The two phases of the experiment showed promising results. However, no evaluation was done with a real patient. A patient suffering from combat-related PTSD may have a different experience working with the application while telling something about a past deployment. Therefore a small case study was organized with a veteran suffering from combat-related PTSD. This patient has served in various deployments, such as Dutchbat I (Srebrenica). As the proposed system was a new concept, the aim was to acquire insights into how a patient would use and interact with the system. Also the initial thoughts were important, together with how he perceived working with the application.

### 6.5.1 Setup

The observations took place at the UMC (hospital) Utrecht, at the MGGZ department. The chosen room was the office of the psychiatrist who was also present during the case study. The application was installed on a laptop and the video output was projected on one of the walls of the room (Figure 6-6).



*Figure 6-6: Office setting at UMC Utrecht*

The patient sat behind the laptop and the psychiatrist was sitting right next to him. An external webcam was attached to the laptop to create quick snapshots of photographs and drawings. The laptop was connected to a cell phone through Bluetooth. With the cell phone it was possible to provide the laptop with an active internet connection. This internet connection was needed to acquire data from 'google maps'.

The patient was not new to treatment of PTSD; he was already undergoing another form of outpatient PTSD treatment at the time the case study was taken. Typically PTSD patients have difficulty to sequence events, and experience distorted processing of time in the context of traumatic memories. As mentioned earlier, the veteran has been in multiple deployments with some of them containing several stressful situations.

The case study consisted of two sessions. The first session took about an hour, while the second session took 40 minutes. Prior to the first session, the patient was asked to bring photographs of a deployment with him. The psychiatrist also explained the idea behind the system and that a student from TUDelft was going to attend the sessions with him. In the first session the application was explained in detail. The first couple of minutes of the first session were dedicated to explain the system and to let the patient play with the application a little bit. The second session and the remainder of the first session were used to let the patient tell more about a deployment while using the 3MR system. During the sessions notes were constantly taken by the observer. These notes consisted of code words to quickly describe a taken action of either the patient or the therapist. Also issues and suggestion were written down. Between the two sessions a small discussion took place to reflect on what happened in the previous session. In this small discussion the patient was also asked what he thought of the application and if he had suggestions. All findings of the two sessions and the discussion can be found in the following subparagraph.

### **6.5.2 Sessions and findings**

#### ***First session***

First the patient created a profile by stating his name and date of birth. Afterwards he added all the deployments he was in. This was all done on the personal page of the patient. When everything was set, the main interface could be initialized (Figure 6-7 and 6-8, permission was given by both the

patient and psychiatrist to use this image in this thesis report). From here the therapist decided which deployment the veteran should work on. After the deployment was selected by the patient, the animation started showing several images of past events which happened in the time period between now and then. Although the patient understood why this animation was included in the system, he suggested that the application should provide an option to turn this off, as it would be annoying if this animation is shown every time a session starts. After the timeline was set to the first day of the veteran's deployment he wanted to load the images he brought with him from his USB-stick. Instead of selecting a specific day to work on, the patient loaded all the photographs and put them on the first day. An example of this situation, but with added text, is given in figure 6-8. He wanted to put everything here, temporarily, so he could sort everything out at a later time. What he actually wanted was a 'clipboard' related to a deployment. With this 'clipboard' he could copy and paste content elements to particular days on the timeline and vice versa.

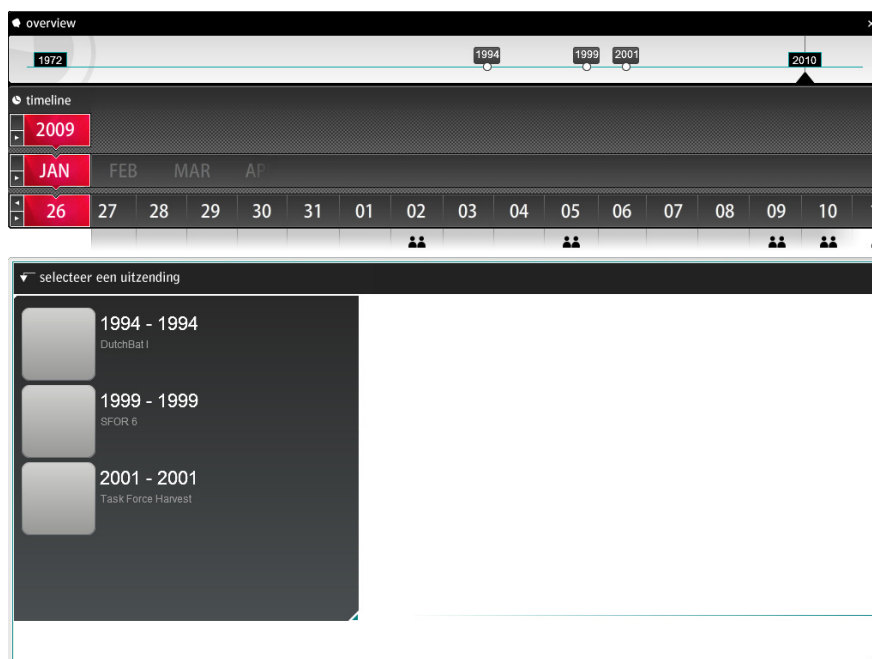


Figure 6-7: Profile list of veteran

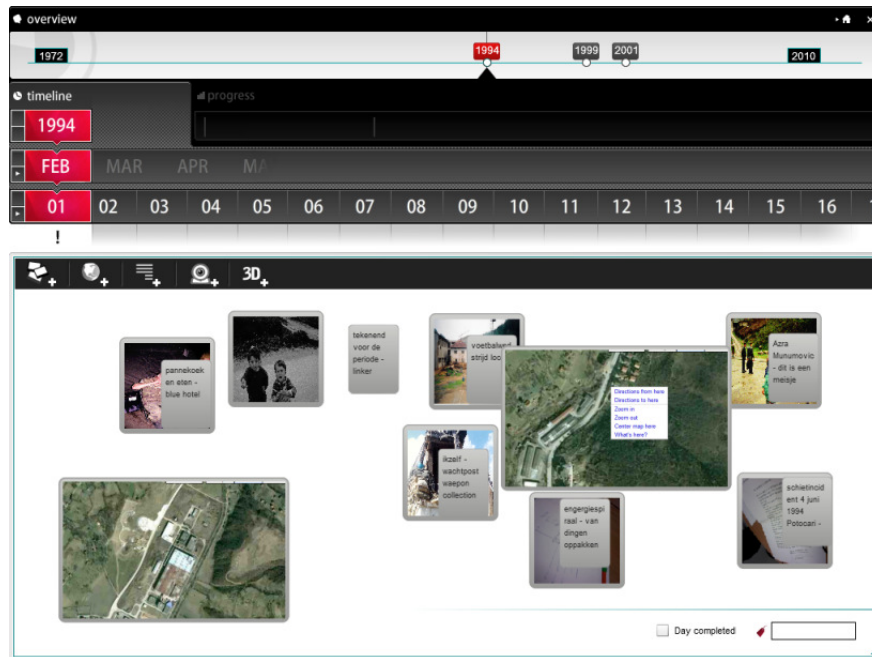


Figure 6-8: Unsorted media and text put on one day

The patient loaded several pictures from his USB-stick and placed them across the screen. Here, the therapist asked the patient to add various text elements to explain, in detail, what was shown on the pictures. He automatically grouped elements together, for example he first added a map and later put corresponding text and images around it (Figure 6-8). Instead of letting the patient type the text, the therapist decided to do it. This way the patient could read what he just said, and add details if needed. The webcam feature was used to make a snapshot of a situation drawing made in an earlier session. The therapist thought it would be good idea to add this image and searched for it in the patient's folder. Afterwards details were given using the text option. One of the most used features during the first session was the 'google maps' option. The patient occasionally added a snapshot of a map. Using the maps, the patient was encouraged to go into details. He started talking about the things he saw and how things have changed compared to the time he was there. He also tried to find specific places and buildings he remembered from back then. Unfortunately the internet connection was slow, resulting in extra load time. However, this time was used to let the patient tell more about what happened back there.

During the session the patient expressed that he found the application very enjoyable to work with, he also thought the idea behind keeping an archive of memories and restructuring the content elements was good. The patient also suggested that the system might be interesting to be used at home. That way the patient can create an 'archive' of the past events at any time and share these stories with friends and family. One of the problems he faced was that the 'balloons' in the overview panel were not selectable (Figure 6-9). He could not quickly switch to a different deployment, however this was done on purpose as the patient should not be able to quickly avoid a certain situation by clicking it away or by selecting a different deployment. The application did not contain a 'clipboard' feature, as mentioned earlier. The therapist agreed that such an option might be useful in a future iteration of the prototype, especially if content elements have to be shifted several days.



Another suggestion was to let photos take up the whole screen, when double-clicked. The prototype did resize the thumbnails, but the patient still thought the images were not large enough if he wanted to explain the things that happened on there.

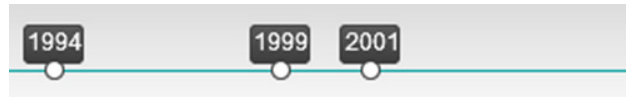


Figure 6-9: Non-selectable 'balloons'

### Reflection and second session

The second meeting started with a reflection of what was discussed during the session conducted in the previous week. The patient mentioned that presenting memories and treatment visually was very appealing and, according to him, useful. He felt that by using the application he was aware of the events that happened a long time ago. Also, the patient liked that he was the one working on his own timeline. He felt that he was more in control of his own treatment and also thought that other veterans with the disorder would find this new approach appealing. The complete list of feedback is given in table 6-8. For this second session the patient brought a document with him. The document was related to the deployment he was editing in the previous session and he thought it was useful for his timeline. The remainder of the session was focused on the events written in the document. Mainly interaction between the therapist and patient took place, putting the 3MR system aside for a while.

The 3D editor option was not chosen during this small case study, but both psychiatrist and patient were hopeful that it would indeed help facilitate processing of complex stressful experiences.

Feedback
+ The application makes you aware of the time-related events
+ Working on your own deployment, more control to add story elements yourself
+ Normally everything is done mentally, now treatment is done with visual aid. Also appealing.
+ Good for group sessions, but also useful for individual treatment
+/- Going back to the past is painful, but it is still important to do so

Table 6-8: Feedback during reflection second meeting

## 6.6 Concluding remarks experiment and case study

The results of the usability evaluation suggested that the three main components of the system (timeline navigation, content manager and the 3D editor) were easy to use. The high rating values may be the cause of the heuristic and formative evaluations that took place prior to the experiment. During that phase a list of usability issues were already addressed, resulting in the final prototype described in chapter 5.

Two sources were used to see if the application affected the way a story was told. Both the questionnaires and the analysis of the voice recordings suggested that differences could be found how stories were told with and without using the 3MR system. The analysis of the recordings showed that participants referenced more to precise dates and detailed events with the application. Also, the amount of time covered in the spoken 6 minutes was smaller with the application than without. The questionnaires also showed promising results. For example, participants thought that

the timeline was an essential component in a way a story was told and participants thought they put more details in the story with the help of 3MR.

The 18 participants found the system appealing and enjoyable to work with. The veteran who participated in the case study was also pleased with the system and felt encouraged to work with it as he saw the purpose of talking about past events by managing a media archive. He liked the visual aid the application provided and the way everything was saved so content added in a previous session could be found and edited at any time. The veteran thought the application would be a good tool during group sessions, as presenting the content elements with the help of a projector makes explaining a story much easier. Other group members can easily understand what happened and give feedback when needed.

A case study cannot provide solid conclusions. However, the combination of the experiments and the case study can, at least partially, support or reject several statements mentioned in chapter 4. The first phase of the experiment was a usability evaluation covering the main components of the system. Six statements per component were given and the same six statements were given to evaluate the application as a whole. These statements do cover a major part of the requirements listed in chapter 4, but it was impossible to verify them all. Each experiment took over half an hour per participant. Additional statements would have made the experiment too long. Therefore a follow-up study is needed to verify other requirements and to support claims concerning aspects not covered in this study, such as, trust and story sharing in a group therapy setting.





## 7 Conclusion and discussion

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### 7.1 Research question and conclusions

In this thesis the design of a multi-modal memory restructuring system was explored, followed by an experiment and case study. The design followed a situated cognitive engineering approach, resulting in a requirements baseline and final prototype needed to answer the research question. The experiment was focused on the usability of the system and the way a story was told. The usability evaluation suggested that all three main interface components of the 3MR system were easy to use. Differences concerning time and event references were found while analyzing the results of the second part of the experiment. These results hinted at a more structured and detailed way of storytelling. A case study with a veteran showed that the patient enjoyed working with the application. He felt encouraged to work with it as he saw the purpose of talking about past events by managing a media archive.

The research question, described in chapter 1, was as follows:

*Is it possible, and what is required, to enhance the treatment of combat-related PTSD, focusing on the restructuring and relearning of a past event, using computer assisted technology?*

Discussions with the psychiatrist from UMC Utrecht and the analysis of the work domain showed that possibilities existed concerning computer assisted technology in a therapeutic setting. Scenarios and prototypes were used to acquire the necessary feedback from experts for the exploration of a system which could support the treatment of combat-related PTSD, focusing on restructuring and relearning. With continuous refinements of the requirements baseline, support grew that the proposed system could indeed enhance the treatment of combat-related PTSD.

The core functions, which answer the question of what is required for the system, were as follows: (1) provide a flexible way of storytelling, (2) provide a structured way of storytelling, (3) prevent losing track of changed and added events (4) ensure trust, (5) ensure usage for therapists with different backgrounds, (6) ensuring treatment awareness, (7) provide a personal approach, (8) prevent unexpected exposure to emotional material and (9) ensure appealing and motivating approach throughout the therapy. In order to accomplish these, various requirements and features were defined, which were later used for the creation of the final prototype.

One could say the research question has been answered as a final prototype was created based on continuous discussions, interviews and evaluations with experts. This strongly supports the idea that the approach can enhance the treatment of combat-related PTSD. The various ways to enhance the treatment are related to the nine core functions of the system. The requirements and features associated with these functions (chapter 4) are the necessary elements to make the approach possible.

### 7.2 Additional support

An experiment and case study were conducted to see if more support could be acquired to the claim that the system can enhance the treatment of combat-related PTSD with the focus on restructuring

and relearning. With the experiment attention was given to statements associated with core functions 1, 2, 7 and 9.

The experiment showed significant differences in a way a story was told with the system, also hinting at a more structured and precise way of storytelling. References to both time and events were more specific and stories told with the application covered a smaller amount of time. The experiment also showed that no large usability issues were found with the three main components of the system. Feedback acquired from the case study was positive, the veteran thought the system could make him more aware of the time-related events in an appealing way and he liked the way that he was in control of the application.

Enhancements were found in a way a story was told, but also the way a session was managed. A more motivating and appealing approach was one of the operation demands discussed in chapter 2. The 18 participants and veteran from the case study enjoyed working with the 3MR system and found it very appealing. The veteran also liked the idea of having a digital archive containing all the past deployments he was in. He also understood the use of the system and did not mind using this or a similar application in future therapy sessions.

### 7.3 Discussion and additional findings

This study showed that both major and minor refinements to the requirements baseline took place as new insights were acquired. It was essential to keep the psychiatrist from UMC Utrecht in the loop as his expertise could be used in all phases of the situated cognitive engineering approach. Unfortunately it was only possible to ask two patients for feedback during this study; one was asked for a small interview and the other one participated in the case study. Therefore the role of the psychiatrist in the analysis, design and evaluation phases was very important. Of course he was not the only one involved. The ten domain experts who reviewed the second cycle of scenarios and the people who helped with the usability evaluations also caused a major impact on the design of the system. It is very likely that additional refinements and knowledge can be acquired by continuing the creation and evaluation of new prototype iterations.

#### *Different uses*

During the entire study, not only knowledge was acquired directly related to the application, but also about a possible therapeutic setting and a how a future session could be managed. Also, the presented scenarios triggered new ideas on how to use this, or a similar application, for different purposes.

Several types of traumatic events, other than combat, can be distinguished, including child abuse, sexual abuse and natural disasters. All these types of traumatic events can eventually lead to a PTSD. In this thesis the focus was on combat-related PTSD, but various features of the proposed system may also be useful for other kinds of PTSDs. One of the experts, who participated in the reviewing phase of the second cycle of scenarios, thought the timeline and text elements could be useful for treating people with a childhood drama. Similar to deployments, the problematic period with this kind of PTSD can also stretch a long period of time. The timeline type of navigation might therefore be an essential tool to restructure or reappraise memory elements. However, PTSDs as a result of, for example, a motorcycle accident might not benefit from this type of navigation as the

period of time is too short. Furthermore, the use of personal data was the result of veterans having all kinds of material related to their deployments at home. This might be a unique aspect only applicable to veterans. Patients suffering from a different type of PTSD might not have access to personal pictures or documents.

The veteran suggested that the application could be used at home, so people could share their stories with friends or family to explain the things they have faced, but also to keep an archive for themselves and add data when more memories return. He also suggested that patients could bring their application and data with them every time they visit the hospital. The system should then be able to sync the stories stored on the local database with the content on the memory stick.

### **3M2R**

The focus of the study was to see if computer assisted technology could enhance treatment, focusing on restructuring. However, throughout the study an additional aspect was introduced: reappraising past events. Personal pictures are sometimes not (directly) related to stressors. Therefore, when a patient adds content to a specific day, the photos may contain events of more enjoyable times which are often forgotten. Cognitive reappraising (Ehlers & Clark, 2000) might be explored more to see if it can be incorporated into the system.

### **3D world editor**

The 3D world editor feature received mixed reviews as described in chapter 3. It seemed that the 3D editor also did not get as much support as the other features of the main application. The editor may be more interesting if it included additional options, such as adding notes in the 3D world (Figure 7-1). However, as seen in the initial scenarios, the creation of a virtual environment might take a large amount of effort and time if the editor features more advanced options.



*Figure 7-1: Adding notes in the 3D world*

## 7.4 Future work

### *A new iteration*

Chapter 5 mentioned several additional features not present in the final prototype: (1) adding goals and session information to the current time period, (2) a clipboard and (3) audio and video features. The first feature may make managing sessions more efficient as therapists are able to look what has been covered in previous sessions. The summaries may also make the patient more aware of the treatment. Goals can be related to session activities, such as covering a part of the deployment, but also to activities in the present time. This distinction was done on purpose. Additional evaluations are needed to verify if this feature would support the treatment of combat-related PTSD. The clipboard feature was a suggestion acquired during the case study, the last phase of the study. Therefore no additional insights could be acquired anymore to see if a clipboard is really a feasible option for the system.

### *Further evaluation and experiments*

Although the acquired knowledge was based on an extensive literature study and discussions with experts in the field, no data was acquired with actual patients over a prolonged period of time. Such data can show if the system is truly beneficial in the recovery of the patient. So far only a small case study was done to observe the way the patient interacts with the system. Therefore, a clinical experiment is needed to obtain the necessary data to make conclusions on. Also the experiment can show if 3MR is more efficient or effective compared to other treatment methods. For such an experiment multiple patients suffering from combat-related PTSD need to be observed over multiple sessions.



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## Appendix A

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# Multi-Modal Memory Restructuring for Patients Suffering from Combat-Related PTSD: a Pilot Study

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**Abstract.** The paper discusses the design and evaluation of a multimedia software application which can be used in the treatment of combat-related Post-Traumatic Stress Disorder (PTSD). The application allows patients and therapist to visualize the patients' past experience using maps, personal photos, stories and self created 3D virtual worlds. The tool aims to allow patients to restructure and relearn about their past experience involving the problematic stressors. Findings of a first experiment with non-patients (N=18) suggests that the tool can facilitate more detailed storytelling. Participants stated that using the application was appealing and enjoyable. Insights were also acquired with a case study of a veteran suffering from combat-related PTSD. This case study showed how a patient uses and interacts with the system in a therapeutic setting.

**Keywords.** PTSD, trauma-focused psychotherapy, memory, multimedia, restructuring, reappraisal

### Introduction

Combat-related Post-Traumatic Stress Disorder (PTSD) is one of the health problems soldiers may face upon their return from deployment. As an increasing number of soldiers return from war situations such as Iraq and Afghanistan, the demand for PTSD treatment is also likely to increase. A review of PTSD treatments by Schottenbauer et al [1] reports high drop-out rates for Cognitive Behavioral Therapy (CBT) and Eye Movement Desensitization and Reprocessing (EMDR). In an attempt to increase appeal relative to traditional face-to-face talk therapy, interest has gone out to developing other methods for improving activation of the traumatic memory during exposure therapy, thereby providing a treatment approach that may be more attractive to some service members. The proposed system presented in this paper explores the possibility of using computer-assisted technology to support trauma-focused psychotherapy, to be used both in a group therapy setting as well as a single patient-therapist setting. Supporting the treatment with computer-assisted technology is, however, not new; recently Virtual Reality Exposure Therapy (VRET) has been extended to the treatment of PTSD. Patients are exposed in virtual reality worlds resembling war situations such as those in Iraq [2]. Using the here proposed Multi-Modal Memory

Restructuring (3MR) System, patients can now build these virtual worlds themselves and link them to a specific day on a timeline, together with media such as personal pictures and geographical maps. This way the system aims to give the patient more flexibility to restructure, reappraise and narrative about their deployment and to manage various deployment related memory elements themselves with the purpose to facilitate time sequencing of memory content.

### **3MR system**

Traditional treatment of veterans with deployment related PTSD is often set within a group context as soldiers are familiar to operate in a group [3]. In these sessions, patients talk about their experiences, in an exposure based format, facilitated by the drawing of maps and other visual aids. Usually a flap-over as well as maps and photographs are used to facilitate memory content. Often memory is compromised and due to memory distortions or amnesia for details these elements can be quite helpful. The 3MR approach takes this a few steps further. The 3MR focus does not lay on direct exposure, but on the way patients facilitate and manage their memory to restructure and relearn about their past experience involving the problematic stressors. Patients are invited along a set timeline to sequentially add media and self-created virtual 3D worlds, patients are able to express and rethink about their experiences during their time of deployment. The 3MR system provides contextual information in various modalities to these experiences. It is designed to run on a laptop with a projector displaying the computer screen on the wall for the group members to see. This in itself creates a safe zone, in which direct eye contact among members can be legitimately avoided; some patients do not like to be stared at during their exposure, and others do not want to look at someone in a potentially distressing state. Additionally, a camera is attached to the laptop allowing snapshots from photos or objects patients brought with them. The system support consists of several elements. (1) Information of patient is created, as a digital space or folder. (2) The session starts with a projection of a timeline set on the present day. From here the patient can move to a specific day of their deployment. To emphasize that this event has taken place in the past, the years and days from the present day to the selected day are counted back while showing photos of historical events of that time period. (3) Once the patient arrives at the specific day, they are asked to organize the event of that day by using their own photographic material, videos, or music, and by annotating satellite based geographical maps (Figure 1a). In addition, the patient can also use an easy-to-use 3D editor to recreate a specific scene (Figure 1b). Using these facilities the patient can restructure the events and place them, together with narrative elements, on a chronological timeline. (4) This can be worked through, commented on back and forth. (5) The session ends again by visually moving back from the event in the past to the present day. The way a patient initially perceives a past deployment may change if the patient continuously also adds positive pictures and documents to his or her timeline. Although a past deployment is often related to traumatic events, the good memories, also related to the same deployment, are often forgotten. Photographs are usually taken during non stressful moments. This material can therefore be very useful, even though they are not directly linked to a stressor. In addition to these features, a psycho-educational element is incorporated to display the past and coming treatment sessions on the timeline. This gives the patient an overview of the entire treatment procedure.

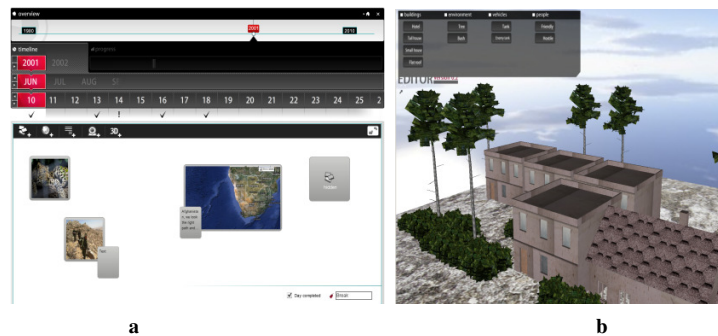


Figure 1. Left the timeline with content management (a), right the 3D world editor (b)

## Analysis and design

The design of the system followed a situated cognitive engineering approach as described by Neerincx and Lindenberg [4]. It is an iterative approach where the requirements baseline is continuously refined as new insights are acquired through prototype evaluations and reviews with therapists. An inventory of envisioned technology, relevant human factors, and operational (therapeutic) demands was established during the domain analysis. This was done in close cooperation with a military psychiatrist experienced in treating PTSD patients. With this information scenarios and claims were specified, which resulted in three short films<sup>6</sup> focusing on (1) personalization of the system (timeline, own text annotations, and 3D virtual world), (2) the use of the 3D editor (pausing and resuming editing work, and interaction with the therapist and other group members), and (3) the return to a previous session (amending and extending previous work). These films were used in a review with ten therapists. At the start of the in-depth interviews, the films were shown to a therapist, followed by a discussion of the underlying claims on the usability and support of the therapeutic process. The three most noticeable changes made after the review were: (1) more modality was added to facilitate memory, (2) options were introduced to personalize the system and (3) the patient was now able to tag or summarize a particular day with keywords. Several prototypes were developed and after a heuristic evaluation and a continuous formative evaluation approach, keeping both experts and therapists in the loop, the proposed 3MR system was created and ready to be used in both an experiment and case study. It is important to note that the proposed system is a new concept and insights are necessary on what features of the system are of importance and how people would use the application. In this early stage the aim was not to acquire data to study the effectiveness of a treatment using the 3MR tool.

## Experiment and case study

Before the case study with a real patient took place, an initial experiment was conducted to see if the system would support people in telling a story from the past. The participants were asked to tell two different autobiographic stories (e.g. holiday trips) of 6 minutes each, one with the help of the 3MR system and one without. The order in which the stories were told was counterbalanced. Prior

<sup>6</sup> <http://mmi.tudelft.nl/vret/index.php/PTSD>

to the storytelling participants already explored the 3MR system. A total of 18 people participated in this experiment, none suffering from a combat-related PTSD. Participants were allowed to bring related photographs with them to make the storytelling a bit easier. After both stories were told, each participant was asked to fill out a 7-point likert scale questionnaire. Using a one sample *t*-test, the following significant results ( $H_0: \text{score} = 4, p < .001$ ) were acquired: (1) participants thought they put more details in the story told with the help of 3MR ( $M = 6.00, SD = 0.69$ ), (2) comparing the two stories, they found more memories came back by using the application ( $M = 5.94, SD = 0.80$ ), (3) participants enjoyed telling a story with 3MR more than telling a story without the application ( $M = 5.28, SD = 1.27$ ) and (4) they thought the timeline was an essential component in a way a story was told ( $M = 5.50, SD = 1.29$ ). Less positive seems the rating on whether the system encouraged them to use the features offered by the application ( $t(17) = 0.92, p = .37$ ) ( $M = 4.39, SD = 1.79$ ). Although there was no need to use them, as most of the components were designed specifically for soldiers with a PTSD, another reason could be that the available 6 minutes were too short to allow them to make use of the available features. Although the results from the questionnaires favor the use of 3MR, an additional analysis was done to see if the tool affected people's storytelling. For this analysis the sound recordings of only 12 participants could be used as 6 participants, mainly typed instead of talked when using the 3MR tool. The analysis focused on: (1) time referencing, (2) location, (3) event description and (4) time period covered. A Wilcoxon Signed-ranks test indicated that more participants mentioned a precise date with 3MR ( $Mdn = 2.50$ ) than without ( $Mdn = 0.00$ ),  $Z = -2.96, p = .003$ . The opposite was true when participants referred to a less precise time frame,  $3MR-Mdn = 1.5, non-3MR-Mdn = 4.0, Z = -2.77, p = .006$ . Concerning events, participants were more precise with the system ( $Mdn = 4.00$ ) than without ( $Mdn = 3.00$ ),  $Z = -2.56, p = .011$ . Examples of these events are actions such as buying a cola and watching football on TV. Again the opposite was the case when participants referred to more general events,  $3MR-Mdn = 1.5, non-3Mdn = 3.0, Z = -2.46, p = .014$ . Going to a business trip and studying for an exam are examples of general events. Also, stories told with 3MR covered a smaller time period in months ( $Mdn = 0.13$ ) than without ( $Mdn = 0.50$ ),  $Z = -2.43, p = .015$ . However, the test indicated no significant difference ( $p > .05$ ) when participants referred to locations.

A small case study of two clinical sessions was organized with a veteran with PTSD who has served in various deployments, such as Dutchbat I (Srebrenica). As the proposed system was a new concept, the aim was to acquire insights into how a patient would use and interact with the system. Before the case study started, the psychiatrist (EV) informed the patient of the study, explained what was going to happen and asked the patient to bring some photographs with him so he could add the data into the system during the first session. The patient was not new to treatment of PTSD; he was already undergoing another form of outpatient PTSD treatment at the time the case study was taken. Typically PTSD patients have difficulty to sequence events, and experience distorted processing of time in the context of traumatic memories. A clinical environment was chosen for the observations, with the patient sitting behind a laptop and the therapist sitting next to him. After introducing the patient to the system, the patient created a profile by stating his name and adding the different deployments he was in. Instead of picking a date, the patient put all the collected (digital) photos on the first date of the deployment. Here, he also added various text elements to explain, in detail, what was shown on the pictures. Instead of letting the patient type the text, the therapist decided to do it. This way the patient could read what he just said, and add details if

needed. One of the most used features during the first session was the 'google maps' option. The patient occasionally added a snapshot of a map to the timeline. Using the maps, the patient was encouraged to go into details. He started talking about the things he saw and how things have changed compared to the time he was there. He also tried to find specific places and buildings he remembered from back then. The patient usually added elements to the timeline independently. However he did not always provide much information. In these cases the therapist asked the patient to tell more about the things he experienced by encouraging to use the narrative element within the system. Overall, the patient was very pleased with the approach and suggested that the system might be interesting to be used at home. That way the patient can create an 'archive' of the past events at any time and share these stories with friends and family. The second meeting started with a reflection of what was discussed during the session conducted in the previous week. The patient mentioned that presenting memories and treatment visually was very appealing and, according to him, useful. He felt that by using the application he was aware of the events that happened a long time ago. Also, the patient liked that he was the one working on his own timeline. He felt that he was more in control of his own treatment and also thought that other veterans with the disorder would find this new approach appealing. For this second session the patient brought a document with him. The document was related to the deployment he was editing in the previous session and he thought it was useful for his timeline. The remainder of the session was focused on the events written in the document. Mainly interaction between the therapist and patient took place, putting the 3MR system aside for a while. Unfortunately the 3D editor option was not chosen during this small case study, but both psychiatrist and patient were hopeful that it would indeed help facilitate processing of complex stressful experiences.

Looking back at both the experiment and case study, participants found the system appealing and enjoyable to work with. It acts as an archive of memories and allows patients to manage this archive by adding various multimedia elements related to their memory. The proposed timeline was found to be a useful feature and the participants thought that more memories came back when using 3MR, in an accurate non-time distorted way. Results from the additional analysis showed significant differences in how a story is told, hinting at a more detailed way of storytelling. The veteran who participated in the case study was pleased with the system and felt encouraged to work with it as he saw the purpose of talking about past events by managing a media archive.

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- [2] Rizzo, A. A., Graap, K., McLay, R. N., Perlman, K., Rothbaum, B. O., Reger, G., et al. (2007, Sep 27-29). *Virtual Iraq: Initial case reports from a VR exposure therapy application for combat-related post traumatic stress disorder*. Paper presented at the Virtual Rehabilitation Conference 2007, Venice, Italy.
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## Appendix B

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Scenario scripts

### Scripts first cycle

#### Scenario [Sc1]

*Patient heeft nog nooit eerder met het programma gewerkt. Het idee is dat de patient thuis een tutorial krijgt en zelf het een en ander mag uitproberen alvorens met het echte programma aan de haal te gaan.*

- Patient Andre gaat thuis achter zijn PC zitten en doet de cd-rom in zijn computer.
- Een scherm verschijnt met daarop een beschrijving van wat hij binnen nu en een half uur gaat zien.
- Andre drukt op 'verder' en krijgt een paar foto's en filmpjes te zien hoe een sessie er ongeveer uit ziet.
- Een dummy interface laat de verschillende features zien die het echte programma aanbiedt.
- Andre drukt op verschillende knoppen en ziet daarbij het resultaat.
- Door de uitleg op de cd-rom weet Andre nu wat hem te wachten staat.

#### Scenario [Sc2]

*Therapeut behandelt een gebeurtenis (kleine tijdframe) geassocieerd met de stressor. De patient moet de omgeving namaken, ondertussen wordt er over de gebeurtenis gepraat. Een kleine review sessie gebeurt aan het einde.*

- Voordat de sessie voor vandaag begint gaat Theo zijn kamer binnen.
- Therapeut Theo neemt plaats achter de 'therapist PC' en logt in door zijn 'username' en 'password' in te voeren.
- Theo kijkt naar zijn papieren en ziet dat patient Andre dadelijk als eerste het programma gaat gebruiken.
- Theo kijkt naar het scherm en ziet een lijst met patiënten die bij hem in behandeling zijn. Theo selecteert vervolgens Andre en kiest voor de template 'berglandschap'. Dit naar aanleiding van het verhaal dat Andre eerder eens heeft verteld.
- Theo selecteert alvast de optie om de wereld en de editor te laden.
- De sessie start en een groepje van 5 personen komt de zaal binnen.
- Theo begroet de mensen en vraagt Andre om plaats te nemen achter de PC.  
**Groep:** *(Goedemiddag/Hallo/Zijn we niet te vroeg?..)*  
**Theo:** *(Goedemiddag, kom binnen.)*  
 Theo: *(Zoals jullie weten gaan we vandaag met de 3D editor aan de gang. Ik zie dat Andre vandaag gaat beginnen met zijn wereld, neem plaats.)*  
**Andre:** *(Natuurlijk.)*
- Andre neemt plaats achter de aangewezen PC en kijkt naar het geprojecteerde beeld van de beamer.
- De overige patienten nemen plaats rondom de PC.  
**Theo:** *(Je hebt als het goed is de tutorial cd doorgenomen, dus je weet denk ik wel wat de bedoeling is.)*  
**Andre:** *(Dat klopt, ja)*  
**Theo:** *Naar aanleiding van een verslag dat ik hier heb, denk ik dat dit een goede basis is om mee te beginnen.*
- Theo selecteert een basislandschap door op het juiste plaatje te klikken op zijn scherm.
- **Andre:** *(Dat ziet er goed uit inderdaad)*
- De beamer laat een 3D beeld zien van de gekozen template.  
**Groep:** *(Veel succes!..)*  
**Theo:** *(Je zei dat de gebeurtenis plaats vond bij wat nederzettingen, zullen we om te beginnen de categorie 'gebouwen' selecteren?)*  
**Andre:** *(Is goed, er zaten wel wat kleine gebouwen voor mij, maar het waren er volgens mij niet zo gek veel)*



- Theo klikt de knop 'gebouwen' aan op zijn scherm. Vervolgens verschijnt er op de beamer een lijst met gebouwen die de patient kan selecteren.
- Andre selecteert een paar gebouwen met de muis en plaatst deze in de wereld (template).  
**Groep:** *(Volgens mij zat daar helemaal niks hoor, het was een open gebied./ Ah ja, zoiets kan ik me ook nog herinneren.)*  
**Theo:** *(Carlos, jij was er ook bij, klopt het een beetje volgens jou?)*  
**Carlos:** *(Jawel, alleen was er nog wel een grote weg met daarnaast wat kleine nederzettingen.)*  
**Andre:** *(Dat kan ik me niet heel goed meer herinneren, wel weet ik dat ik met twee anderen hier [wijst met de muis naar een plaats in de 3D wereld]aan het zoeken waren naar overlevenden)*  
**Andre:** *(10 minuutjes later gingen we weer terug)*
- Theo vraagt naar meer details  
**Theo:** *(Kan je misschien iets meer vertellen wat jij en je twee collega's daar precies deden?)*  
**Andre:** *(We dachten iets vreemds gezien te hebben hierzo [wijst met muis naar gebied in wereld], maar het was echter loos alarm. We konden niks vinden in het gebouwtje, dit hebben we gemeld en zijn weer terug gegaan naar de groep.)*
- Andre krijgt het hier een beetje moeilijk en praat zenuwachtig.
- Theo: *(Okay rustig aan... jullie gingen dus samen terug...)*
- Andre vraagt of het mogelijk is om wat soldaten neer te zetten.  
**Andre:** *(Kan ik misschien wat militairen op het veld plaatsen?)*  
**Theo:** *(Natuurlijk, 1 moment)*
- Theo selecteert de categorie 'mensen en soldaten' door op de desbetreffende knop te drukken.
- *Fade out/fade in (enige minuten later...)*
- Theo neemt controle over de camera en geeft een recap van wat Andre heeft verteld.  
**Theo:** *(Okay, dus jij en twee andere militairen stonden hier [wijst naar veld], maar gingen naar deze plek [wijst naar veld] om te kijken of er iets aan de hand was. Vervolgens zagen jullie niks, hebben dit gemeld en gingen weer terug. Daarna werd Alex geraakt door een kogel die plotseling van de linkerkant kwam. Klopt dit een beetje?)*  
**Andre:** *(Ja, voordat hij geraakt werd stond ik net voor hem, we waren allemaal dat kleine hutje gepasseerd. Ik heb de schot zelf niet gezien, maar wat er daarna gebeurde kan ik me nog erg goed herinneren)*
- *Fade out*

### Alternatief voor scenario [Sc3]

Als alternatief het volgende (grotendeels hetzelfde):

1. Bouwen van de wereld geschiedt nu in meerdere sessies.
  2. Aan het einde een review en..
  3. ... tijdens de sessie wordt er nog steeds vanalles besproken.
  4. Groter tijdframe, mogelijkheid om meerdere (of grotere) plekken te bouwen
- Therapeut Theo neemt plaats achter de 'therapist PC' en logt in door zijn 'username' en 'password' in te voeren.
  - Theo kijkt naar het schema en ziet dat patient Andre dadelijk als eerste het programma gaat gebruiken.
  - Theo kijkt naar het scherm en ziet een lijst met patiënten die bij hem in behandeling zijn. Theo selecteert vervolgens Andre en kiest voor de template 'berglandschap'. Dit naar aanleiding van het verhaal dat Andre eerder eens heeft verteld.
  - Theo selecteert alvast de optie om de wereld en de editor te laden.
  - De sessie start en een groepje van 5 man komt de zaal binnen.
  - Theo begroet de mensen en vraagt Andre om plaats te nemen achter de PC.  
**Groep:** *(Goedemiddag/Hallo/Zijn we niet te vroeg?...)*  
**Theo:** *(Nee hoor, kom binnen.)*

- Theo:** *(Andre, ik zie dat jij gaat beginnen vandaag. Kan je plaats nemen achter de PC?)*
- Andre:** *(Oh, okay natuurlijk.)*
- Andre neemt plaats achter de PC en kijkt naar het beeld van de beamer
  - De overige mensen nemen plaats rondom de PC.
- Groep:** *(Veel succes!...)*
- De beamer laat een 3D beeld zien van de gekozen template.
- Theo:** *(Je zei dat de gebeurtenis plaats vond bij wat nederzettingen, zullen we om te beginnen de categorie 'gebouwen' selecteren?)*
- Andre:** *(Is goed, er zaten wel wat kleine gebouwen voor mij, maar het waren er volgens mij niet zo gek veel)*
- Theo klikt de knop 'gebouwen' aan op zijn scherm. Vervolgens verschijnt er op de beamer een lijst met gebouwen die de patient kan selecteren.
  - Andre selecteert een paar gebouwen met de muis en plaatst deze in de wereld (template).
- Groep:** *(Volgens mij zat daar helemaal niks hoor, het was een open gebied./ Ah ja, zoiets kan ik me ook nog herinneren.)*
- Theo:** *(Carlos, jij was er ook bij, klopt het een beetje volgens jou?)*
- Carlos:** *(Jawel, alleen was er nog wel een grote weg met daarnaast wat kleine nederzettingen.)*
- Andre:** *(Dat kan ik me niet heel goed meer herinneren, wel weet ik dat ik met twee anderen hier [wijst met de muis naar een plaats in de 3D wereld]aan het zoeken waren naar overlevenden)*
- Andre:** *(10 minuutjes later gingen we weer terug)*
- Theo vraagt naar meer details
- Theo:** *(Kan je misschien iets meer vertellen wat jij en je twee collega's daar precies deden?)*
- Andre:** *(We dachten iets vreemds gezien te hebben hierzo [wijst met muis naar gebied in wereld], maar het was echter loos alarm. We konden niks vinden in het gebouwtje, dit hebben we gemeld en zijn weer terug gegaan naar de groep.)*
- Andre vraagt of het mogelijk is om wat soldaten neer te zetten.
- Andre:** *(Kan ik misschien wat militairen op het veld plaatsen?)*
- Theo:** *(Natuurlijk, 1 moment)*
- Theo selecteert de categorie 'mensen en soldaten' door op de desbetreffende knop te drukken.
  - *Fade out/fade in (enige minuten later...)*
  - Theo neemt controle over de camera en geeft een recap van wat Andre heeft verteld.
- Theo:** *(Okay, dus jij en twee andere militairen stonden hier [wijst naar veld], maar gingen naar deze plek [wijst naar veld] om te kijken of er iets aan de hand was. Vervolgens zagen jullie niks, hebben dit gemeld en gingen weer terug. Daarna werd Alex geraakt door een kogel die plotseling van de linkerkant kwam. Klopt dit een beetje?)*
- Andre:** *(Ja, voordat hij geraakt werd stond ik net voor hem, we waren allemaal dat kleine hutje gepasseerd. Ik heb de schot zelf niet gezien, maar wat er daarna gebeurde kan ik me nog erg goed herinneren)*
- *Fade out*

## Scripts second cycle

### Scenario 1

#### Tekst therapeut scenario 1 (gespeeld door Christian)

*Patient + groep komt binnen*

*Therapeut start GUI op en bekijkt de papieren. Therapeut logt in en selecteert de patient.*

- Goedemorgen!

- Hi Guntur, we gaan vandaag met jou beginnen, neem alstublieft plaats achter de pc.
- **(Guntur neemt plaats achter de pc)**
- We hebben gisteren een set foto's van je gekregen en die hebben we meteen in het systeem gezet. Misschien is het handig om die foto's aan de juiste datum te hangen. Ik zie dat je in een eerdere sessie al een verhaaltje had geplaatst, laten we de foto's er bij plaatsen om het plaatje wat completer te maken.
- **(Guntur kijkt naar het scherm en drukt op '2 oktober')**
- **(Guntur verplaatst de foto's naar de rechterkant)**
- Ah ja, 2 oktober hadden jullie een korte pauze toch?
- **(Guntur antwoordt en is klaar met het plaatsen van de foto's)**
- Mooi.
- **(Guntur wil wat in de 3D edit doen en de omgeving van 2 oktober nabootsen)**
- Okay, dat is goed, laten we de editor opstarten.

### Tekst patient scenario 1 (gespeeld door Guntur)

*Patient + groep komt binnen*

*Therapeut start GUI op en bekijkt de papieren. Therapeut logt in en selecteert de patient.*

- Goedemorgen!
- Goedemorgen!
- Hi Guntur, we gaan vandaag met jou beginnen, neem alstublieft plaats achter de pc.
- **(Guntur neemt plaats achter de pc)**
- Sure!
- We hebben gisteren een set foto's van je gekregen en die hebben we meteen in het systeem gezet. Misschien is het handig om die foto's aan de juiste datum te hangen. Ik zie dat je in een eerdere sessie al een verhaaltje had geplaatst, laten we de foto's er bij plaatsen om het plaatje wat completer te maken.
- Okay, even de juiste datum er bij pakken hoor.
- **(Guntur verplaatst de foto's naar de rechterkant)**
- Eens even zien, okay dat waren deze 2 foto's.
- Ah ja, 2 oktober hadden jullie een korte pauze toch?
- **(Guntur antwoordt en is klaar met het plaatsen van de foto's)**
- Zeker, we hadden mooi de tijd om de omgeving te verkennen, deze foto's had een maat van me gemaakt. Zijn hobby is fotograferen en upload de foto's meestal op zijn persoonlijke website.
- Zo, ik ben klaar!
- Mooi.
- **(Guntur wil wat in de 3D edit doen en de omgeving van 2 oktober nabootsen)**
- Ik weet eigenlijk best wel veel van het gebied, zal ik misschien iets in de editor mogen maken? Gewoon de omgeving eigenlijk. Deze dag kan ik me namelijk nog best goed herinneren.
- Okay, dat is goed, laten we de editor opstarten.

### Patient/therapeut scenario 2 en 3

*Scenario 2 volgt script als vorige cycle*

*De therapeut stelt voor om verder te gaan waar ze vorige week zijn gebleven.*

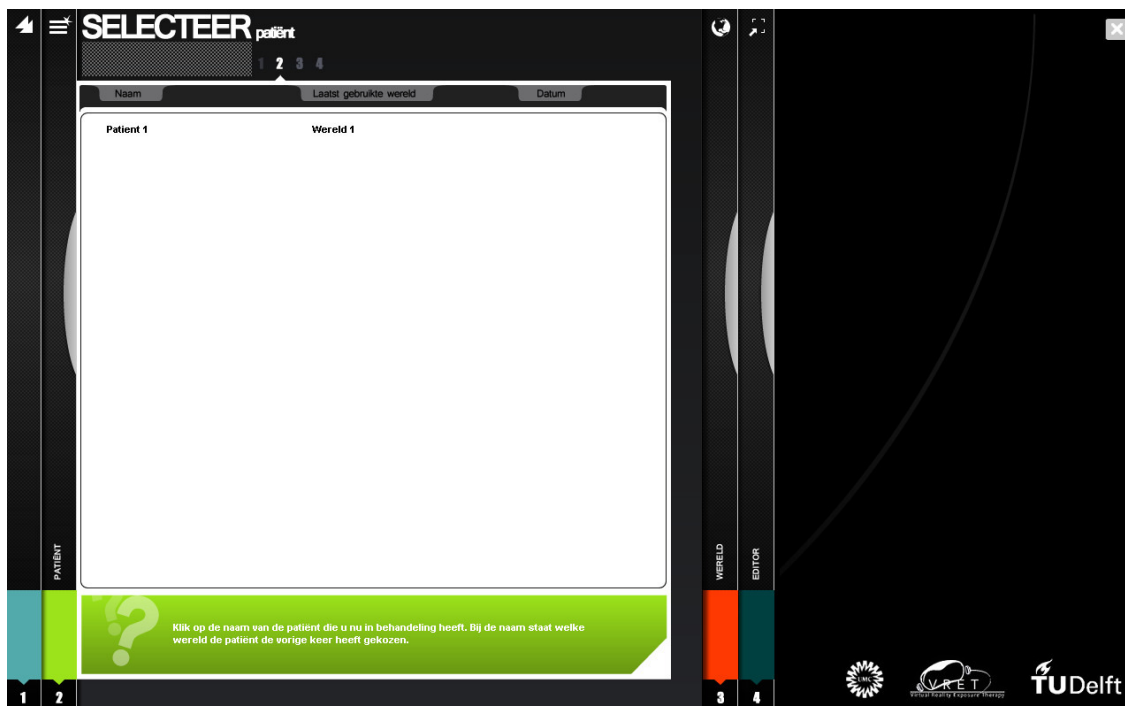
- Okay, is goed.
- **De wereld laadt en guntur plaatst hier en daar wat dingetjes.**
- Dat was deze wereld inderdaad.
- ...Uhhh sorry, maar ik zit ergens mee
- **De therapeut vraagt wat er aan de hand is.**

- Eigenlijk wil ik terug komen op wat ik vorige week heb gemaakt.
- **De therapeut vraagt waarom**
- Ik heb er toch wel even van wakker gelegen, maar ik denk dat het toch wel belangrijk is om er op terug te komen.
- Ik had mijn vriend namelijk niet gewaarschuwd dat ik achter dit gebouw *[wijst naar gebouw]* iets zag...
- **Therapeut zegt: Okay, dat is niet erg, laten we even een paar dagen terug gaan...**

## Appendix C

Screenshots low- and high fidelity prototypes

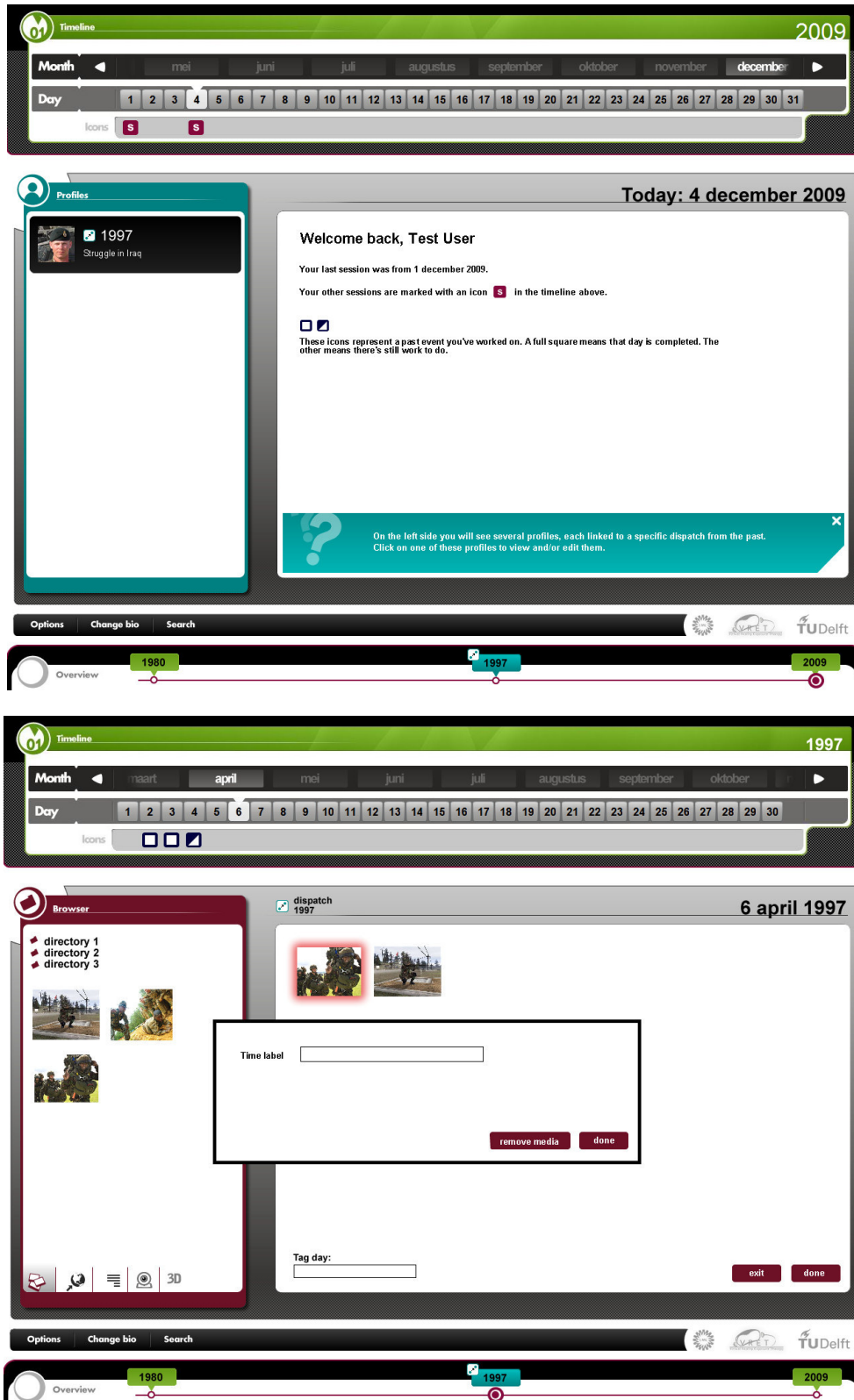
### Therapist user interface (low-fidelity prototype): log-in screen and selecting a patient



## User interface (low-fidelity prototype, revised scenarios): Edited day and adding images

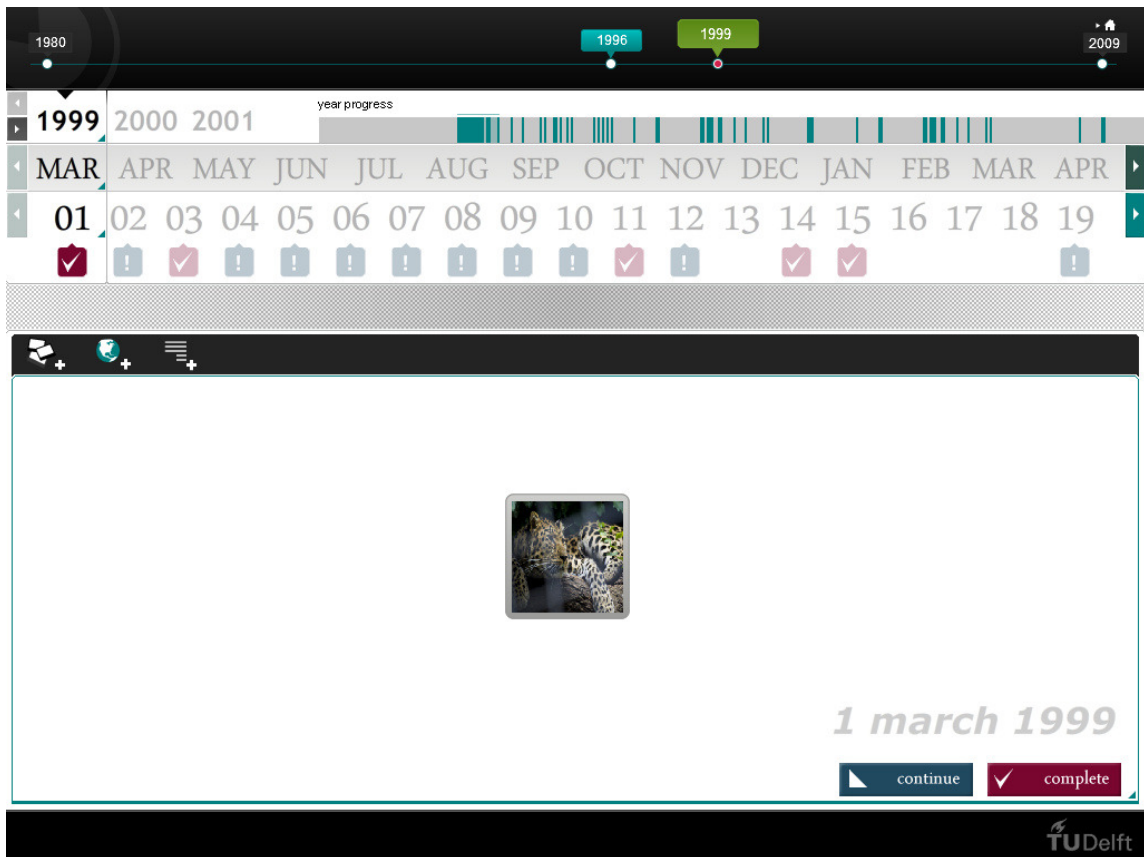
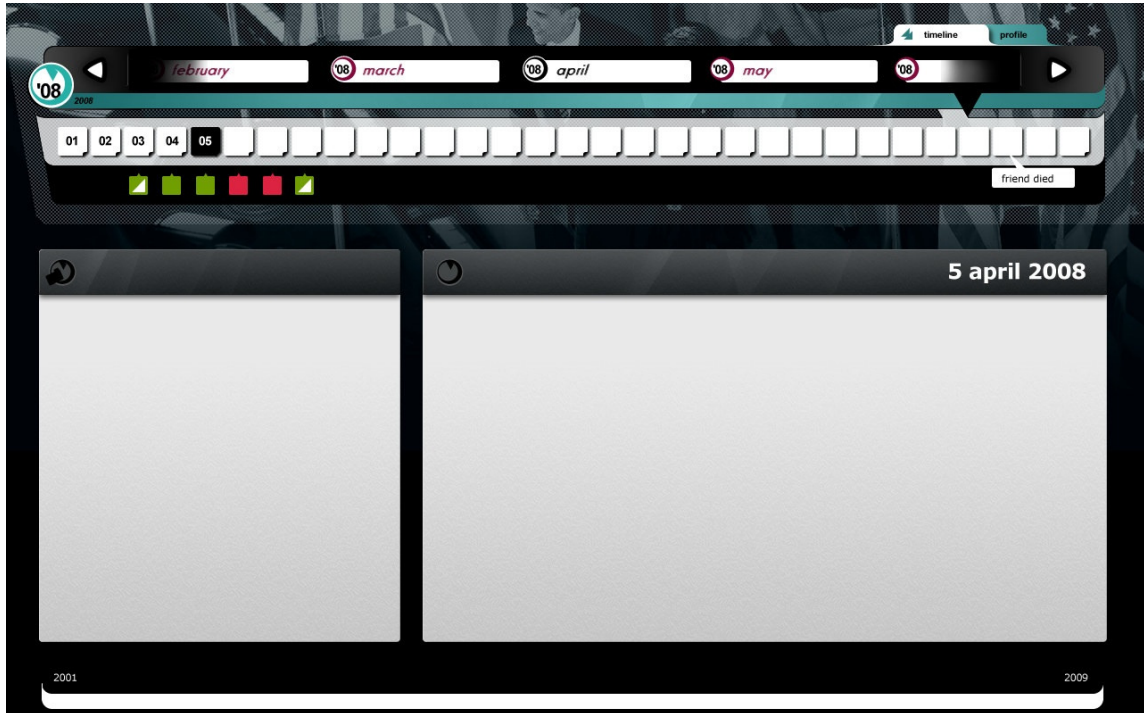


User interface (high-fidelity prototype, version 1): Current time period and past time period





User interface (high-fidelity prototype, version 2 and 3)





## Appendix D

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Form heuristic evaluation

**Your name:**

### Visibility of system status

The system should always keep users informed about what is going on, through appropriate feedback within reasonable time.

**Your findings:**

### Match between system and the real world

The system should speak the users' language, with words, phrases and concepts familiar to the user, rather than system-oriented terms. Follow real-world conventions, making information appear in a natural and logical order.

**Your findings:**

### User control and freedom

Users often choose system functions by mistake and will need a clearly marked "emergency exit" to leave the unwanted state without having to go through an extended dialogue. Support undo and redo.

**Your findings:**

### Consistency and standards

Users should not have to wonder whether different words, situations, or actions mean the same thing. Follow platform conventions.

**Your findings:**

### Error prevention

Even better than good error messages is a careful design which prevents a problem from occurring in the first place. Either eliminate error-prone conditions or check for them and present users with a confirmation option before they commit to the action.

**Your findings:**

## Recognition rather than recall

Minimize the user's memory load by making objects, actions, and options visible. The user should not have to remember information from one part of the dialogue to another. Instructions for use of the system should be visible or easily retrievable whenever appropriate.

### Your findings:

## Flexibility and efficiency of use

Accelerators -- unseen by the novice user -- may often speed up the interaction for the expert user such that the system can cater to both inexperienced and experienced users. Allow users to tailor frequent actions.

### Your findings:

## Aesthetic and minimalist design

Dialogues should not contain information which is irrelevant or rarely needed. Every extra unit of information in a dialogue competes with the relevant units of information and diminishes their relative visibility.

### Your findings:

## Help users recognize, diagnose, and recover from errors

Error messages should be expressed in plain language (no codes), precisely indicate the problem, and constructively suggest a solution.

### Your findings:

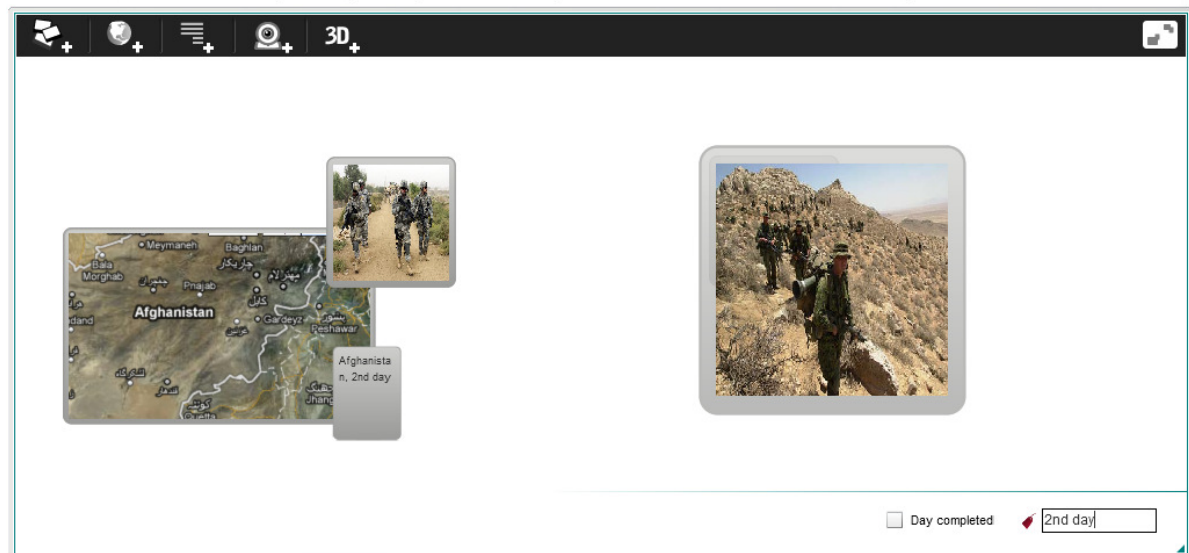
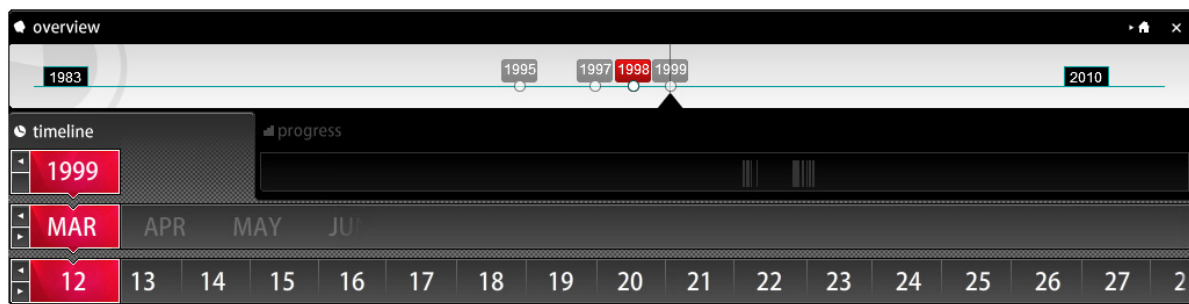
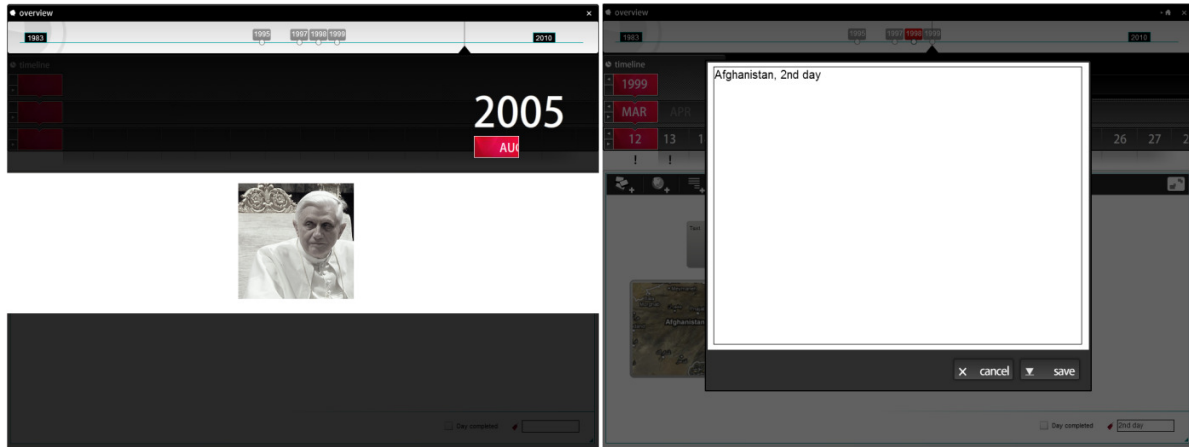
## Help and documentation

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation. Any such information should be easy to search, focused on the user's task, list concrete steps to be carried out, and not be too large.

### Your findings:

# Appendix E

## Screenshots final prototype



## Appendix F

### XML save data examples

#### Profiles XML

```
<?xml version="1.0" encoding="utf-8" ?>
- <PROFILES name="Persoon" preference="1" dob="1983">
  <THERAPY startyear="2010" startmonth="1" endyear="2011" endmonth="12" />
  <YEARIMG id="2009" image="/yearimg/2009.png" />
  <YEARIMG id="2008" image="/yearimg/2008.png" />
  <YEARIMG id="2007" image="/yearimg/2007.png" />
  <YEARIMG id="2006" image="/yearimg/2006.png" />
  <YEARIMG id="2005" image="/yearimg/2005.png" />
  <YEARIMG id="2004" image="/yearimg/2004.png" />
  <YEARIMG id="2003" image="/yearimg/2003.png" />
  <YEARIMG id="2002" image="/yearimg/2002.png" />
  <YEARIMG id="2001" image="/yearimg/2001.png" />
  <YEARIMG id="2000" image="/yearimg/2000.png" />
  <YEARIMG id="1999" image="/yearimg/1999.png" />
  <YEARIMG id="1998" image="/yearimg/1998.png" />
  <YEARIMG id="1997" image="/yearimg/1997.png" />
  <YEARIMG id="1996" image="/yearimg/1996.png" />
  <YEARIMG id="1995" image="/yearimg/1995.png" />
  <YEARIMG id="1994" image="/yearimg/1994.png" />
  <YEARIMG id="1993" image="/yearimg/1993.png" />
  <YEARIMG id="1992" image="/yearimg/1992.png" />
  <YEARIMG id="1991" image="/yearimg/1991.png" />
  <YEARIMG id="1990" image="/yearimg/1990.png" />
  <YEARIMG id="1989" image="/yearimg/1989.png" />
  <YEARIMG id="1988" image="/yearimg/1988.png" />
  <DISPATCH startyear="1995" startmonth="1" endyear="1995" endmonth="1" comments="Code of commentaar" image="none" />
  <DISPATCH startyear="1999" startmonth="3" endyear="2000" endmonth="6" comments="Test deployment" image="none" />
  <DISPATCH startyear="1997" startmonth="2" endyear="1998" endmonth="8" comments="DutchBat" image="none" />
  <DISPATCH startyear="1998" startmonth="2" endyear="1999" endmonth="8" comments="DutchBat II" image="none" />
</PROFILES>
```

#### Deployment XML

```
<?xml version="1.0" encoding="utf-8" ?>
- <DISPATCH>
  <DAY nr="34" tag="complete" keyword="" />
  <DAY nr="37" tag="complete" keyword="" />
  <DAY nr="38" tag="incomplete" keyword="" />
  <IMG src="H:\My Documents\willemvanoranje.png" x="193" y="133" status="true" />
</DAY>
- <DAY nr="132" tag="incomplete" keyword="">
  <MAP src="O:\4MR/mappics/1997-132-1.png" x="395" y="142" />
  <TXT tekst="Text" x="68" y="67" />
</DAY>
- <DAY nr="137" tag="incomplete" keyword="">
  <IMG src="H:\My Documents\willemvanoranje2.png" x="194" y="159" status="true" />
</DAY>
- <DAY nr="144" tag="incomplete" keyword="">
  <TXT tekst="Text" x="71" y="76" />
</DAY>
- <DAY nr="146" tag="incomplete" keyword="">
  <TXT tekst="Text" x="128" y="118" />
</DAY>
- <DAY nr="94" tag="incomplete" keyword="">
  <TXT tekst="Text" x="26" y="53" />
</DAY>
- <DAY nr="84" tag="complete" keyword="" />
  <DAY nr="90" tag="complete" keyword="" />
- <DAY nr="83" tag="incomplete" keyword="Friend wounded">
  <IMG src="D:\mvandensteen\Desktop\large_368988.jpg" x="557" y="66" status="true" />
  <IMG src="D:\mvandensteen\Desktop\53384-a.jpg" x="651" y="144" status="true" />
  <IMG src="D:\mvandensteen\Desktop\militairenw.jpg" x="457" y="276" status="false" />
  <IMG src="D:\mvandensteen\Desktop\militairenw.jpg" x="389" y="218" status="true" />
  <TXT tekst="We were going to the nearest village, afterwards..." x="748" y="92" />
  <TXT tekst="Earlier that day..." x="191" y="171" />
  <MAP src="O:\4MR/mappics/1997-83-7.png" x="23" y="34" />
</DAY>
</DISPATCH>
```

## Appendix G

### Questionnaires

#### Component-based questionnaire used for the usability evaluation

If you have completed all the tasks from table 1, you should be able to fill out the questionnaire below. Please rate the likelihood of each statement by putting a cross in the one of the appropriate boxes (1-7). The usability evaluation is concerned with the three user interface components: (1) timeline navigation, (2) content manager (media elements and placement) and (3) the 3D editor.

Statement	Unlikely				Likely		
	1 extremely	2 quite	3 slightly	4 neither	5 slightly	6 quite	7 extremely
Learning to operate the timeline navigation would be easy for me.							
I would find it easy to get the timeline navigation to do what I want it to do.							
My interaction with the timeline navigation would be clear and understandable.							
I would find the timeline navigation to be flexible to interact with.							
It would be easy for me to become skilful at using the timeline navigation.							
I would find the timeline navigation easy to use.							

Comments

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Statement	Unlikely				Likely		
	1 extremely	2 quite	3 slightly	4 neither	5 slightly	6 quite	7 extremely
Learning to operate the content manager would be easy for me.							
I would find it easy to get the content manager to do what I want it to do.							
My interaction with the content manager would be clear and understandable.							
I would find the content manager to be flexible to interact with.							
It would be easy for me to become skilful at using the content manager.							
I would find the content manager easy to use.							

Comments

---

Unlikely

Likely

Statement	1	2	3	4	5	6	7
	extremely	quite	slightly	neither	slightly	quite	extremely
Learning to operate the 3D editor would be easy for me.							
I would find it easy to get the 3D editor to do what I want it to do.							
My interaction with the 3D editor would be clear and understandable.							
I would find the 3D editor to be flexible to interact with.							
It would be easy for me to become skilful at using the 3D editor.							
I would find the 3D editor easy to use.							

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 Comments
 

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### Questionnaire used for the storytelling evaluation

Unlikely

Likely

Statement	1	2	3	4	5	6	7
	extremely	quite	slightly	neither	slightly	quite	extremely
I prefer a timeline, such as the one in the application, to tell my story.							
I found the story telling with the application more enjoyable							
I was able to tell everything I wanted (story telling <b>without</b> the application)							
I was able to tell everything I wanted (story telling <b>with</b> the application)							
I put more details in the story told with the application							
By using the application, I was encouraged to add media such as text, maps or webcam pictures to explain things better.							
I found that more memories came back with the application							

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 Comments
 

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