Usability and Presence in
Virtual Reality Exposure Therapy for Fear of Flying

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Lucy Trianawaty Gunawan (1113097)

Master programme Media & Knowledge Engineering
Delft University of Technology

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Supervisor:
Dr.ir. C.A.P.G. van der Mast

Graduation Committee:
Prof. dr. M. A. Neerincx, Delft University of Technology
Dr.ir. C.A.P.G. van der Mast, Delft University of Technology, Supervisor
Prof. dr. P.M.G. Emmelkamp, University of Amsterdam
Drs. L.J. van Gerwen, VALK Foundation
Drs. dr. L.J.M. Rothkrantz, Delft University of Technology
Dr. J.M. Schuemie, Erasmus University Rotterdam.

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1 Introduction

As a relatively new technology, virtual reality is intensively being improved over the years. A vast number of applications have been developed based on this particular technology in many different fields of life. Most of its early applications have been for entertainment purposes only, such as those implemented in creating Virtual Reality games. Recent researches, though, have proved that virtual reality technology can be implemented in more useful applications to improve quality of life. One of them is in clinical therapy. The implementation of virtual reality in clinical therapy has brought many advantages that traditional way of clinical therapy could not offer. Thus, understanding how this immersed virtual reality can support clinical therapy is very challenging.

One of the virtual reality projects in Delft University of Technology is virtual reality exposure therapy for treating fear of flying (Schuemie, 2003). This project is collaboration between two different disciplines, Psychology and Human Computer Interaction (HCI), by Delft University of Technology, University of Amsterdam, and VALK (Vlieg Angstbestrijding Leidse universiteit KLM) foundation in Leiden. Being a technical university, the department of HCI of Delft University of Technology is in charge in the technical part for this project, makes the VR system for exposure therapy possible to be implemented. University of Amsterdam (UvA) and VALK give information and techniques from therapist's and psychological point of view as input to the system. This system was implemented successfully during therapy sessions in Delft and Amsterdam. Several years after its implementation, feedbacks were collected and improvements to the system are urged to be undertaken. This thesis is based on this particular issue.

In the following sub-chapters, some terms will be introduced to give an overview of our project.

1.1 Virtual Reality

Ivan Sutherland defines *virtual world* as, "The ultimate display would be a room within computer can control the existence of matter. A chair displayed in such a room would be good enough to sit in. Handcuffs displayed in such a room would be confining, and a bullet displayed in such a room would be fatal. With appropriate programming such a display could literally be the wonderland in which Alice walked" (Harrison, et. al., 1996)

The term virtual reality (VR) was first coined by Jaron Lanier in 1989 (Bryson, 2003), to give a response to another term "Virtual World" by Ivan Sutherland, the father of computer graphics or even the father of this new technology.

Bryson (1993) defines *virtual reality* as the use of computer technology to create the effect of an interactive three-dimensional world in which the objects have a sense of spatial presence. According to Bryson, the word "computer technology" is required to distinguish VR from telepresence and other remote sensing approaches. This requirement is driven by the desire to use computer programs to create interesting and novel tailor-made environments. "Effect" is used rather than "illusion" because it is a cognitive effect that is achieved rather than illusion, this also undercuts the presumption of fooling the user. "Three-dimensional world" is used to exclude text-based environments and to turn discussion away from 1D and 2D programs. "Objects have a sense of spatial presence" means that the objects seem to have a spatial location independent of both the user and the display technology.

According to Lanier, the difference between virtual reality and virtual world was that in virtual reality there could be a number of people involved at the same time instead of the just you and the world. There would be a shared world.

Merriam-Webster Dictionary (2003) defines *virtual* as “being such in essence or effect though not formally recognized or admitted”, *reality* as “the quality or state of being real”, and *real* as “the property of having concrete existence”. Putting those together, *virtual reality* means to have the effect of having concrete existence without actually having concrete existence.

Merriam-Webster Dictionary (2003) defines *virtual reality* as an artificial environment which is experienced through sensory stimuli (as sights and sounds) provided by a computer and in which one’s actions partially determine what happens in the environment.

Harrison et. al. (1996) defines a useful definition for virtual reality. *Virtual reality* is the delivery to human of the most convincing illusion possible that he is in another reality. However, this is the “ideal dream”, the limitation of hardware and software makes the definition lower in implementation phase.

Sherman et. al. (2003) defines *virtual reality* as a medium composed of interactive computer simulations that sees the participant’s position and actions and replaces or augments the feedback to one or more senses, giving the feeling of being mentally immersed or present in the simulation (a virtual world).

Schuemie (2003) defines *virtual environment* as the use of computers, displays and sensors to create the illusion that the user is in another environment than the real one.

From these definitions can be concluded that they overlap each other. The main points of these definitions are “being real”, “using computer”, “another world”, and “sensory stimuli”. As a summary, virtual reality can be defined as the use of computer technologies to create an imitation of three-dimensional environments from the real world, which give the feeling that the user is in another world.

1.2 Fear of Flying

Flying is considered to be one of the safest public ways of transportation in the world because of its relatively small number of accidents occurring in aviation. Anyone flying realizes that there will be a chance of accident whenever they use manmade “flying machine”. It is because humans were not designed like birds to fly. Some people have to confront the deepest fear of this human vulnerability.

1.2.1 Definition

The “fear of flying”, aerophobia (also known as *aviophobia*) is a specific phobia, a kind of anxiety disorders. It is also one of the hardest phobias to cure. As anxiety, the fear of flying is more concerned with what might happen, than with what actually is happening. It triggers a reaction in the body that causes the person to feel threatened.

1.2.2 Causes of “Fear of Flying”

Richmond (2003) describes fear of flying to have many causes and components, such as anxieties about heights, enclosed spaces, crowded conditions, sitting in hot – stale air, being required to wait passively, not understanding the reason behind all the strange actions, sounds, and sensations that are occurring around, being worried of the danger of turbulence,

being safety dependent on unknown mechanical things, being dependent on an unknown pilot's judgment, not feeling in "control", and the possibility of terrorism.
The experience of a past trauma or accident or an unpleasant flight experiences are also considered as major causes of fear of flying (Wilhelm and Roth, 1997). Listening to other people stories and problems can affect the mind, and ones can start imagining the same experience will happen (vicarious learning) to them. If the mind is repeatedly imagining a traumatic event, the body will react, and anxiety feeling will appear. In most cases, people develop such an intense feeling of fear and distress. This feeling become overwhelming so that they want to avoid the situation completely.
The fear of flying is not really about the risk in aviation. It is based on the uncomfortable awareness that life is fragile and vulnerable, and that none of us has any real control over it, whether in the air or on the ground.

1.2.3 Symptoms

In general, people who have fear of flying show two basic kinds of symptoms (Richmond, 2003), physiological reactions and psychological symptoms. Some of psychological reactions that trigger fear and stress are muscle tension, tremors, heavy, labored breathing, heart palpitations, chest pain, abdominal and intestinal discomfort, sweating, weakness, dizziness, prickly sensations, dry mouth and flushed pale face. Psychological symptoms can be in forms of impaired memory, narrowed perceptions, poor or clouded judgment, negative life expectancy and preservative thinking.

1.2.4 Treatment for "Fear of Flying"

There are several forms of treatments for the fear of flying (Richmond, 2003). One might simply need factual information about flight and flight safety principles, such as turbulence. If simple information is not enough, one might treat the fear of flying by eliminating all negative thinking or by learning a relaxation technique. If a basic symptomatic treatment is not sufficient, then one should try to explore the psychodynamic aspects of the anxiety. A clinical approach, self-help treatment, consulting with a psychologist for phobia treatment or spiritual healing can be considered for treatments of this phobia.
There are also group programs (run in conjunction with airlines), individual treatment, clinics that offer therapy and hypnosis, and courses by mail. Most of these programs have similar theory and treatment processes. These include explanations of airplane mechanics, stress management, deep breathing exercises, and other relaxation techniques.
One example of this clinical therapy is performed in VALK foundation, Leiden, the Netherlands in collaboration with University of Leiden and KLM. The therapy includes several stages; diagnostic stage, training program that includes training in Leiden (inside the clinic), training in Schiphol (in the airport) and a follow up program (VALK, 2003). What makes it difficult for fear of flying treatment is there might be some fears which appears on the same time and confronting each other. Repeated practices will be needed but costly.

1.3 Virtual Reality Exposure Therapy

Decreasing the level of anxiety can treat phobias. Traditionally by presenting the patient with actual physical situation (In Vivo) or by letting the patient imagine the stimulus (In Vitro). As a third option (Schuemie, 2003), there is Virtual Reality Exposure Therapy (VRET). In VRET, the virtual environment is displayed in such a fearful situation using Head-Mounted

Display (HMD). The patient can see computer simulation inside the aircraft; they can look outside through the window. The therapist collaborates with the patient to experience and to be familiar with the synthetic environment during therapy, in which more and more fearful situation will be experienced. The patient travels through flying sequences such as taking off, flying with bad weather and landing. This system provides two user interfaces (UI): one for the patient and one for the therapist. The UI for the patient is the VE immersed to the patient, therefore it is necessary for the patient to have the feeling of being immersed and a sense of presence, to experience the similar emotional response as In Vivo therapy. The therapist controls the VE exposed to the patient using therapist's UI.
This technique has also proved as an effective tool to combat fear of flying (Rothbaum, et. al, 2000). Some researches have been done to support this new technology in therapy world. They are mainly to make this technique works better and more efficient, to produce a cheaper and an easier system to make and to maintain.

1.3.1 The advantages and disadvantages using VRET

There may be advantages using VRET than Standard Exposure (SE) In Vivo. SE is more costly because it usually requires leaving the therapist's office, to go to the exposure place, for example, airport, high building, etc and back to the therapist's office. VRET can do the same exposure without leaving the therapist's office and in less time than that required when doing SE. SE is also more expensive because the therapist needs to arrange a real condition that involves real airplane at the airport, flying it up, etc. This kind of arrangement has its limitation like only one take-off and landing per flight. VRET, on the other hand, allows the therapist to control situations according to the patient's need (for example: good or bad weather can be arranged, how many flights per session are also possible). Logs of patient's progress are neatly stored in databases. Therapist can then review these logs as needed and replay them according to patient's need. This shows how VRET is an effective means of saving both therapist's and patient's time, and keeping everything in the privacy of only concerned parties. VRET also helps a patient having problem to re-experience the traumatic memories. Another advantage from VRET is the possibility to standardize therapy methods, techniques and skills. In the near future will be possible for a remote therapy by using good internet connection.
VRET is not perfect and it does come with its own disadvantages. Visually, VE is still far from looking like a real world. VE visualizations are still in cartoon shapes and are not realistic. Complexity of VE creation is also one of the technical difficulties (Huang, 1998). Objects and shapes need to be defined in three dimensions using 3D modeling software before orientation and mapping can be constructed. Heavy programming is needed to make these models to interact appropriately. Equipments used in VE creation have limited capabilities and equipment failures, especially HDM device, it is not unusual. But all of these technical difficulties soon will be solved with rapidly growing technological development. Visual stress and motion sickness are reported as side effects of using immersed VR.

1.4 Usability

According to Rosson and Carroll (2002), the emergence of usability is the quality of a system with respect to ease of learning, ease of use, and user satisfaction. The three distinct perspectives: human performance, learning and cognition, and collaborative activity, have contributed to modern views of usability. These three perspectives emerge at different points in time, they are not independent, and their relation is not one of succession. Rather they are complementary, pointing to the increasing richness of the general concept. *Figure 1.1* shows the three perspectives contributing to the general concept of usability.

The ISO definition of usability (ISO 9241) as quoted by Schuemie (2003) is the effectiveness, efficiency and satisfaction with which specified users achieve specified goals in particular environments. Effectiveness is defined as the accuracy and completeness with which users achieve specified task and efficiency, the resource expended in relation to the accuracy and completeness with which users achieve goals. Satisfaction is a subjective measure and concerns the comfort and acceptability of use by end users.

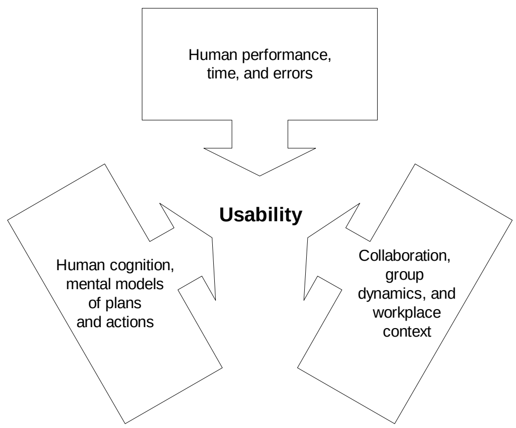


Figure 1.1: *Three perspectives contributing to the general concept of usability*

Nielsen (1993) defines the usability associated with this five usability attributes:

- Learnability: The system should be easy to learn so the user can rapidly start getting some work done with the system.
- Efficiency: The system should be efficient to use, so once the user has learned the system, a high level of productivity is possible.
- Memorability: The system should be easy to remember, so the casual user is able to return to the system after some period of not having used it, without having to learn everything all over again.
- Errors: The system should have a low error rate, so the user makes few errors during the use of the system, and so if they do make errors they can easily recover from them. Further, catastrophic errors must not occur.
- Satisfaction: The system should be pleasant to use, so the users are subjectively satisfied when using it; they like it.

The comparison of these usability definitions can be seen in *table 1.1*.

Rosson & Carroll	***ISO 9241***	***Nielsen***
Ease of Use	Efficiency	Efficiency
Ease of Learn		Learnability
		Memorability
	Effectiveness	Errors/Safety
User satisfaction	Satisfaction	Satisfaction

Table 1.1: *Usability as in (Rosson & Carrol,2002), (ISO 9241) and (Nielsen, 1993)*

The usability aspect defined by Rosson and Carroll provides a modern usability view that we used in this thesis.

1.5 Presence

The term presence has been defined to describes the sense of being in a virtual world, presence indicates the level to which human respond to a virtual environment as if it were

real (Schuemie, 2003). Schuemie also described that presence gives the illusion of being in a different place than the real world; of simulating another environment that is possibly similar to real environments but has the advantages of not being similar in certain respects such as the danger, costs or scale of the environment that is simulated.
According to Laurel (1991) in presence we can see things in virtual scenes as if these were real and the computer system no longer only supplies the user with information; but it also gives the user an experience.

1.6 Research goal

As the foundation research about VRET for clinical psychology, the system designed by Schuemie (2003) has its simple and basic characteristic. In other words, we can say that the system is good enough to run and to work with, but there are several aspects, which needed to be improved to support therapy more easily and efficiently. Thus, we formulate this research thesis goal as follows:

Improve and evaluate the usability and presence of Virtual Reality Exposure Therapy system for fear of flying treatment at Delft University of Technology.

In this research we will focus more to the usability problem of the therapist than on the presence of the patient, the preliminary study during our research assignment (Gunawan, 2003) proved that improving the hardware and software that we have right now as overall can solve the inside quality of the world for the patient.

1.7 Thesis outline

In this chapter, we have introduced important terms used in this thesis, the defining purpose is to make definitions of the terms clear and not overlapping each other. The research goal is also formulated and described. Thus, this goal will outline this thesis.
The second chapter introduces our research approaches, both design and evaluation methods.
In the third chapter, the analysis and design of the system are described. The background analysis that was conducted before, and the new requirement and design overview of the new system are presented.
In the forth chapter, we will discuss the detail evaluation for the Patient’s and Therapist’s UI. The conducted experiments detail, the result of experiments and the evaluation analysis will be reported in sequentially.
At last, Conclusion is drawn in chapter five.

2 Methodology

System development is an iterative process that might never end; a system can be improved continuously until it meets its satisfaction level. As we intend to improve our current VR system, at first we have to evaluate it to find out what kinds of improvements are needed. We adapt the usability evaluation model proposed by Scriven (1967) quoted by (Rosson & Carroll, 2002), as our research methodology. The model is distinguished between formative and summative evaluations, as shown in *figure 2.1*. The goals of formative evaluation are to identify the design aspects that can be improved, to set priorities, and to provide guidance in how to make changes to a design. This evaluation is usually conducted during the design process. The summative evaluation goals are to measure quality; to evaluate a design result whether the system has met its usability objectives and it is conducted at the end of development process. This model can be seen as iterative process that the current system can be evaluated as if it still in the design process, although it was finished before.

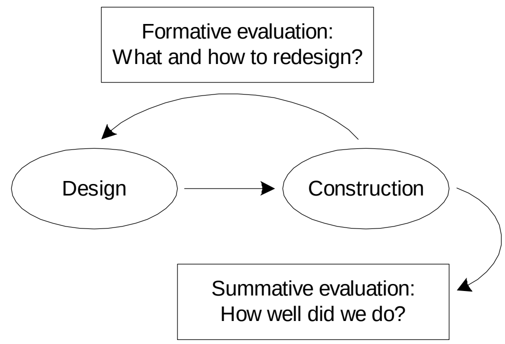


Figure 2.1: *Formative and summative evaluation. (Rosson & Carroll, 2002)*

We add the analysis process to complete our methodology model. The analysis process had some inputs such as task analysis of the current system, new requirements gathered by interviewing the users, evaluation result of the current system and some suggestions from the previous researcher. *Figure 2.2* shows our complete thesis methodology.

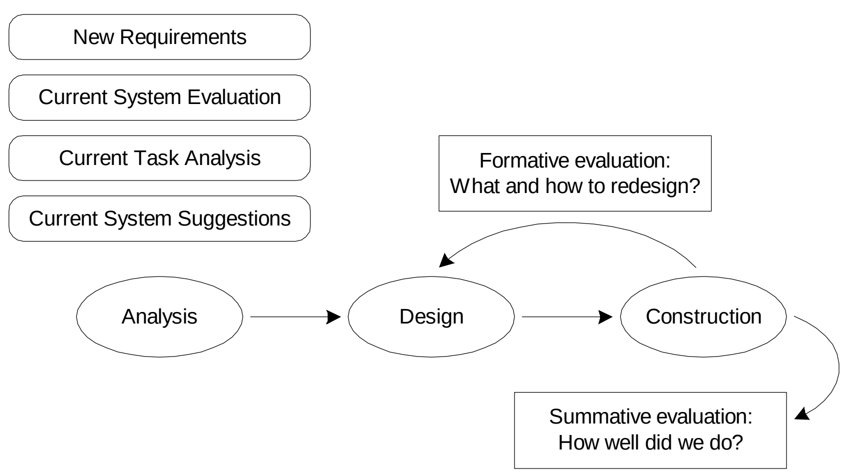


Figure 2.2: *Methodology in this thesis*

The development process of our project is divided into two parts, the patient's UI and the therapist's UI. The approach, design, construction and evaluation for these UI are different. The patient's UI, the patient is immersed to the VE, thus the sense of presence or the sense of being in another world is needed. In the contrary, the therapist's UI does not need the immersion and sense of presence. The therapist's UI is designed to control the VE experienced by the patient and provide information of the therapy session. We then applied improvements to the system and re-evaluate the system again to verify that changes made really reflect on what are expected.

2.1 Analysis & Design

Based on the new requirements gathered through the current user of the system, we started to do the analysis phase. Other inputs for this analysis phase were the old system task analysis, the suggestions given from the author of the system, and the evaluation conducted by us. We also conducted research in software and hardware used to find out the capability and limitation of our resources. Based on our analysis, a new design was proposed to enhance the richness of the VRET system.

In order to design the patient's UI, we took into account the guidelines for VRET design proposed by Schuemie (2003) and general step in VE design by Kaur (1998) as interpreted by Schuemie (2003). For re-designing the patient's UI, most of the time was spent to enhance the environment with texture, lighting, sound, interactivity within our system's limitations. User interface for the therapist was created from scratch, and we took into account Human and Computer Interaction principals to ensure the usability of the system. The history of the intermediate designs can be seen in Appendix B: Design Documents.

2.2 Construction / Implementation

The patient's UI is constructed using VR WorldUp 4 from Sense8, an object-oriented software development tools for building VR applications. Visual Basic syntax is provided in this software as a tool for scripting. We used WorldUp Modeler to modify and render the VE objects. Textures were designed and modified by Photoshop 7, sound effects editing by Cool Edit 2000 and avatars was created using Poser 4.

The therapist's UI is implemented using Delphi 5, an event-driven software development from Borland. We used Microsoft Access Database to support the therapist's UI and Crystal Report 8.5 to design the report feature.

2.3 Evaluation

The basic evaluation criterion of our system is to test whether the new system completely works, the VE for the patient, the therapist's UI and the communication between them. Formative evaluation was done whenever an intermediate design was achieved by asking the user's opinion or asking the user to think aloud about the new intermediate design. At the end of the development process, we conducted summative evaluation to check whether all improvements done met its requirements. The summative evaluation was made by conducting therapy session experiments. We conducted sixteen experiments with sixteen pairs of patient and therapist (32 participants). In each experiment, we conducted two therapy sessions, using the old system and the new system with randomly order. During the therapy session, the therapist controlled the VE using therapist's UI and exposed the patient gradually to the flying sequences in VE. Two groups of questionnaire were designed for evaluating the usability of therapist's UI and the presence in patient's UI. Microsoft Excel and SPSS 10 supported analyses of evaluation results.

2.3.1 Usability Evaluation

The evaluation of the therapist's UI is measured in the term of usability. A usability evaluation is an analysis or empirical study of the usability of a system and the goal is to give some feedback in software development, supporting and iterative development process (Rosson & Carroll 1985).
Scriven (1967) as quoted by (Rosson & Carroll, 2002) described two classes or evaluation methods, analytical and empirical. Empirical methods involve study of actual users, can be observing people while they explore the system, study of performance times and error rate or survey of users. The analytical method identifies significant features in a design and generates hypothesis about the consequences. Usability inspection using guidelines is one of the examples of this method. The proposed method is a mix between analytical and empirical method, called *mediated evaluation*: where analytic evaluation is done early and during the design process, the result of this analyzes is used to motivate and develop materials for empirical evaluations.

Analytical method: Guidelines and principles

The goal of usability inspection using guidelines is to find the usability potential problem in a user interface design during the design process. Nielsen (1993) described heuristic evaluation as an inspection method, ten general guidelines are listed as follow: simple and natural dialogue, speak the user's language, minimize user memory load, consistency, feedback, clearly marked exits, shortcuts, good error messages, prevent errors, help and documentation. Heuristic evaluation is conducted by inspecting interface and trying to evaluate which one is bad and which one is good. This analytical method with inspecting guidelines is done during the design of the therapist's UI. The user evaluates the intermediate design and gives some feedbacks to improve it again.

Empirical method: User evaluation

By user evaluation, the users tested the system directly. Some tasks were given to the users to complete. Information was gathered, such as observation note, performance time, errors and subjective evaluation. Subjective information was acquired by using usability questionnaires and interviews. We chose to use empirical method of user evaluation by conducting experiments

The analysis for usability analytical and empirical evaluation results used ANOVA repeated measure with Cronbach's alpha for its reliability consistency measure.

2.3.2 Presence Evaluation

To see evidence of improvements to our system, we evaluate patient's UI by means of term of presence whether it is an improvement. We chose subjective measures by questionnaires, as the most common method, to evaluate our recent system. Questionnaires were given to the patient after or/and before the each session.

Igroup Presence Questionnaire

To measure presence in this research, we used the Igroup Presence Questionnaire (IPQ) developed by Schubert (Schubert et al., 1997). According to Schubert, the sense of presence is the subjective sense of being in a virtual environment; it is a user's experience, so the measurement will be obtained from subjective rating scales.

The IPQ project is an ongoing project that started in 1997. It was constructed using a large pool of items and two survey waves with approximately five hundred participants.

The IPQ version we used in this research has three subscales and one additional general item not belonging to a subscale. The three subscales can be regarded as fairly independent factors. They are:

1. Spatial Presence (SP) – the sense of being physically present in the VE;
2. Involvement (INV) – measuring the attention devoted to the VE and the involvement experienced;
3. Experienced Realism (REAL) – measuring the subjective experience of realism in the VE.

The additional general item assesses the general "sense of being there", and has high loadings on all three factors, with an especially strong loading on Spatial Presence.

There are fourteen items in this questionnaire, comprising:

- SP (SP1, SP2, SP3, SP4, SP5) – five items
- INV (INV1, INV2, INV3, INV4) - four items
- REAL (REAL1, REAL2, REAL3, REAL4) – four items
- G (G1) – one item

All items have a range from zero to six. The left end point of the scale is always zero, and the right endpoint is always six. There are three items that need to be reversed, because these three items use reversed wordings, they are SP2, INV3 and REAL1.

To compare the results between systems, the old system and new improved system, the results from this questionnaire were analyzed using Analysis of Variance (ANOVA) repeated measure. The ANOVA repeated measure was chosen because the same participant took part in each condition. In our case, the participant tried both the old and new systems we wanted to compare. The ANOVA repeated measure allows comparison of the variance caused by the independent variable to more accurate error terms by removing the variance caused by differences in individuals. It increases the power of the analysis, thus fewer participants were needed to have adequate power. The Reliability analysis was conducted in the term of Cronbach's alpha. Cronbach alpha is one of the most commonly reported reliability estimates in the language testing literature. The purpose of a reliability analysis is to determine how consistently the variables measure some construct. It range from 00.0 (if no variance is consistent) to 1.00 (if all variance is consistent). For example, if the Cronbach alpha for a set of scores turns out to be 0.90, we can interpret that as meaning that the test is 90% reliable, and by extension that it is 10% unreliable.

SAM Questionnaire

The sense of presence can be measured by emotional changes after some stimuli are exposed. The measurement of emotion in our research was conducted by using SAM Questionnaire. SAM stands for the Self-Assessment Manikin, a picture based scale, which is used to measure a person's feeling or emotional response. This subjective measurement was developed by Lang (Bradley & Lang, 1994). It is designed to represent the Pleasure (P), Arousal (A) and Dominance (D) with a graphic character arranged on a linear nine-point scale. *Figure 2.3* shows the SAM questionnaire. The first line goes from a very Big Smile to a very Big Frown. This line represents feelings that range from completely happy or elated to completely unhappy or sad. The second line of SAM represents feelings that range from very excited or involved to very calm or bored. The third line represents feelings that range from being controlled to be being taken care of or being in-control or on top of things (large figure). By using this questionnaire, we are interested in find changes of emotional feeling before and after therapy sessions (stimuli).

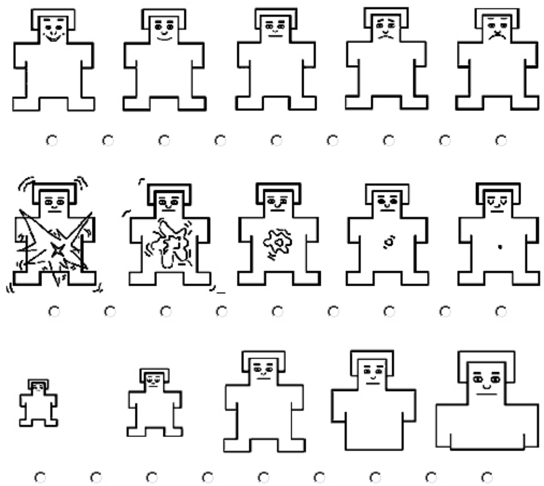


Figure 2.3: *SAM Questionnaire*

The analysis for SAM questionnaire results use ANOVA repeated measure with Cronbach's alpha for its reliability consistency measure.

2.4 Conclusion

Generally, we used software engineering development methods such as analysis, design, implementation and evaluation principals. In analysis phase, we conducted interviews and survey in order to find features that need to be implemented in the system. Then we would ignore features that could not be implemented on our development machine.

In the design phase, we designed two kinds of UI, the virtual world for the patient and the user interface control for the therapist. We took into account the guidelines in HCI, VR and VRET design. The detail of this phase will be explained in chapter 3.

In the implementation phase, for the patient's UI, textures were designed or modified, sound effects were recorded and new features were added by using our software development tools. For the therapist's UI new user interface was implemented.

At last, two kinds of evaluations were designed, for the usability of therapist's UI and for the presence of patient's UI. The conducted evaluation will be explained in chapter 4.

3 Analysis and Design

3.1 Analysis

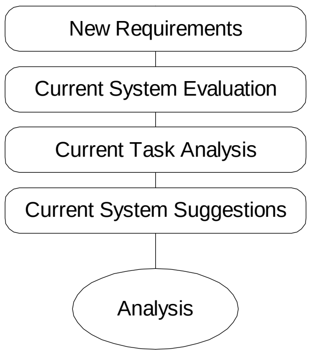


Figure 3.1: *The analysis phase*

The new requirements were gathered from interviewing the current and the potential users of the system, these users are the therapists from UvA and VALK foundation. The current system evaluation was done from reading materials, trying the program by ourselves and trying to think-aloud, studying the current system structure and the way it works, readings the system manual, etc. The task analysis was done by Schuemie (2003), because it is a continuation of his work, we referred to his task analysis done before. By the end of his research, he gave some suggestions to the next research, he also showed the weaknesses of the current system. *Figure 3.1* shows the analysis phase with its inputs. Based on these inputs we analyzed what kind of improvement we can propose.

3.1.1 New Requirements

After some interviews with the therapists, P. Emmelkamp, M. Krijn, R. Olafsson from UvA and L. van Gerwen from VALK foundation, new requirements are collected. At least four interview sessions have taken place both in Amsterdam and in Leiden since September 2001. The new requirements are summarized as follow:

- Flying schedules to some different locations is not just Milan, with other voices and different instructions. Therapies need variation. When done repeatedly, with the same environment, the patients were likely to get bored and not afraid anymore;
- The possibility for the therapist to slightly turning the airplane to the right or left when flying so the patient can see better down to the earth. The purpose of this new functionality is to make the virtual flying more realistic. When doing the turn, patients can have different views from outside the window. Turns are needed during the climbing, during the level flight and during decent flight. A patient who has flying phobia usually has fear of height too. By rolling the airplane slightly, patients are given more fearful condition;
- Better quality of pictures: clouds, people, the wing of the airplane. Another example is during a bad weather, adding more lightning and turbulence effects can give a more realistic feeling and view of a bad weather condition;
- The possibility for the therapist to turn the lights off/dim them in the cabin;
- The possibility for the therapist to create night condition for flying;
- Special sound effect for flying needs to be improved, landing gear sound, flap wings sound, turbulence, lightning and turbulence;
- Different weather conditions during taking off, flying and landing, such as rainy, sunny, snowy;

- Possibility to land with different conditions, cross during and before landing;
- Easier and friendlier therapist's UI.

3.1.2 Current System Evaluation

By trying often to use the system, we know the ability and features of the system. We evaluated the ability and limitations of the hardware and software used. We researched and compared the abilities of current hardware and software.

For the patient's UI, we tried to know the structure of the VEs, how it worked and how to do the improvements, but not all improvements could be seen and decided directly from this phase, sometimes we had to try to implement it first than we knew it is possible or not. The analysis, design and implementation phase could work simultaneously.

For the therapist's UI, we tried to think aloud which parts can be improved and how to do that. The therapist's UI was not used efficiently, in one part, there were a big blank gap, and in other part, we found very dense controls and widgets. This might because the UI is used standardized across all VEs. Inappropriate object size used, for example the big text box used as note and tiny SUDs chart visualization. Note was not often used, while the SUDs chart were used by the therapist all the time during therapy. We will discuss the complete evaluation with its design requirements later in chapter 3.3.

3.1.3 Current System Task Analysis

We refer to the previous task analysis (Schuemie, 2003). He formed task model for phobia treatment based on the current In Vivo therapy. In this sub-chapter, we summarize the model as described by Schuemie in section 3.7 of his dissertation. *Figure 3.2* shows the high-level goals or tasks of the therapist. The holy goal of each therapy is to cure the patient. During the exposure, the therapist determines patient's fear by exposing manipulating stimuli to patients, and changing it when needed to adjust patient's fear. The therapist responds to each question the patients might have. This solves any ambiguity patients might have. Responding or answering the patient's question might not have contribution to cure the patient directly, but at least it will facilitate patients in performing their tasks. *Figure 3.3* shows the high-level goals of patient. Patients believe that by following the therapist's instruction, they can get rid of their fear. People with phobias have tendency to avoid fearful situations. This conflicts with therapist's instruction. To resolve ambiguity in therapy, the patient sometimes need to inquire about certain matters.

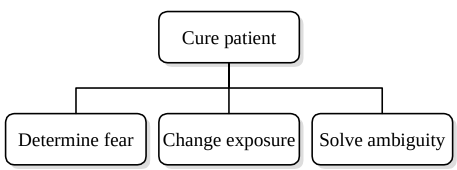


Figure 3.2*: Therapist's goals (Schuemie, 2003)*

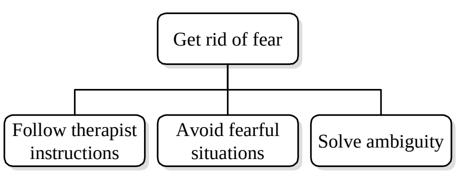


Figure 3.3*: Goals of the patient (Schuemie, 2003)*

The media for communication implemented are as shown in *figure 3.4*. The patient can change his or her viewpoint in VE by changing their body posture, for example: turn the head to the left or right. Therapist can control the VE using therapist's UI (therapist's screen) and manipulating it using keyboard or joystick. Both the system and the therapist can generate sound needed during the therapy that can be heard easily by the patient and therapist. The therapist can directly observe the patient's experience by monitoring the patient's view and posture during the therapy.

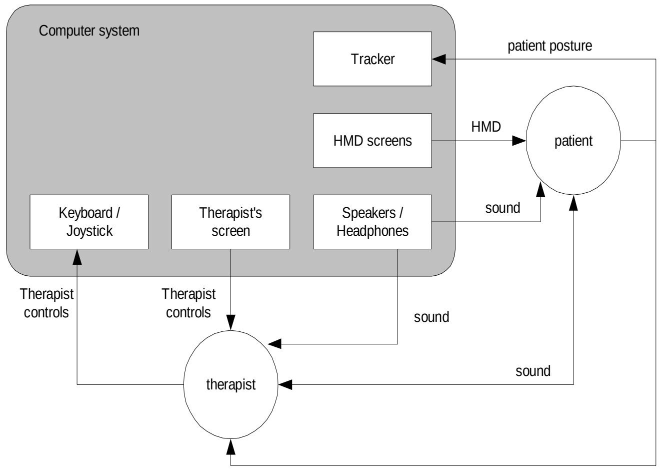


***Figure 3.4**: Overview of the media used for communication (Schuemie, 2003)*

To understand the relation of the high-level goals with media provided, task decomposition was being formed. The task decomposition shows the sub-goals, action taken and media used to achieve its sub-goals. For example, to determine the patient's fear, the therapist asked a patient by using media sound to report his or her fear. The therapist monitors any responses that made by a patient such as sound and movement by media of computer screen or by direct observation to patient's posture. The complete decomposition of these high-level goals to its lower sub-goals can be seen in Appendix A.

By supporting each goal with at least one procedure and supporting each task with at least one high level goal, the functionality of the used system for a phobia treatment application is made sufficient although several tasks are not supported by computer.

It is required to answer the question 'Does the system provide the users with the information they need?' Informational requirement is distinguished state information from procedural information. Complete information requirements gathered from Schuemie (2003) and can be found in appendix A.

3.1.4 Suggestions

According to Schuemie (2003), there are several areas where usability can be improved.

- *Fear determination*
  To determine the patient's fear, therapist uses several information sources such as patient's posture and view that can be monitored using therapist's screen and changing of SUDs score. In most time, therapist depends on the use of SUDs to gain insight into patient's experience. The changing in SUDs has more meaning than its absolute value, because each patient uses his own reference in determining this scale. Thus, the historical SUDs of each patient in a therapy session is needed. With the current system configuration, the therapist memorizes this information during the therapy. A simple opportunity for improving the design of the system is to provide the therapist with cognitive artifacts representing the historical SUD scores, allowing the therapist to work more efficiently.
- *Lack of affordances for the therapist*

Currently, the therapist needs to memorize most procedures for operating the system. Perceivable affordances should be introduced to increase the learnability and memorability of the system.

3.1.5 Challenges

Initially, our formulated goal was to improve the virtual environment for fear of flying. But from our early research, observation and implementation, we discovered that the first formulated goal to wholly improve the VE for fear of flying was difficult because of hardware and software limitations. Our system was rather old while recent hardware and software should be able to overcome our problems partly and easily. With faster and more reliable hardware, we can produce improvements that are more significant. With upgraded software, it will be possible to make VE easier and much more realistic. However, there is no budget for new hardware and software right now. We also had limited time to do this project, even became worse when we changed our goal in the middle of this project. Due to this limitation, we changed our goal to researching and improving the usability of therapist's UI instead. Our system also has minimal system documentation. This leads to time consuming when understanding the technical part of the system. Some survey to Schiphol airport and inside the airplane was needed, to see and experience the real situation, and also to get some pictures and videos. Getting permission for survey of our scale is difficult. We could not get as much information as needed. Most of information that we used was obtained from the Internet. The tools needed to support the projects are minimal in quality and their availability was also an issue. (Digital camera, video recorder and audio recorder)

3.2 The System

Figure 3.5 shows the overview of VR environment in our laboratory. The patient is seated in a real airplane seat equipped with bass amplifier to simulate vibration in the airplane. By wearing the HMD, the patient is immersed in virtual world, enters the computer-generated cabin of virtual airplane and experiences various aspects of flying. The patient is exposed to flying situations such as: sitting in standing still airplane, taxiing on the runaway, taking off, flying in good weather, flying in bad weather and landing. During therapy, therapist can see and hear patient's experience during the virtual flight.

The therapist works most of the time using the therapist's computer where he/she can control the VR world, monitor the patient regularly and check the level of fear experienced by the patient.

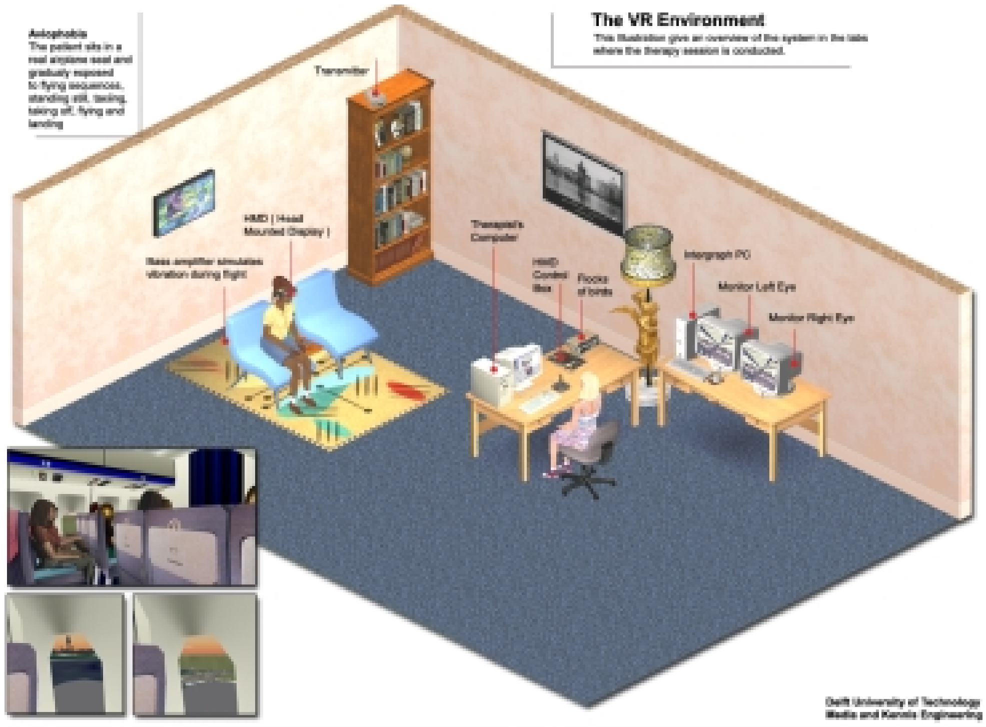


Figure 3.5: *The VR Environment in Delft University of Technology*

Detail hardware specifications and their connections are shown in *figure 3.6*. Martijn Schuemie as his research project in Delft University of Technology built the system in 1999.

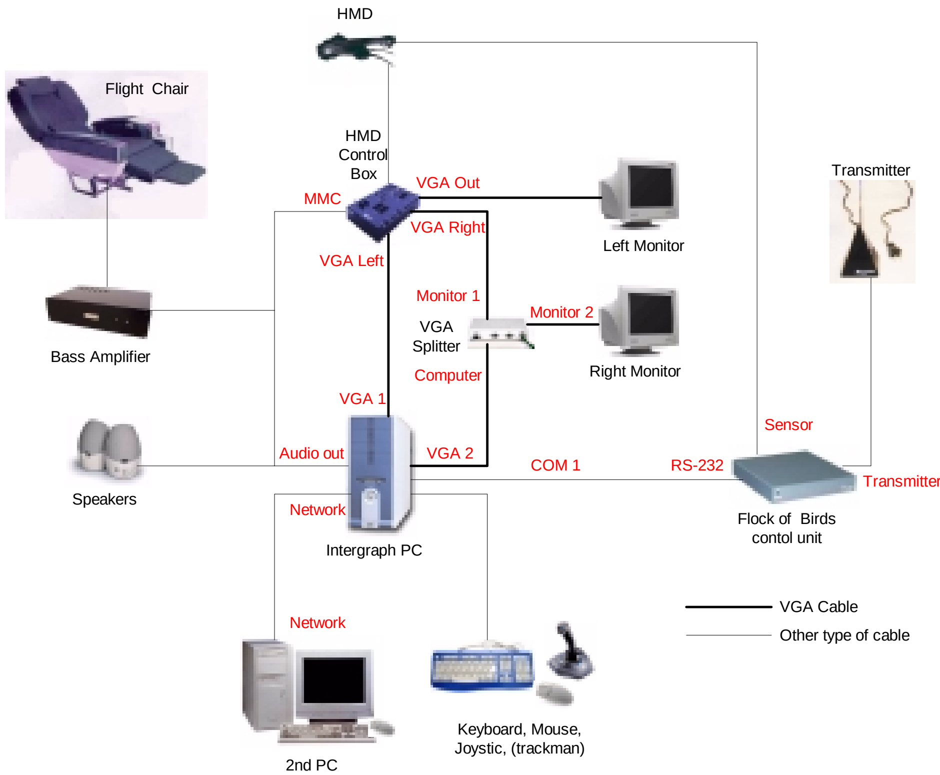


Figure 3.6: *Overview of the components of the system and their connections*

Follows are brief explanations of *figure 3.11*. The type of HMD is Visette Pro, manufactured by Cybermind. It has a remarkably high Field of View (FoV) of about 70 degrees diagonally. It also supports stereoscopy, but the weight is one of its disadvantages. The resolution is quite low, 640 * 480 and RGB as its color element. This HMD requires two standard VGA inputs with resolution of 640 * 480 each using 60 Hz refresh rate. The Flock of Birds (FoB) is the tracking tool for this system. It consists of a transmitter (the large, heavy block) that creates a magnetic field, and a sensor (build in the rear of the HMD) that measures the magnetic field and a control unit that uses the data from the sensor to calculate the translation and rotation, communicated to the computer by using a standard RS-232 serial connection. The airplane seat is a real passenger seat from KLM airplane, custom-build amplifier is put behind the passenger's seat, filtering out low frequency sounds and amplifying these to create the vibrations effect. We used 2 personal computers (PC) in our system, the therapist computer where the therapist controls the therapy session and the Intergraph PC which gets input from HMD and therapist computer. The Intergraph PC is an ordinary Pentium 2 450 MHz PC, 256 Mbyte memory and 3DLabs Oxygen GVX420 graphic card. This card has two VGA outputs and 'GenLocked', meaning that the vertical retrace of both outputs is synchronized, a necessary requirement for most stereoscopic HMDs, including the Visette Pro. The therapist's computer is a Pentium II with 196 Mbyte memories running under Microsoft Windows 98. These two PCs are communicated by standard ethernet network with TCP/IP protocol. The WorldUp R4 is used as VR software package by Sense8, it supports for a wide variety of input and output devices. For extended functionality, such as two-dimensional graphical UI, network communication, database access and complicated computations, Borland Delphi 5 is used to create Dynamic Link Libraries (DLLs) called from WorldUp. An overview of the software used is presented in *figure 3.7*.

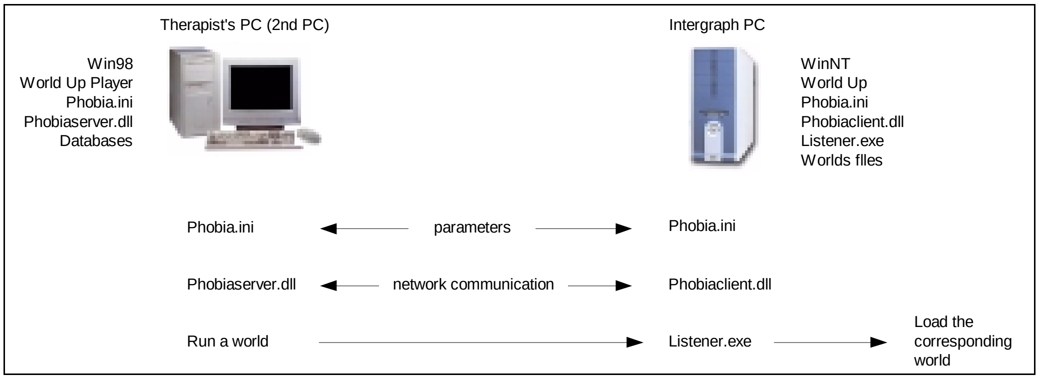


Figure 3.7: *Software specification diagram*

3.3 Design

Though all new requirements urged to be added, some consideration was taken, and we could not implement them all. As we described earlier, our focus is to improve the usability and functionality of therapist's UI. Some improvements to the VE itself have also been done to support the overall functionality and usability of the system. Most of the time was spent on improving the virtual environment, making a new therapist's UI and enhanced it. A new UI for the therapist was designed, some features to the world were added such as: lightning, possibility of flying during different time of the day (morning, day, afternoon, and night), possibility to change the cabin's passenger density, possibility to fly to another destination, possibility to choose the voice of pilot and purser, possibility to roll the airplane during the flight, possibility to dim the cabin's light and the most important one is the feature of database, the possibility to save and print historical data of the patient with its SUDs artifacts. *Table 3.1* shows comparison features of the old and new system.

Feature	***Old System***	***New System***
Destination	Milan	Paris Milan Barcelona
Flying time	Daylight	Morning Day Afternoon Night
Bad weather control	Turbulence	Turbulence Lightning
Landing gear control	✓	✓
Flap wings control	✗	✓
Rolling control	✗	✓
Cabin density control	Few passenger	No passenger

Feature	***Old System***	***New System***
		Few passenger Moderate passenger
Pilot & Purser voice control	✓ (max 2 voices)	✓ (can be added more as needed)
Cabin’s light control	✗	✓
Fasten seatbelt control	✓	✓
Flight view	✗	✓
Window’s control	✓	✓
SUDs recording	✓	✓
Report	✗	✓
Reminding timer for stages	✗	✓
Alarm	✓	✓
Notes	✓	✓
Free view monitor	✓	✓
Patient’s view monitor	✓	✓

Table 3.1 *Feature comparison the old and new system*

3.3.1 Therapist’s User Interface

According to Schuemie (2003), the therapist’s UI is different from the patient’s UI. This is because the therapist does not have to be immersed in the virtual world and does not have to have the sense of presence. What the therapist need is the control and overview of the therapy situation. Since the therapist user interface can be called minimal, some improvement emerged to overcome this issue in the term of its usability. In this research the therapist’s UI become our focus, the improvement in this area get more priority than the improvement of patient’s UI. In this design phase, we keep all the good features in the current system, improve the usability of some controls and add more features that might be useful for the therapist.

Users

The user of the therapist’s UI is the therapist. Therapists used to In Vivo therapy sessions, so they know the sequences of flying and condition of the airplane. They also used to the announcements made by the pilot or the purser. The only thing that has to put into our consideration is the therapist sometimes does not used to use computer. Trainings will be needed for the therapist before using the system.

State Transition Diagrams

Some transition diagram was drawn to show the transition of states in our system. *Figure 3.8* shows the state transition diagram for starting and stopping the simulation. Therapist loads the world and waits until it fully loaded both for therapist’s computer and for VRstation. The can fill in the session information and then start the simulation. During running the simulation, the therapist exposes the patient to the VE. After stopped the simulation, the therapist can print the report session. *Figure 3.9* shows the state transition diagram for cloud transition. It shows all possible transition of clouds. *Figure 3.10* shows the state transition diagram for voice announcement control. *Figure 3.11* shows the state transition diagram for flying sequences.

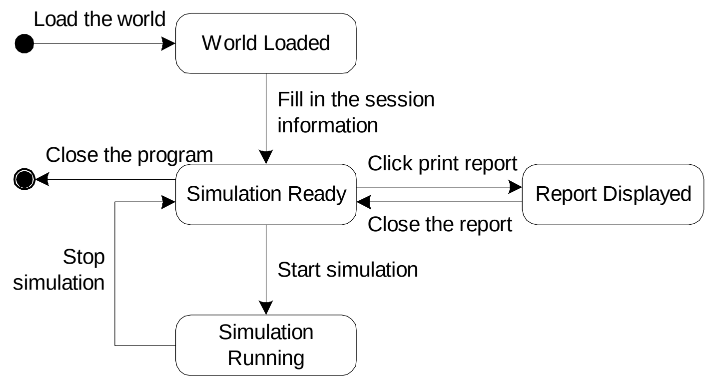


Figure 3.8: *State transition diagram for starting and stopping the simulation*

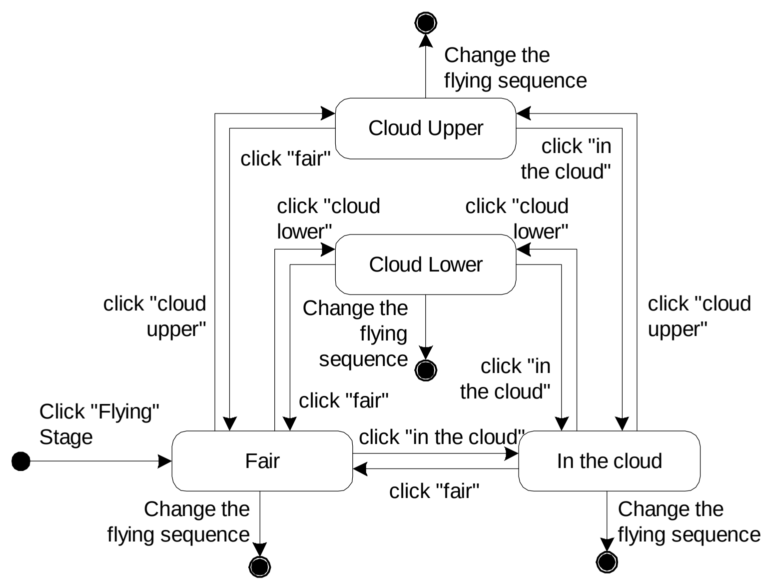


Figure 3.9: *State transition diagram for cloud transition*

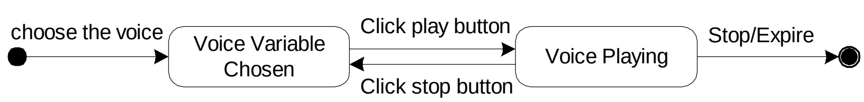


Figure 3.10: *State transition diagram for playing the voice announcement*

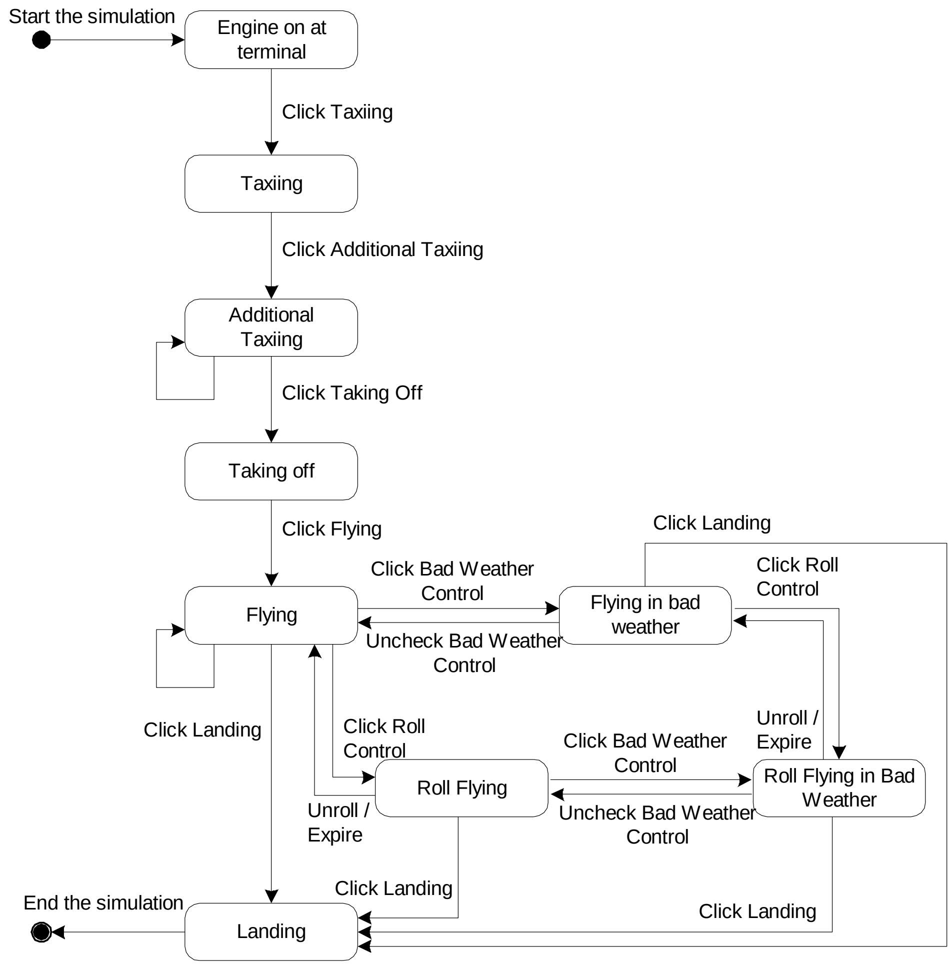


Figure 3.11: *State transition diagram for flying sequences*

Usable Features

The prior research by Schuemie (2003) formulated some guidelines that an extended therapist UI in the shape of a combined 2D – 3D console will increase the usability of the system. These extended UI provides a tool to keep track the patient's fear (SUDs recording) and provides an 'external' viewpoint of the VE with a projection of real world object (Free viewpoint). Therefore, in our new design these three important features are reserved and used. The session time, alarm clock reminder was also kept. We also kept the system status information with modification of its content. Because the new therapist's UI is designed for only the airplane world and we do not redesign it for all other worlds, so the world identification is not needed. We only need the information of network status with amount of received and sent data. We do not need the pad control so we eliminated this feature.

User Interface Guidelines

The old therapist's UI is a standard UI for all VEs. It is consistent across all the VEs that have been created, makes it becomes poor in design. For example, the map of the airplane seat is much more smaller than the place given to it, so there is a big blank space beside this map. In contrary, the widgets for controlling the VEs are squeezed into small container. The old therapist's UI is also not taking into consideration size of frequent used and useful controls. The therapist rarely uses the note feature, but SUDs recording is used often. The size of the note text box is very big whereas the SUDs chart is small. These kinds of weakness in the old therapist's are improved. *Figure 3.12* shows the size comparison of the note and SUDs recording features

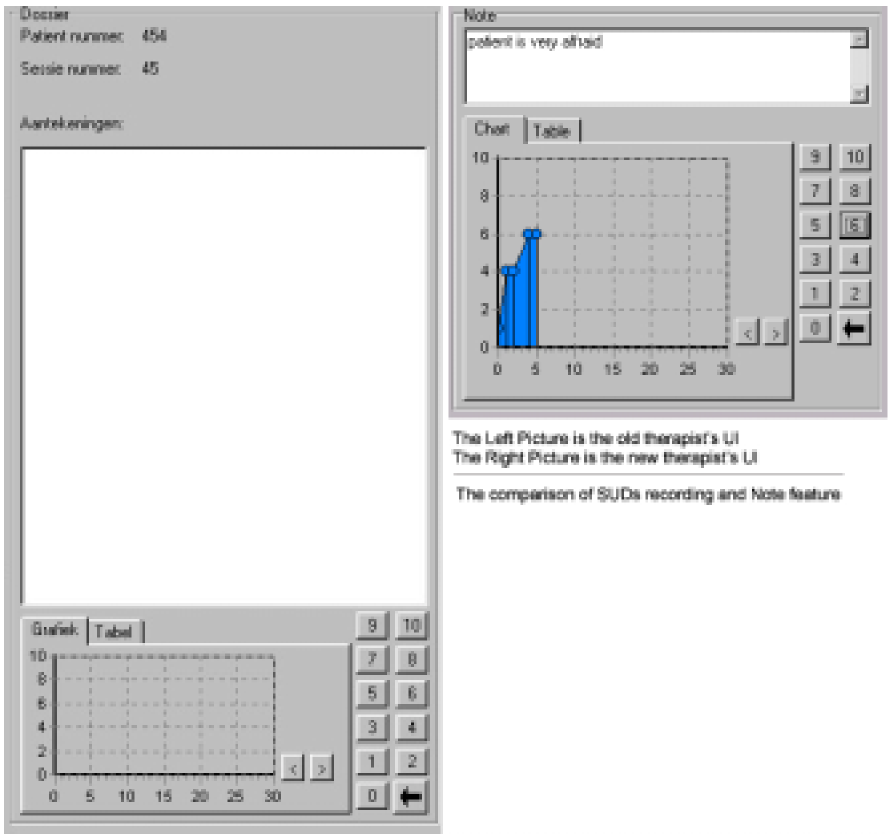


Figure 3.12: *The comparison of SUDs recording and Note features*

Cognitive artifacts

It has already proved that providing the SUD recording and reviewing tools is really needed for the therapist, but the historic data have not yet provided. The emergence of this historic SUDs data is to track the history of patient's treatment. The report printed after each session will be put in the patient's file, so the therapist can easily look the history of the patient's treatment progress.

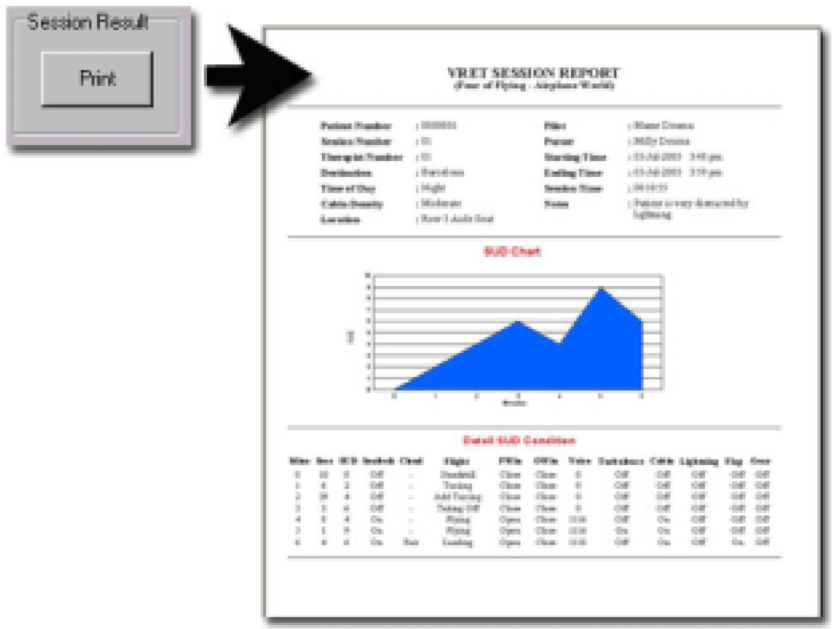


Figure 3.13: *Overview of the printing and report feature.*

Therefore, this allows the therapist work more efficiently rather than memorizes and writes a note of the SUD scores during therapy. This feature made possible by the enhance of database system enriched with report feature. *Figure 3.13* shows the overview of the print and report feature supported by database system. This report gives information about the therapy session such as patient's number, therapist's number, session's number, which destination, which time of day, which cabin density, which pilot and purser, starting time, ending time, session time, notes, SUDs chart, and detail SUDs table

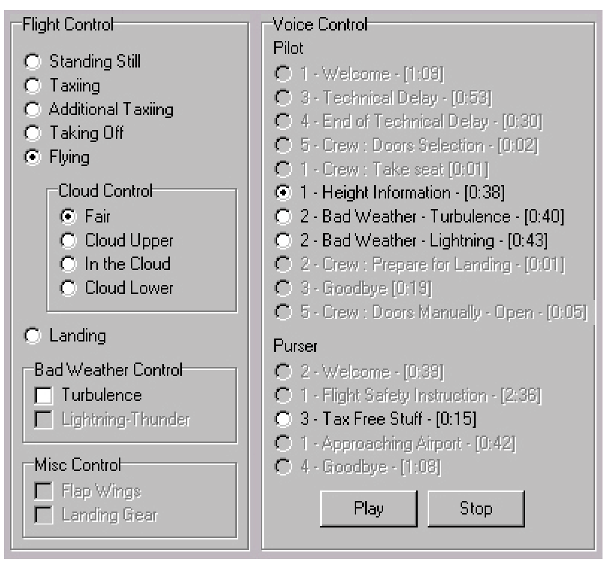


Figure 3.14: *Limitation in therapist user interface, widgets in greys means disabled*

Affordances for the therapist

One of the eight golden rules of interface design by Shneiderman is offer error prevention. Meaning we have to prevent the possible error as much as possible. By using this guidance, we tried to emend the voice announcements control in the old therapist's UI, where the voice

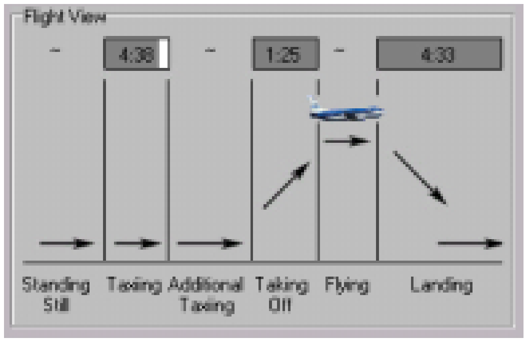


Figure 3.15: *Flight View*

announcements can be played anywhere and anytime in the simulation. The widgets in grays, means that the user cannot use that widgets, the control are disabled for the current stage. For example, in *figure 3.14,* we are in flying stage, and the voice control that possible in flying stage is the height information, bad weather and tax-free stuff announcements. Thus, limitation control in every stage of therapy by enabling and disabling widgets will guide the user to do more successful task and decreasing the error rate, so it will improve the usability of the system. Right after the radio button for voice announcements there is order (suggestion) guidance to play sequentially. The length of voice announcements is given after its name. This is an informative purpose that the therapist can plan the therapy session effectively.

Figure 3.15 shows the graphical view of stages in flying. The therapist has to memorize in which stage he/she is at that moment, and by this feature the therapist instead of memorizing, he/she can concentrate to other important matter during therapy. Thus, this issue expected will lead to the increasing of the usability for the therapist.

As also shown in *figure 3.15*, in taxiing, taking off and landing stages there are guided timers that show the remaining time when the stage will be over. In *figure 3.14*, there is also time information for each voice announcements. The therapist sometimes has difficulties in planning a session, because he/she does not know the exact time every stage will be over. Thus with this feature expected the planning for therapy session will be easier, and therapy session more effective because of the right information given and will increase the usability of the system.

Database

The Microsoft Access database was chosen to support our new therapist's UI. This decision mainly because we need to replace the old database provided by Delphi 5. An informal consultation with the author of the system gave information that this database is easy to corrupt beyond repairs. Therefore, we chose Microsoft Access because we have already the license of this program, it is easy to use and it is easy to integrate with Borland Delphi 5. The database itself has two tables (Session, SUDs) and one query (Report). The session table saves the session information of the therapy, such as patient's number, therapist's number, session's number, etc. Table SUDs saves the information of patient's SUDs. The query is used by the report to display the historical data and SUD chart in the report. The database structure and the report layout can be found in Appendix B.

Other features

A new therapist's UI was designed and implemented; some changes could be seen easily, it was clearly visible to the therapist.

We changed the language used in the system from Dutch to English. Complete pictures of the old and new therapist UI could be found in Appendix B. The first change made was the patient and session information entry, the old system used separated forms while the new

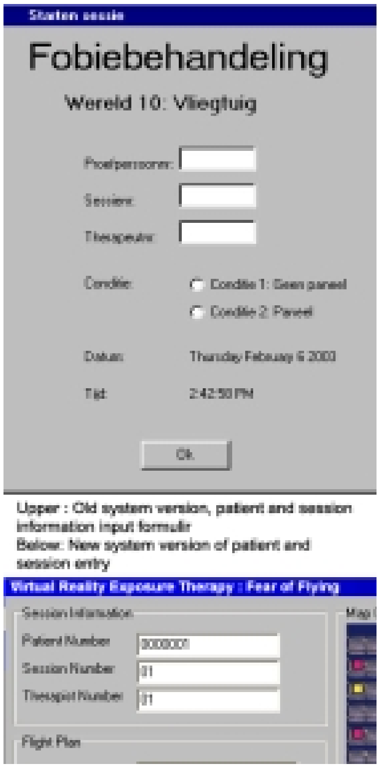


Figure 3.16 *Session Information*

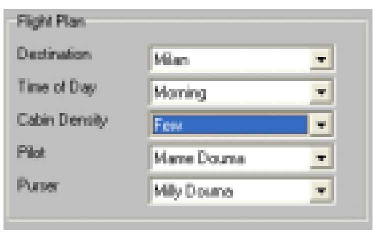


Figure 3.17: *Flight plan control*

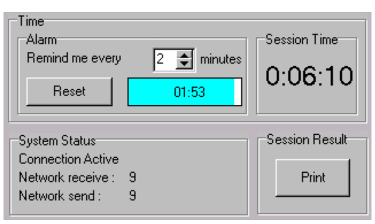


Figure 3.18: *The time controls, system status and print control.*

system presented complete user interface in one form, the reason behind this change was to simplify the UI. *Figure 3.16* shows comparisons of the patient and session information entry for both systems.

The flight plan is a new feature added to the therapist's UI. Using this control, therapist can plan the session with certain destination, choose the flying time, choose the cabin density and choose the pilot and purser voices for announcement. *Figure 3.17* shows the flight plan control.

Figure 3.18 shows the session time and alarm feature, session time is the indicator how long the therapy session has begun. It will start after start button is pressed. The alarm feature is used to give reminder to the therapist when he needs to ask the patient's fear level. The blue gauge shows the remaining time before the alarm fired. System status shows the network connection; in this example, the connection is active. Print button is used to print the report.

Cabin density can be controlled by selecting the variable given in the cabin density combo box. Changing in the cabin density control will affect the map control as shown in *figure 3.19*. In the map control there are some symbols which represented the location of the patient (red square), the possible location for the patient (yellow square) and the locations of the other passengers (pink square). This illustration is expected to help therapist to choose the patient's location in the therapy session by taking into account the distribution of other passengers (crowded or less crowded passengers near patient). There are six different locations, at the front, at the middle or at the back seat in the cabin, and the window seat or aisle seat. Placing the patient by the window seat will allow him to see the sequence of flying through the passenger's window.

In the new therapist's UI, the start and stop of the simulation is introduced, to give the exact time to start and to end the therapy session after the therapist fills in the flight plan. The simulation button control can be seen in *figure 3.20*. After starting the simulation, the therapist has the full control to expose the patient to the virtual world. The main control of this action is laid in the flight control, voice control, cabin control, flying control and flight view.

The old system has a centered world control, meaning one can only control what is inside it (Besturing wereld). This control can be seen in *figure 3.21*. In the

Figure 3.19: *Cabin density control*

Figure 3.20: *Simulation Control*

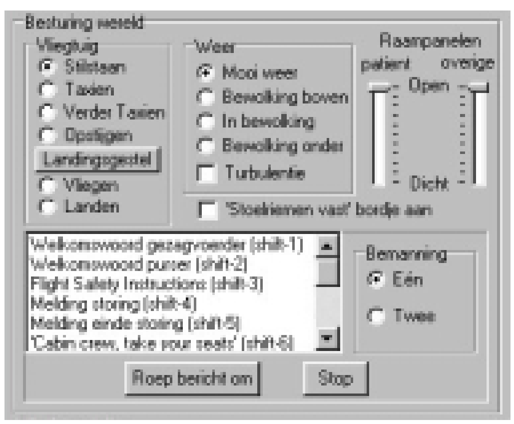


Figure 3.21: *Centered virtual world control in old system*

new system, these controls are separated into some groups. Flight control controls the flight sequences from standing still, taxiing, further taxiing, taking off, flying and landing. During flying stage, the therapist can control the clouds. They can be fair, clouds above the airplane, airplane in the clouds or clouds below the airplane. In the flight control, the therapist also can control the bad weather (turbulence and lightning). Lightning feature can only be carried out when flying at night. The other feature is the sound effect control of landing gear and flap wings. Landing gear will be enabled during taking off and landing, while flap wings will be enabled in every sequence of flying except standing still. The changes in flight control will affect the flight view, because the flight view illustrates the current state of flying stage.

The voice control is used to play the correspondences voice announcement during each stage of flying. It is divided into two parts, pilot voices and purser voices. The number in front of voice's name means the suggested sequence and the length of each voice is given after the voice's name. To play the voice, the therapist first has to choose the specific voice by clicking the control then clicks the play button. To stop the voice, the therapist simply needs to press the stop button. Cabin control, according to its name, is used to control what is happening in the cabin: to control the cabin's light, fasten seatbelt sign and passengers window. Rolling control can only be used during flying. The location is not really correct or grouped together. This is because of the difficulties to arrange all the controls. The overview of the world control in the new system can be seen in *figure 3.22*.

The last change made is the size of patient's view and free view control. Because controls and features were added to the therapist's UI, the patient's view and free view could not be designed as big as the original.

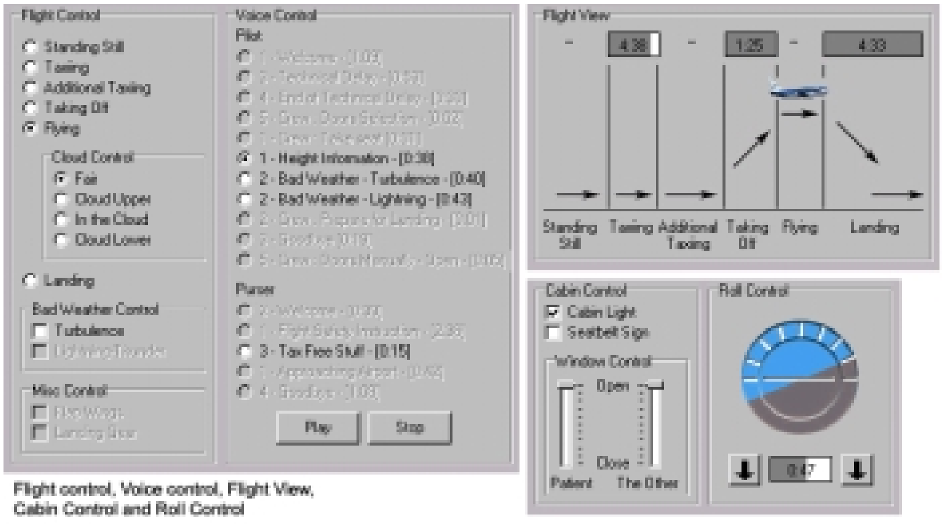


Figure 3.22: *The overview of the new world controls*

3.3.2 Patient's User Interface

The users of the patient's UI are the patient having fear of flying. Our users right now limited only to those who are treated in VALK or UvA.

The possibility to change the flying time is made by changing its panorama, to different time of the day, morning, day, afternoon and night. *Figure 3.23* shows sixteen possible panorama images.

More avatars were added from fourteen to thirty avatars in the cabin. These avatars were static and could not move. We tried to add the number of passengers to make a fully booked cabin (sixty passengers inside the virtual airplane) but the hardware limitation made it impossible to do so. The cabin density could be control through therapist's UI with no passenger, few passengers (fourteen people) and moderate (thirty people). Pilot and purser's voice were recorded from a real pilot and purser, which made the voice announcements be heard really professional. The possibility to fly to other destinations instead of just Milan was also made by pilot and purser voice announcements. The destination airport was actually the same, only the announcements were different. Some sound effects also changed, e.g. the landing gear sound and flap wings sound.

Cabin's light can be turned on and off by changing all textures inside the airplane into shaded textures, but textures for objects that loaded during run time had to be loaded again in every change of the cabin's light, for example avatar's textures.

We changed some of the textures in the airplane. However, these changes are not very significant, resulting in not so visible results. Changes included the wing's texture, window's texture, and no smoking sign beside the fasten seatbelt sign. By changing the wing's texture eliminated big grey area outside the window, made it easier for patients to see down to the earth.

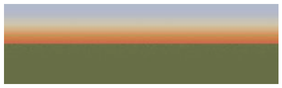
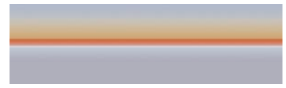
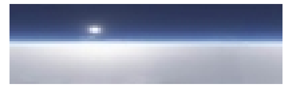
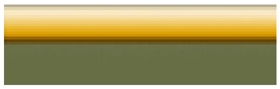
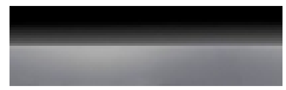
Morning	*Skymorning.tga* 	*Skycovermorning.tga* 	*Cloudskymorning.tga* 
Day	*Skyday.tga* 	*Skycoverday.tga* 	*Cloudskyday.tga* 
After noon	*Skyafternoon.tga* 	*Skycoverafternoon.tga* 	*Cloudskyafternoon.tga* 
Night	*Skynight.tga* 	*Skycover.tga* 	*Cloudskynight.tga* 

Figure 3.23 *Panorama images*

The bad weather condition was created by adding one more feature, lightning. During the lightning, a flashing light could be seen by the patient. This feature was made possible by adding one light object and manipulating the ambient of the system.

3.4 Conclusion

Our analysis was based on the new requirements gathered with referencing to the task analysis and evaluation of the current system. The limitations of the current resources were also taken into account. Some improvements were made and not all of the new requirements could be implemented. The most significant improvement was the new therapist's UI with new features in it, such as flight planner, display overview, rolling control, light control, lightning, timer tools and report feature. The VE for the patients was also modified and added by adjusting with improvements done in therapist's UI. However, the changes in the VE were not seen significantly although a lot of effort was put to improve this VE.

4 Evaluation

The evaluation phase took place in the end of system development. Summative Evaluation was carried out for both patient's UI and therapist's UI. There were some differences in evaluating these two kinds of UI. The patient's UI evaluation was carried out in the term of presence and the therapist's UI was carried out in the term of usability. The experiments for both UIs were done in the same time. We did sixteen experiments with sixteen pair of patient and therapist (32 participants), five of them are real therapists, and the rest were students. There were two-therapy sessions for each therapist and patient pair, one using the old system (System A) and one using the new improved system (System B). The order of the sessions was randomly chosen, and actors are randomly assigned to be a therapist or a patient. During the therapy session, some tasks were assigned to the therapist and the patient. The therapist controlled the VE using therapist's UI and exposed the patient gradually to the flying sequences in VE. Two groups of questionnaires were designed for evaluating the usability of therapist's UI and the presence in patient's UI. These questionnaires were given before and/ after each sessions.

4.1 Patient's User Interface

Requirements gathered for patient's UI initially depended on our new requirements, Since we changed our goal in the middle of our thesis project, it resulted in changing the requirements for patient's UI to get the kind improvement expected from therapist's UI. Although our direct goal is not to improve the sense of presence in the VE, it is also interesting to evaluate whether the added new features in the VE also increase the sense of presence of the VE. Therefore, we formulate our hypothesis:

Hypothesis 1: The new added features to the VE will increase the sense of presence for the patient.

4.1.1 Experiment 1: Presence in Patient's UI

The experiment goal is to evaluate the sense of presence of VE in the two systems, system A and system B

Method & Design

Design

Sixteen students were participated during this experiment, seven are female and nine are male. They were asked to be patients who has fear of flying and exposed to the VE. During the exposure, they experienced virtual flying in the virtual airplane controlled by the therapist. Two VEs are tested: the old system (System A) and the new system (System B), so there are two sessions for each patient. For balance consideration, some patients experienced system A first then B and the other will experience the system in inverse order. Short briefing was given before the session, on information about the background of the experiment, the goal and the task of the patient. They are asked to fill in the computer experience questionnaire and SAM questionnaire before the first session conducted. The patient was exposed to the flight sequence experiences such as standing still, taxiing, taking off, flying and landing. During the flying stage, the patient was being exposed to more fearful situations, such as turbulence and thunderstorm. Every three minutes, the patient is asked to report his/her level of fear in the scale from zero to ten, from not being afraid at all to very afraid. After each session, the patient has to fill in the IPQ to measure the presence experienced in the session and SAM questionnaire again to measure his/her feeling after the session.

Measures

Presence was measured using the IPQ by (Schubert et al., 1999). The IPQ is divided into three subscales: Involvement, Spatial Presence and Realness, and was discussed in more detail in chapter 2. SAM Questionnaires were also given before and after each session to measure the emotional feeling of the patient.

Result

Igroup Presence Questionnaire (IPQ)

The reliability analysis is done in the term of Cronbach's alpha=0.7901(N of cases=32, N of items=14), showing that responses had internal consistency.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
SISTEM	Sphericity Assumed	82.167	1	82.167	2.895	.111
	Greenhouse-Geisser	82.167	1.000	82.167	2.895	.111
	Huynh-Feldt	82.167	1.000	82.167	2.895	.111
	Lower-bound	82.167	1.000	82.167	2.895	.111
SISTEM * ORDER	Sphericity Assumed	87.917	1	87.917	3.098	.100
	Greenhouse-Geisser	87.917	1.000	87.917	3.098	.100
	Huynh-Feldt	87.917	1.000	87.917	3.098	.100
	Lower-bound	87.917	1.000	87.917	3.098	.100
Error(SISTEM)	Sphericity Assumed	397.302	14	28.379		
	Greenhouse-Geisser	397.302	14.000	28.379		
	Huynh-Feldt	397.302	14.000	28.379		
	Lower-bound	397.302	14.000	28.379		

Table 4.1: *The ANOVA Test within-subjects effect of presence questionnaire*

The total score of the presence questionnaire for each system was used as within subject variables for the ANOVA repeated measure with two number of level. Order (first means the system A was conducted first and second the system B was conducted first) was introduced as the between-subjects factors. This ANOVA did not show a significant differences between two system in the scores of the presence questionnaire (F=2.895, p=0.111) as also shows in *Table 4.1*. Session order was also did not have significant influences on this result. *Figure 4.1* shows a box plot of presence of the two systems.

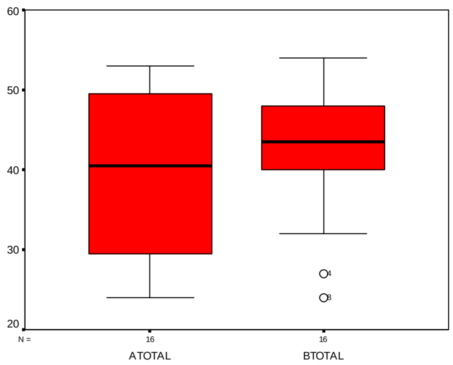


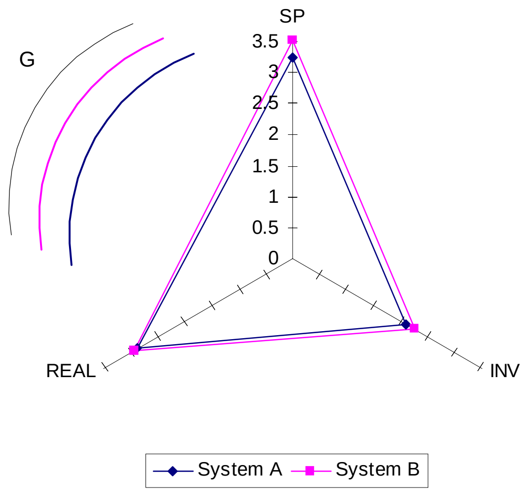
Figure 4.1: *Boxplot of the presence score in the two systems.*

	F	*p*
SP	3.151	0.098
INV	1.158	0.300
REAL	0.161	0.695
G	2.547	0.133

Table 4.2: *Summary of ANOVA presence questionnaire results per sub group.*

For each sub total of Spatial Presence, Involvement, Experienced Realism, and Sense of being there, ANOVA repeated measure was also conducted, over all result showed that the sense of presence for each category also showed there are no significant differences. The complete summary of this result is shown in *table 4.2.*

By calculating the means of the presence per sub group, we can also plot diagrams of a "presence profile". The following diagram shows a comparison of the presence between system A and system B, with n=16. The diagram plots SP, INV and REAL on three axis (range 0 – 7), and additionally the general item as a bow on the left.



	A	*B*
SP	3.2250	3.500
INV	2.0938	2.2656
REAL	2.8594	2.9375
G1	3.6250	4.0625

Table 4.3: *Means of subscale in presence questionnaire*

Figure 4.2: *Presence profile, the comparison of system A and B*

We did not find any significant correlation between the scores of Computer Experience Questionnaire (CEQ) and IPQ scores (System A and B). The Pearson correlation between CEQ and IPQ system A was 0.325 (p=0.220), and between CEQ and IPQ System B was 0.339 (p=0.199). We did however find a significant positive correlation between IPQ score of System A and B. (Pearson correlation=0.661, p=0.05). It means that in general, higher score on IPQ System A tend to be paired with higher score on IPQ System B. The complete correlation results can be seen in *table 4.4*. *Figure 4.3* shows the bivariate plot of the relationship between IPQ scores.

Correlations

		IPQ System A	IPQ System B	CEQ
IPQ System A	Pearson Correlation	1.000	.661**	.325
	Sig. (2-tailed)	.	.005	.220
	N	16	16	16
IPQ System B	Pearson Correlation	.661**	1.000	.339
	Sig. (2-tailed)	.005	.	.199
	N	16	16	16
CEQ	Pearson Correlation	.325	.339	1.000
	Sig. (2-tailed)	.220	.199	.
	N	16	16	16

**. Correlation is significant at the 0.01 level (2-tailed).

Tabel 4.4: *Correlations between CEM and IPQ score*

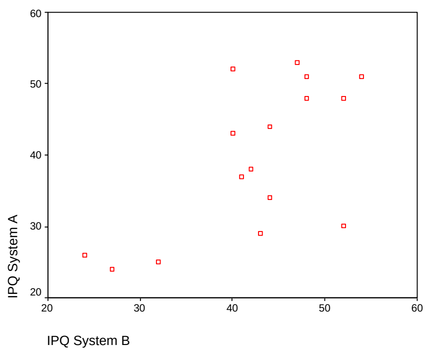


Figure 4.3: *the bivariate plot of the relationship between IPQ scores*

SAM Questionnaire

A reliability analysis has been performed for this questionnaire using Cronbach's alpha. The alpha = 0.8500 (N of cases = 16, N of items=3), this shows the internal consistency of the data. Using ANOVA repeated measure F=0.156, p=0.699, there are no significant differences of SAM scores before and after session of system A. The order also did not give significant differences with F=0.373, p=0.551. The boxplot of the SAM score before and after the session of system A is illustrated in *figure 4.4*. The SAM score for system B was also not significant before and after the session F=0.771, p=0.247. The boxplot of the SAM score before and after the session is illustrated in *figure 4.5*. Therefore, from these results we can conclude that there are no significant changes of emotional feeling after each session.

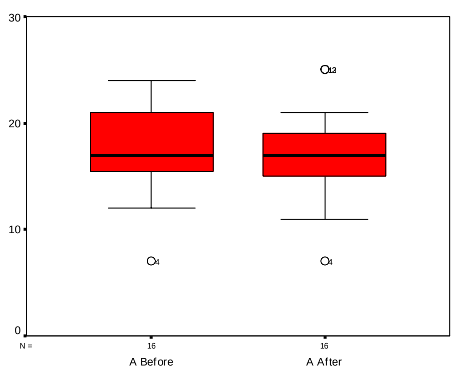


Figure 4.4: *The boxplot of SAM score before and after the session of system A*

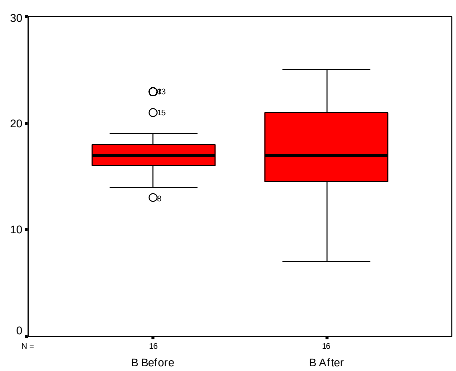


Figure 4.5: *The boxplot of SAM score before and after the session of system B*

SUDs

The SUD recording most of the time during the experiments most of the time is zero, because almost none of the participants actually have fear of flying. An interesting incident is we really have a student who has a real fear of flying. He gripped his hand tightly and he was not breathing regularly. Fortunately, this student was exposed to the VE by the real therapist, so she could really understand what happened to him. During this therapy, the SUD of the patient was very high.

Another observation in SUD recording, if the patient's SUD increased, it was due to lightning and thunder or also during turbulence. Therefore, the bad weather control actually is an effective tool to expose the patient to the fearful condition.

Discussion

Some remarks were collected after sessions. In general, patients like the system and had good impression. They gave comments such as *'Quite good'*, *'good'*, *'nice idea'*, *'Certainly a good idea'*. Our biggest problem was the HMD, it is very heavy and distracted the comfort of the patients. It was also difficult for the patient to move it. From observation during the therapy sessions, patients were likely to hold the HMD with their hands, and their gesture told us that wearing the HMD was uncomfortable and tiring for their eyes. Some people with glasses also have difficulties to use focused HMD, because the left eye focusing control of HMD was broken, they report that the pictures look blurry. There was also a large gap, a black room between the eyes and the monitor in HMD. Despite those disadvantages, the 3D impression by the HMD (stereoscopy) was very good and captured clearly by the patient. Some suggestions were made to overcome this HMD issue. It was suggested to find a lighter or a wireless HMD. Some patients could hear the differences of the pilot and purser voices between two VEs, and they mentioned that the voices in system B was nice and sounded professional. The only problem about voice and sound is when two kinds of sound were played at the same time. The output voice flickered and it sounded less realistic.

More avatars in the VE in system B is also identified by the patients. They liked this feature, especially when a nice girl or boy is near them, *'There's a cute girl near me'*. These avatars are static avatars. They sit still and do not move. When lightning and thunder occurred, these avatars did not give emotional feedback and still in their chair, no panic situation appears, no panicky sound is heard and no movement happens. What happens in the VE becomes inconsistent with the real world. Lightning and thunder were indeed fun and frightening, but the only lightning effect without environment consequences was not enough.

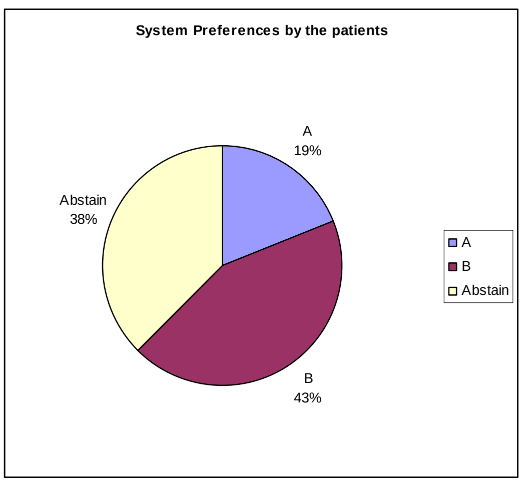


Figure 4.6: *System preferences by the patient*

There were also no avatars beside the patient, and there was no avatar model for the patient himself. When a patient tried to look down to her/his seat, he/she saw the empty seat and can not see her/his own body, *'Now I'm starting to*

feel afraid, where is my body?' This inconsistency was shown clearly during the therapy session.
Although there were still lots of shortcomings in our VE, the sense of real world could still be felt by the patient. The possibility to see down the earth and the effect of turbulence and lightning represent realism. Turbulence and lightning were their favorite. Most of the patients did not have real fear of flying, they saw this feature as creative, challenging and entertainment objects.
The pie chart of system preferences chosen by the patient can be seen in *figure 4.6*. System B gains more preferences than system A. From our observation during therapy sessions, these preferences were formed due to the lightning effect, and the differences in avatar's quantity. The lightning and thunder effect are only enabled during the night flight. This was a disadvantage as being dark during the night flight, patients could not see clearly to the outside world. Therefore, when a patient was exposed to use the system B with a night flight, he/she could experience a 'nice' thunderstorm, but could not see clearly the scenery through the window. In contrast with system A, where patient could see more clearly the 'height' feeling of flying during daylight flight. In our experiments, the patient did not know that the system B also could do the daylight flying they assumed that each system could only do what they perceived. This assumption led to preferences to system A. It can be concluded also that our experiment was not maximal, because it could not reveal all the improvement of the VE. The passenger seat for our simulation right now have the vibration from the bass amplifier attached to it, but this effect is not enough to simulate real movement during taking off and turbulence. We were thinking about the suspension chair for our simulation, but once again, we were confronted with the financial limitation. As we know, people's height differs from one to other. This led to a problem when a short patient wore the HMD and sat in the simulation chair. This condition is explained in *figure 4.7*. Patient B felt more uncomfortable wearing HMD.

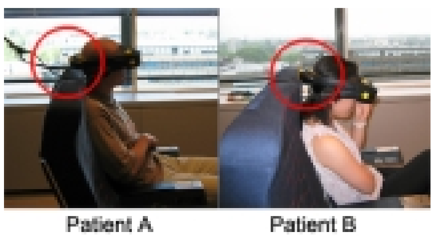


Figure 4.7: *HMD problem*

The last suggestion we received was about the detail texture of the outside environment of the airplane that needed to be improved.

Conclusion of Patient's UI

Based on our analysis, we can conclude that our first hyphotesis was incorrect, thus we rejected it.

Hypothesis 1: The new added features to the VE will increase the sense of presence for the patient.

The new added features to the VE for supporting the therapist's UI did not increase or add the sense of presence for the patient.

4.2 Therapist's User Interface

Some therapists participated during re-design and evaluation. We use most of the subjective evaluation by the therapist, and since it is difficult to therapists who are willing and able to participate in our experiments, the evaluation is also given by students trained as therapists. Although some students also participated during the evaluation, the sample amount could not represent the whole population. We need at least thirty real practicing therapists to do reliable experiment according to the statistical rule, but that amount was unachievable with our given condition that at time. Therefore, the results of our research in this area might be not being entirely reliable, but still we can see the result as indicators.
Our goal is to improve the usability of the therapist's UI. Thus, we want to evaluate whether our goal is fulfilled and we formulate our hypothesis:

Hypothesis 2: The improvements in Therapist UI are increasing the usability of the system.

4.2.1 Experiment 2: Usability Overview

The experiment goal was to evaluate the usability of the therapist UI whether the entire feature added and changed showed significant improvement.

Method

Eleven students trained as therapist (most of them never try our system before) and five real therapists were asked to do therapy sessions. The demographic table of the participant is shown in *table 4.5*. Every therapist conducted two sessions; using the old system and new system. The old system named as System A and the new system named as System B. To give more objective judgment of the two systems, none of them was informed which the old system was and which the new improved system was. Each session took about twenty minutes and there were a small break between the sessions. To balance the experiment results, around half of the therapists will use the System A first than System B, and the other half in contrary order. Detailed therapy session tasks (Appendix C) was given to the therapist. It included instructions to load the correspondence world, fill patient and session information, gradually expose the patient to the virtual world and end the simulation. Time elapsed was recorded during each task and what the therapist done was monitored and noted such as mistakes done by therapist, questions, and assistance needed. Each therapist had to fill in the computer experience questionnaire before starting the therapy sessions, and the usability questionnaire was given after each sessions. After finishing the therapy sessions, the therapist were asked about general remarks, comments, suggestion and general comparison about two systems. Another extended subjective evaluation with real therapist also was done for gathering information that is more authentic.

	N	*Female*	*Male*
Student trained as therapist	11	4	7
Real Therapist	5	4	1
Total	***16***	***8***	***8***

Table 4.5 *Participan'st demographic table*

Results and Discussions

Usability Questionnaire

ANOVA

TOTAL

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2397.781	1	2397.781	4.767	.037
Within Groups	15090.938	30	503.031		
Total	17488.719	31			

Table 4.6: *The One-way ANOVA result table*

The reliability analysis for the usability questionnaire was performed and the result surprised us. Cronbach alpha was 0.9254 (N of cases = 32, N of items = 27), showed that responses have a really good internal consistency. The One-way ANOVA result of the usability questionnaire showed significant differences in the total score between two systems: F=4.767, p=0.037 (n=32).

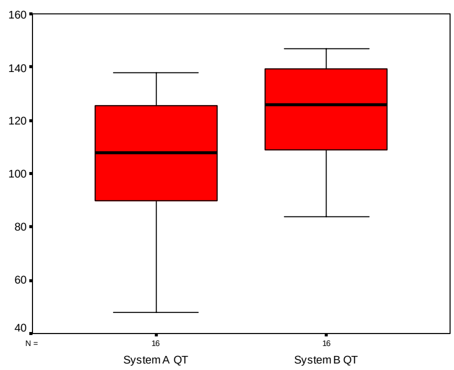
Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
SYSTEM	Sphericity Assumed	2189.584	1	2189.584	15.376	.002
	Greenhouse-Geisser	2189.584	1.000	2189.584	15.376	.002
	Huynh-Feldt	2189.584	1.000	2189.584	15.376	.002
	Lower-bound	2189.584	1.000	2189.584	15.376	.002
SYSTEM * ORDER	Sphericity Assumed	205.084	1	205.084	1.440	.250
	Greenhouse-Geisser	205.084	1.000	205.084	1.440	.250
	Huynh-Feldt	205.084	1.000	205.084	1.440	.250
	Lower-bound	205.084	1.000	205.084	1.440	.250
Error(SYSTEM)	Sphericity Assumed	1993.635	14	142.402		
	Greenhouse-Geisser	1993.635	14.000	142.402		
	Huynh-Feldt	1993.635	14.000	142.402		
	Lower-bound	1993.635	14.000	142.402		

Table 4.7: *The ANOVA for repeated measure result*

Because in our experiment the same patient took part in two sessions (system A & B), we could analyze our data using ANOVA for repeated measure. The repeated measure allows us to compare the variance caused by the independent variable to a more accurate error term by removing the variance caused by differences in individuals. This increases the power of the analysis and means that fewer participants are needed to have adequate power. The ANOVA for repeated measure shows much better result. There was a significant difference in the total score between two systems: F=15.376, p=0.002. There were no significant differences between the groups who tried the systems in different order, system A for first session followed by system B, or system B for first session followed by system A.



Picture 4.8: *The boxplot of the usability Questionnaire for system A and B*

Case Summaries

	AQT	BQT
N	16	16
Sum	1687.00	1964.00
Mean	105.4375	122.7500
Std. Deviation	24.8193	19.7501
Minimum	48.00	84.00
Maximum	138.00	147.00

Tabel 4.8: *Usability questionnaire case summaries*

This was indicated by the interaction between 'system' and 'order' (system*order) which is not significant: F=1.440, p=0.250. In other words, the different order in our experiment did not affect the relative ratings of the different people. *Table 4.7* shows the ANOVA repeated measure result. The significant differences proved earlier should be verified; which one had the higher or lower usability. By calculating the means of questionnaire A and B, we drew a box plot as seen in *figure 4.8* This figure shows us that the means of system B is higher than system A. Thus, by this result we accepted our second hypothesis that the improvements made in therapist UI increase the usability of the system. The complete case descriptive of the usability questionnaire result can be seen in *table 4.8*.

Additional usability questions filled only for system B to evaluate the new features had a reliability alpha of 0.8216 (N of cases=16, N of items=8). It means that these eight additional questions had a good internal consistency. The results of the additional questionnaire are displayed in *table 4.9*, which shows that all the new features were evaluated positively; they were very useful and/or easy to use. Thus, by these results we add our second hypothesis to include proof that the new added features are useful and easy to use.

Element	***Usefulness(SD)***	***Ease of use (SD)***
Flight Plan Control		4.9375(1.3401)
Cabin Control		4.8750(1.0247)
Roll Control		4.8125(1.1087)
Flight View		5.3125(1.0145)
Print Function	5.1250(1.2583)	4.8750(1.5000)
Timer feature	4.5000(1.3166)	
Simulation Control		4.9375(1.5262)

Table 4.9: *Average scores (and standard deviation) of the additional usability questions (n=16) regarding new features of the therapist UI, scale from 1 to 7.*

There was no significant correlation between Computer Experience Questionnaire and Usability Questionnaire scores as shown in *table 4.10*. Between CEM and Usability A

Correlations

		Usability A	Usability B	CEM
Usability A	Pearson Correlation	1.000	.727**	.066
	Sig. (2-tailed)	.	.001	.808
	N	16	16	16
Usability B	Pearson Correlation	.727**	1.000	-.028
	Sig. (2-tailed)	.001	.	.919
	N	16	16	16
CEM	Pearson Correlation	.066	-.028	1.000
	Sig. (2-tailed)	.808	.919	.
	N	16	16	16

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.10: *Correlations between CEM and Usability Questionnaires*

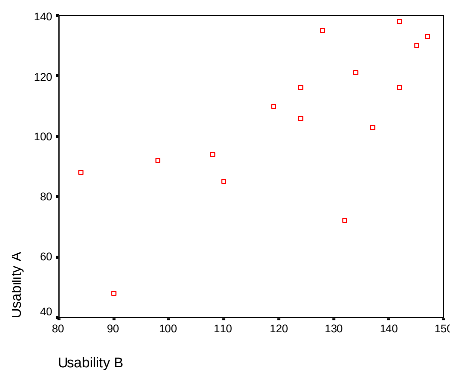


Figure 4.9 *shows the bivariate plot of the relationship between usability questionnaire scores*

(Pearson Correlations=0.66, p=0.808) and between CEM and Usability B (Pearson Correlations=-0.28, p=0.919). However, we found a significant correlations between usability A and B (Pearson Correlations=0.727, p=0.01), Higher score in usability System A tend to paired with higher score in usability questionnaire System B. *Figure 4.9* shows the bivariate plot of the relationship between usability questionnaire scores

Performance time and Error

Performance time and error were measured during experiment, in every task given, the complete task measured can be seen in *table 4.11*. At the start of each task, the therapist will say aloud "Beginning Task" followed by the number of the task, and say "Task Complete" at the end of each task.

Task	***Activities***
Task 1	• Loading the correspondence world
Task 2	• Filling in the therapy session information (Patient, Therapist and Session Number) • Put the patient to the right chair (window seat)
Task 3	• Set the alarm to remind every 3 minutes • Gradually expose the patient to the flying sequences, standing still, taxiing, additional taxiing, taking off, flying, flying in bad weather, and landing. • Play the correspondences voices of pilot and purser. • Try to use all features in the system. • Ask the patient's level of fear when the alarm fired, and put it to the SUD entry.
Task 4	• (Only for system B) Print the session report.

Table 4.11: *Tasks defined for the session therapy*

The fourth task only for system B, because in system A there was no report that can be printed. The average comparison of the results can be seen in *table 4.12* and *figure 4.11*. It shows that the first task took longer time to complete in system B than in system A. The second task, though, took longer time to complete in system A than in system B, this is because the system loading in both tasks are in different time. System A had a separate form for patient and session entry, in contrast to system B that had same form for both. This led to the difference time in loading time of the VE. This can be illustrated as show in *figure 4.10*.

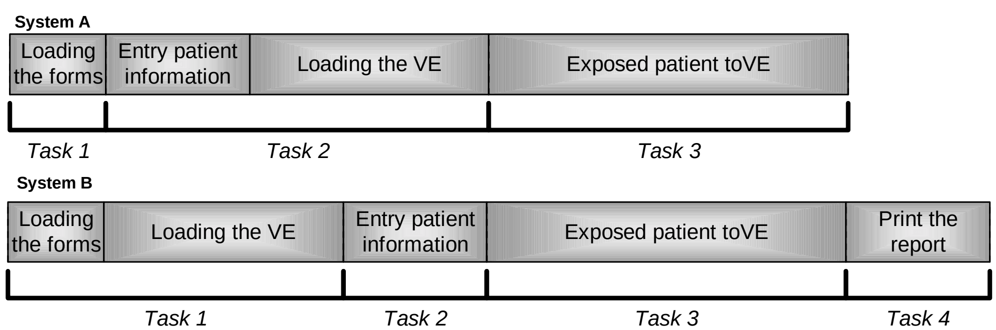


Figure 4.10: *Task with loading differences for system A and B*

We can therefore calculate the added Task 1 and Task 2, to give a better way of comparison. After all this, system A still had a faster loading time of two minutes and thirty forty four seconds (02:44.2) compared to three minutes and thirty four seconds. (03:34.2). There was almost a minute difference between the two. We also analyze this result using ANOVA repeated measure and the result is significant: (F=10.731,p=0.005). The third task took longer to complete in system B than system A. This was due to the added features in system B. The additional types of announcements by purser and pilot also affected the outcome of the experiments. The new voice announcements in system B were actually longer than in system A.

In the third task, we asked the therapist to try the entire feature in the system. This comparison was no longer suitable for us to analyze any further. This result was also proved very significant time using ANOVA repeated measure: F=74.262, p=0.000.

During sessions in our experiment, sometimes we needed to restart both computers because they did not response. The 'not responding' system occurred four times during all thirty-two sessions that were conducted.

	Task 1	*Task 2*	*Task 3*	*Task 4*
System A	00:49.2	01:55.0	14:02.9	-
System B	02:21.3	01:15.2	17:15.4	01:08.2

Table 4.12: *Comparison of average task completion time*

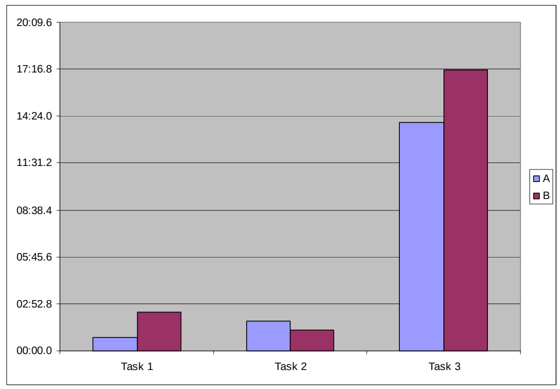


Figure 4.11: *Bar chart comparison of average task completion time for system A and B*

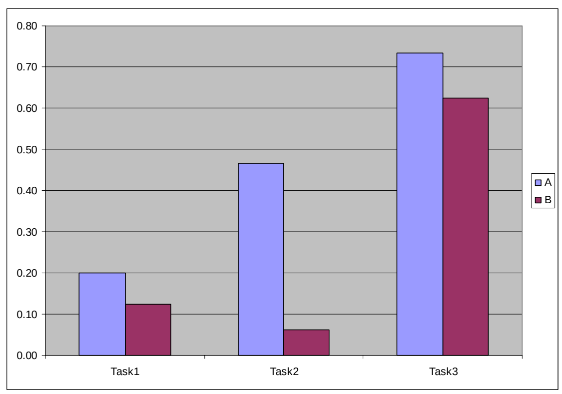


Figure 4.12: *Bar chart comparison of average error rate for system A and B*

	Task1	*Task2*	*Task3*	*Task 4*
System A	0.19	0.44	0.69	
System B	0.13	0.06	0.63	0.06

Table 4.13: *Comparison of average error rate*

The comparison of error rate for both systems can be seen in *table 4.13* and *figure 4.12*. Error in our system was defined as errors which made by the therapist during the therapy sessions, and when assistance were needed. The ANOVA repeated measure analysis shows

insignificantly results between the sum of error rate for A and B, although from the graphics and ordinary means calculation, the error rate for system B is better than system A.
There were also no significant correlation between computer experience questionnaire with the performance time and error. CEM and Time A (Pearson Correlations = 0.153, p=0.570), CEM and Time B (Pearson Correlations = 0.324, p = 0.220), CEM and Error A (Pearson Correlations=-0.192, p=0.476) and CEM with Error B (Pearson Correlations=0.097, p=0.720).

Therapist Subjective Evaluation

Five therapists were given more questionnaires after conducting two sessions. The results of the first nine questions are summarized as in *table 4.14*. The roll control was not used often, and it was not too easy to use either. The roll control is used during flying stage. It rolls the airplane so the horizon will slightly leaning in the patient's view. It was unclear in the therapist's UI when the roll control can be used. To be able to use the roll control, the therapist simply needs to press the control once to roll to the left or to roll to the right. The airplane will then gradually roll to the angle of fifteen degrees, and roll back again to the original position in the length of one minute and sixteen seconds (1:16). Unfortunately, the therapists were not very clear on these instructions.

Element	***Frequency of use(SD)***	***Ease of use (SD)***	***Usefulness(SD)***
Roll Control	2.2000(1.3038)	3.6000(1.9494)	-
Bad Weather Control	3.6000(1.6733)	4.8000(0.4472)	-
Flight View	4.0000(1.7321)	-	4.8000(0.4472)
Timer feature	-	-	4.8000(0.4472)
Print Function	-	-	4.4000(0.8944)

Table 4.14: *Average scores (and standard deviation) of the therapist subjective evaluation, scale from 1 to 5.*

The therapist did not too often use the bad weather control but the easiness of this control was evaluated very positively. The new feature of flight view was evaluated positively both for the frequent use and usefulness, this allowed the therapist to see overview of the sessions. The timer feature was also found to be very useful. It gave information when one stage was about to finish so the therapist can plan the next action to be carried out in the therapy session. The print function was also discovered to be very useful. Most therapists supported their answer by stating that the report will be used in the future, to know the overview what the patient did during the sessions and also to give feedback to the client.
Four therapists stated their preferences to fill in the patient and session information in the same user interface with the world control. One therapist stated that it actually does not matter, as long as this feature exists. Five therapists agreed that the same form for patient and session information entry was easier to use than the separated ones. Therapists also liked the flight control subjectively. It helped the therapist in planning a session. One said that in the flight plan all options were combined.
Three therapists liked the idea of given restrictions in controlling the VE, but two of them stated these limitations were very annoying and did not give them enough freedom, especially in controlling the voice announcements.
In general, all therapists agreed that the system B, the new improved system was easier to use than the old system. One therapist said that system B was more difficult to learn due to

the more complicated features. However, system B had a more logic and more convenient in the user interface and it is believed that after few times of training a therapist will learn it quickly. Three therapists stated the system B is easier to learn and one therapist said it did not a matter. All therapists also agreed that they liked all the added features. Most of them like the lightning and thunder, because they were fun to operate. The most useful feature of all was the flight view that combined options from flight control and voice control. The therapists also liked real voice announcements from pilot and purser, and the sound of flap wings and landing gear. One therapist stated that the report feature would be very useful in the future. All therapists preferred to use system B to treat a patient who has fear of flying. They said that system B was more organized than system A. One therapist who gave initial requirements states that we had almost everything fulfilled, except for the amount of the avatars and the unreal look of the clouds. One therapist suggested that we should have separated approaching, touch down and taxiing stages during aircraft landing.

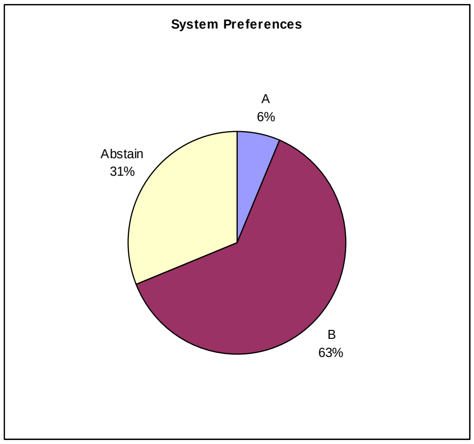


Figure 4.13: *System preferences by therapist*

Remarks

At the end of each session, therapists were asked about general remark, system preferences and suggestions. As a general remark, they opinion were that VRET is really a good idea. Some of them said that it was fun and nice to operate. The user interface for system B looked more complicated at the beginning, but after a while, it became easier to master. Overall, they gave positive feedbacks to the improvement of the therapist's UI. From sixteen therapists, ten of them state their preferences in using system B instead of system A. One therapist preferred system A to system B, and five therapists did not given their preferences. Most of them preferred system B to system A because of the language used, more controllable features, its ease of use, easily learnable, and it provides clearer instructions. Almost nothing can go wrong with system B. One therapist preferred system A to system B because it was less complicated due to less number of buttons that needed to be pressed to operate the system.

The possibility to compose scenarios and to simply run them afterwards was coined by one of the therapist as his suggestion. We referred to this function as autopilot. We thought about this function in the beginning, but from initial interviews, the therapist wanted to have complete control during therapy session. Thus, this feature was not implemented. Other useful suggestions were the introduction of cabin sound (people talking, baby crying, etc.) and alert sound for alarm.

Some feedbacks also gathered when all the participants were asked to list three things they liked most and least in using the system. The results of these questions varied from one to the other. Most participants listed all the new features as the ones that they like about the new system. Lightning and thunder became favorite features in system B, followed by feature of information overview during therapy sessions with linked option and limitation. The possibility to see what the patient's sees in VE by the therapist also evaluated very well. The system gave therapists a feeling of full control during the therapy session. It was also fun to operate. The overall sound effects in system A was louder than system B. It can clearly be heard during landing stage. We think it would be nicer if system B could use the same quality of sound as in system A. System A was also evaluated as being simple because there were not many controls and buttons to be pressed. Most of the therapist did not like the alarm reminder that was not functioning very well in system B. It did not produce a reminder alert. The note feature was also not too useful either.

Conclusion of Therapist's UI

By analyzing our result experiment, we can conclude that our formulated hypothesis for usability is accepted. It was significantly different from the old system, and it is improvement, thus it increases the usability for the therapist.

Hypothesis 2: The improvements in Therapist UI are increasing the usability of the system.

Thus, the usability of therapist's UI increase by improvements made.

5 Conclusions

The goal of this thesis mainly is to improve the usability of the therapist's UI. To achieve this goal, we also have to evaluate the improvements made. During our journey in this project, we discovered that the patient's UI and therapist's UI are dependent each other. We cannot improve only patient's UI or only therapist's UI to make the system useful. Thus, we made the improvements for both UIs, and evaluated them to see the result overview of our improvements.

5.1 Statement of the Result

The evaluation for the patient's UI is to evaluate whether the improvements added the sense of presence for the patient. The results of IPQ show that there is no significant differences between the IPQ score for both old and new system. The results SAM questionnaires even cannot to be used to evaluate the presence in our case. It did not show the emotional feeling differences before and after using both systems. The SUDs recordings were not effective due to zero majority scores that we got. Hence, based on this analysis, we can conclude that our first hypothesis was incorrect. We reject our first hypothesis and conclude as follow.

Conclusion 1: The new added features to the VE did not increase or add the sense of presence for the patient.

The causes of this unsuccessful experiment might caused by: (a) unrepresentative participants, since most of the participants are student who does not have fear of flying, or (b) the improvements of the VE is not relevant to the sense of presence, or (c) the conducted experiments could not reveal the improvements made.

On the other hand, our formulated hypothesis for the usability was strongly supported by the analyzed results from experiments done under the term of usability of the therapist's UI. We can conclude that our formulated hypothesis can be accepted. It was significantly different from the old system, and it has shown significant improvements. Therefore, it increased the usability for the therapist.

Conclusion 2: The improvements in Therapist UI are increasing the usability of the system.

Although the result of this usability evaluation was very good and promising, we have to take into account the sample population that was not represented properly. Students trained as therapist sometimes regarded the system as an entertainment media instead of media to cure the patient.
Our evaluation was based more on interview with the real therapist and feedback from them, because they will be the real user of the system. Thus, we cannot prove formulated hypothesis in full confidence. All we can do is to conclude that the results of our evaluation give positive indicators leading to the acceptance of the hypothesis.

5.2 Statement of the Problem Unsolved

Some requirements could not be fulfilled; because of the limited resources we had. Most of the unsolved technical requirements were related to the objects in VE for the patient, such as clouds, avatars, grounds, etc. This is because we are very short on time, hardware, and software resources. It is very challenging to do our project with our technical limitation. We could not enhance more features in the therapist's UI without adding features in VE. Limited resources prevented us to improve the VE that could result in improvements in therapist's UI. We could always do something to temporarily improve the VE. However, the big question is whether it is wise to invest time and efforts to temporarily bring those improvements while ones that are more permanent can be achieved in less time by investing a reasonable amount of money in hardware and software.

5.3 General conclusion

In the term of presence, the improvements made were not significant enough to be called improvement. In contrary, the new system was improved significantly under the term of usability. Thus, we hope through this research, we enable therapists to conduct therapy sessions more efficiently and effectively. Although it has not been proven that the efficient therapist and therapy would lead to the efficiency to cure the patient, we nevertheless hope that it forms better communication between the therapist and its media.

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Abbreviations

1D	One Dimensional
2D	Two Dimensional
3D	Three Dimensional
Alt.	Alternative
ANOVA	Analysis of Variance
CEQ	Computer Experience Questionnaire
DLL	Dynamic Link Libraries
DoF	Degree of Freedom
FoB	Flock of Birds
FoV	Field of View
G	Sense of being there
GUI	Graphical User Interface
HCI	Human-Computer Interaction
HMD	Head-Mounted Display
INV	Involvement
IPQ	Igroup Presence Questionnaire
PC	Personal Computer
REAL	Experienced Realism
SAM	Self Assessment Manikin
SD	Standard Deviation
SE	Standard Exposure
Seq.	Sequential
Sim.	Simultaneous
SP	Spatial Presence
SUD	Subjective Unit of Discomfort
TA	Task Analysis
UI	User Interface
UVA	University van Amsterdam
VE	Virtual Environment
VR	Virtual Reality
VRET	Virtual Reality Exposure Therapy

Appendix A: Task Analysis

A.1 Task Decomposition [1]

Figures A.1 to *A.6* show the decomposition of the higher-level goals into procedures encountered in VRET. In decomposing a goal into its lower level task components, the following abbreviation is used:

- *Seq.*: Sequential. These tasks are performed in sequence.
- *Sim..*: Simultaneous. These tasks can be performed simultaneously
- *Alt.*: Alternative. The user selects only one of these tasks at a time.

Figure A.1 shows that the goal ‘Determine fear’is decomposed into the speech act ‘Ask patient to report fear’ through medium sound and the observational act ‘Monitor patients response’ while therapist monitors any responses made by a patient such as sound and movements using computer screen or by direct observation to patient’s posture.

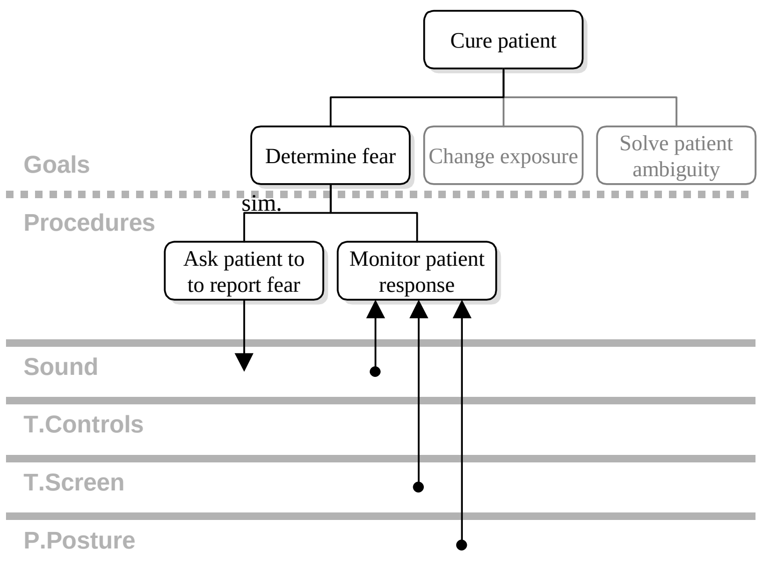


***Figure A.1**: ‘Determine fear’ goal decomposition (Schuemie, 2003)*

[1] Retrieved from Schuemie (2003)

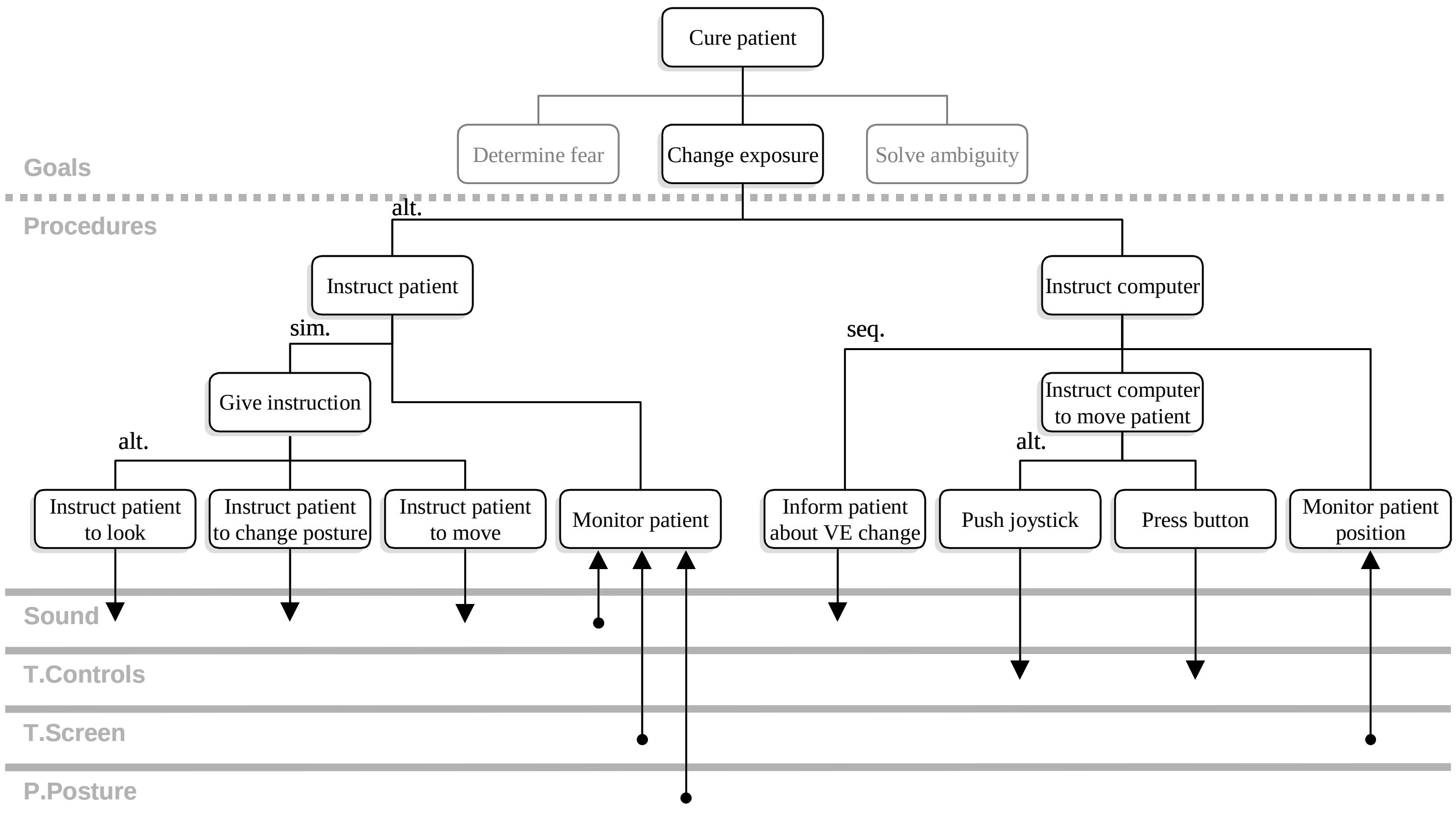


Figure A.2*: ‘Change exposure’ goal decomposition (Schuemie, 2003)’*

Figure A.2 shows the ‘Change exposure’ goal decomposition. The therapist has two choices, to instruct the patient or the computer. An instruction to a patient can be an instruction to look at something, change the posture or move. This instructions given is monitored by the therapist whether it was executed correctly by the patient. The therapist will inform every changes made when he or she intends to change the VE. Instruction to move patient will use either the joystick or keyboard. Once again the therapist will monitor the effect of these actions.

Figure A.3 shows the ‘Answer patient questions’ goal decomposition. When a patient asks something, the therapist will give a response and answer right away. However, some explanations of certain aspects of the therapy or VE will be given without being asked.

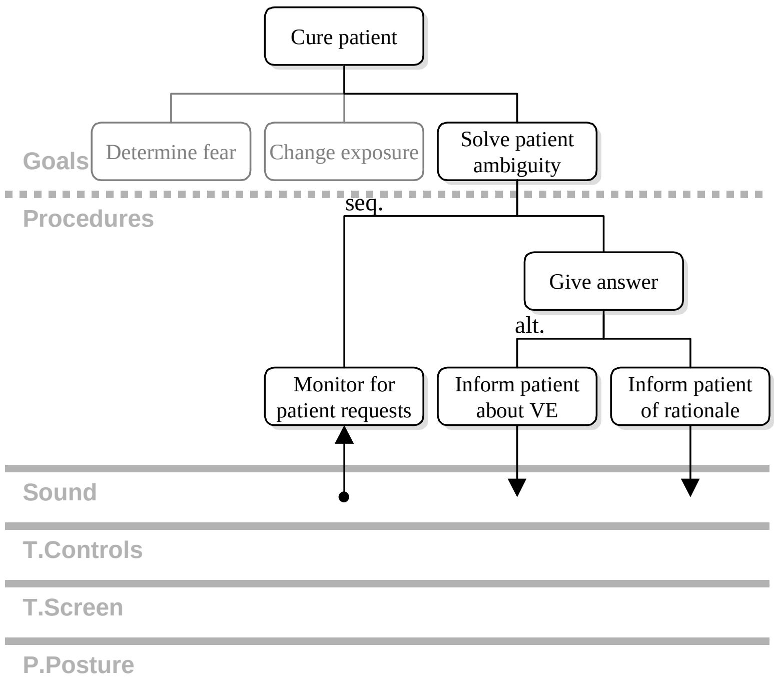


***Figure A.3**: ‘Solve ambiguity’ therapist goal decomposition (Schuemie, 2003)*

Figure A.4 shows ‘Follow therapist instructions’ goal decomposition. To follow the therapist instruction, the patient must be aware of the instruction given and executes it immediately. This instruction can change the VE experience by the change of the patient’s posture or report the patient’s fear level. When the patient asks to change his or her experience, the therapist will monitor the effect of every change.

Figure A.5 shows the ‘Avoid fearful situations’ goal decomposition. It is a tendency of phobic people to avoid some fearful situations by looking to other direction or step back from the fearful stimuli and situation. This action will be visible in the VE.

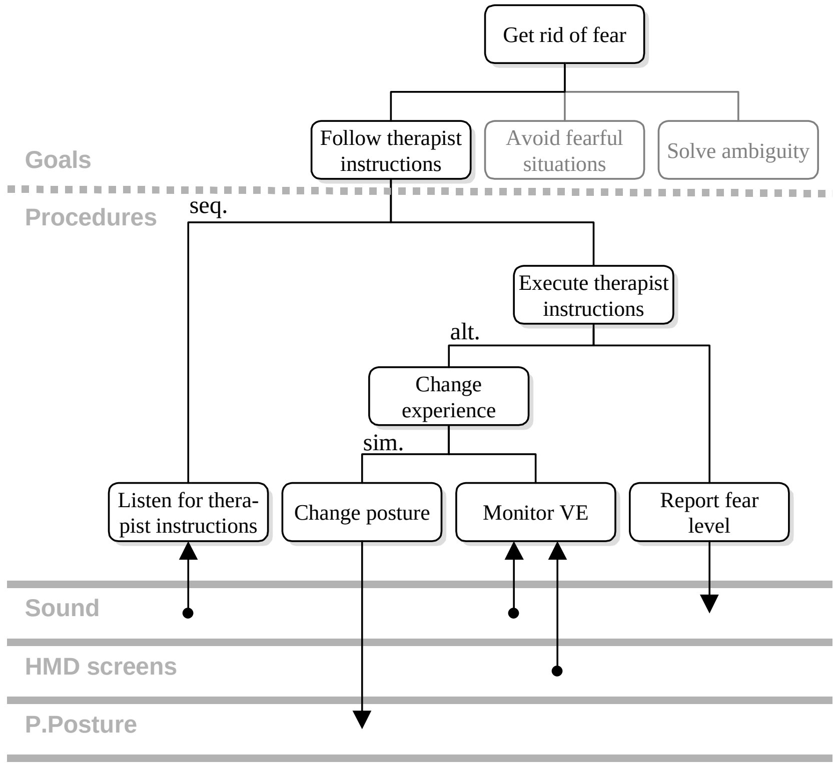


Figure A.4*: 'Follow therapist instructions' goal decomposition (Schuemie, 2003)*

Figure A.6 shows 'Solve ambiguity' goal decomposition. The patient asks a question when he/she finds an ambiguity about something in VE and waits for therapist's response.

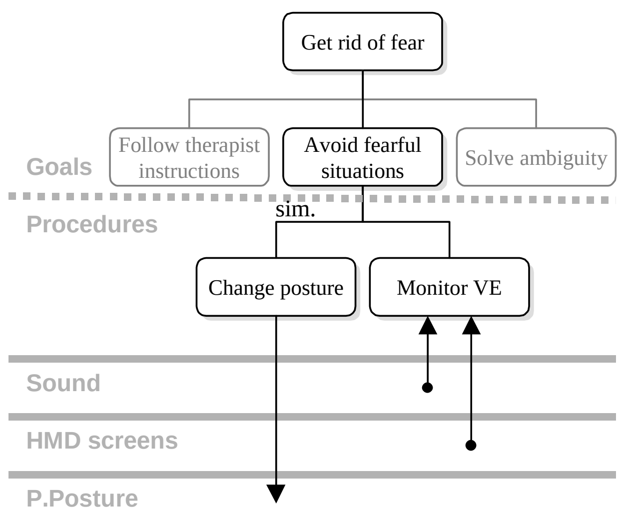


Figure A.5*: 'Avoid fearful situations' goal decomposition (Schuemie, 2003)*

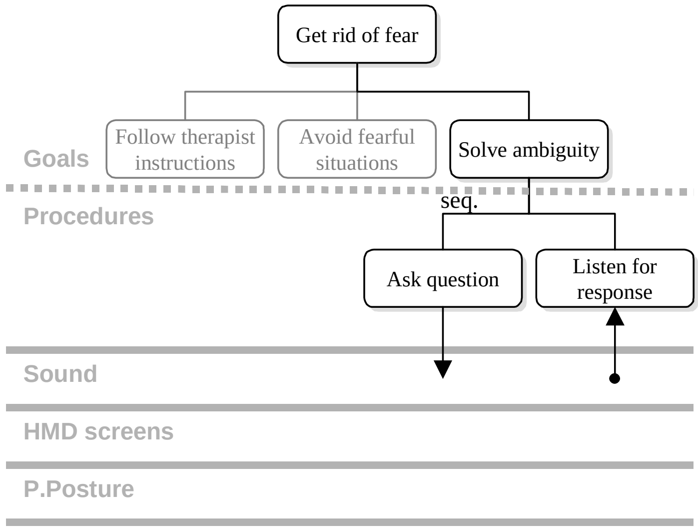


Figure A.6*: 'Solve ambiguity' goal decomposition (Schuemie, 2003)*

A.2 Information needs[2]

Element: **Ask patient to report fear**	
Description: **Verbal question by the therapist to the patient to report what level of fear he or she is currently experiencing.**	
Procedural information needs:	Sources:
State information needs:	Sources:

Element: **Monitor patient response**	
Description: **Monitoring the reactions of the patients that might indicate his or her fear level**	
Procedural information needs:	Sources:
State information needs: **Patient's fear responses**	Sources: **Sound** **T.Screen** **P.Posture**

Element: **Instruct patient to look**	
Description: **Verbally instructing the patient to look into a certain direction**	
Procedural information needs:	Sources:
State information needs:	Sources:

[2] Retrieved from (Schuemie, 2003)

Element: **Instruct patient to change posture**	
Description: **Verbally instructing the patient to change his or her posture in a certain way**	
Procedural information needs:	Sources:
State information needs:	Sources:

Element: **Monitor patient**	
Description: **Monitoring whether the patient is following instructions**	
Procedural information needs:	Sources:
State information needs: **Current patient looking direction** **Current patient posture** **Current patient location in VE** **Potential patient movement**	Sources: **Sound** **T.Screen** **P.Posture**

Element: **Inform patient about VE changes**	
Description: **Verbally informing the patient about any changes that the therapist will make to the VE**	
Procedural information needs:	Sources:
State information needs:	Sources:

Element: **Push joystick**	
Description: **Operation of the joystick in order to move the patient**	
Procedural information needs: **Operation of the joystick**	Sources: **Training** **Manual**
State information needs:	Sources:

Element: **Press button**	
Description: **Pressing one of the buttons to start or stop the autopilot**	
Procedural information needs: **Relationship between buttons and locations** **Operation of the autopilot**	Sources: **Training** **Manual**
State information needs:	Sources:

Element: **Monitor patient position**	
Description: **Monitoring the effect that the therapist's controls have on the VE**	
Procedural information needs:	Sources:
State information needs: **Position of the patient in the VE**	Sources: **T.Screen**

Effect of interactions by patient	

Element: **Monitor for patient request**	
Description: **Listening to the patient to determine if the patient has a question**	
Procedural information needs:	Sources:
State information needs: **Does the patient have a question**	Sources: **Sound**

Element: **Inform patient about VE**	
Description: **Informing the patient about the VE**	
Procedural information needs:	Sources:
State information needs:	Sources:

Element: **Inform patient of rationale**	
Description: **Informing the patient about the rationale of the therapy**	
Procedural information needs:	Sources:
State information needs:	Sources:

Element: **Listen for therapist instructions**	
Description: **Listening for any instructions that the therapist might give**	
Procedural information needs:	Sources:
State information needs: **Therapist instructions**	Sources: **Sound**

Element: **Change posture (Change experience)**	
Description: **Changing one's posture in accordance with therapist's instructions**	
Procedural information needs: **Effect of posture change on the view in the HMD**	Sources: **Training**
State information needs:	Sources:

Element: **Monitor VE (Change experience)**	
Description: **Monitoring the effect that one's actions have on the VE as seen in the HMD**	
Procedural information needs:	Sources:
State information needs: **Effect of own actions on VE** **Effect of therapist actions**	Sources: **Sound** **HMD screens**

Element: **Report fear level**	
Description: **Reporting of the fear level to the therapist**	
Procedural information needs:	Sources:
State information needs:	Sources:

Element: **Change posture (Avoid fearful situations)**	
Description: **Changing one's posture to avoid a situation that is fearful to the patient**	
Procedural information needs: **Effect of posture change on the view in the HMD**	Sources: **Training**
State information needs:	Sources:

Element: **Monitor VE (Avoid fearful situations)**	
Description: **Monitoring the VE to determine whether avoidance behavior is successful**	
Procedural information needs:	Sources:
State information needs: **Effect of avoidance behavior**	Sources: **Sound** **HMD screens**
Element: **Ask question**	
Description: **Asking a question to the therapist to resolve an ambiguity**	
Procedural information needs:	Sources:
State information needs:	Sources:

Element: **Listen for response**	
Description: **Listening to any answer the therapist might give in reply to a question**	
Procedural information needs:	Sources:
State information needs: **Therapists answer**	Sources: **Sound**

Appendix B: Design Documents

B.1 Patient's User Interface

B.1.1 Structure

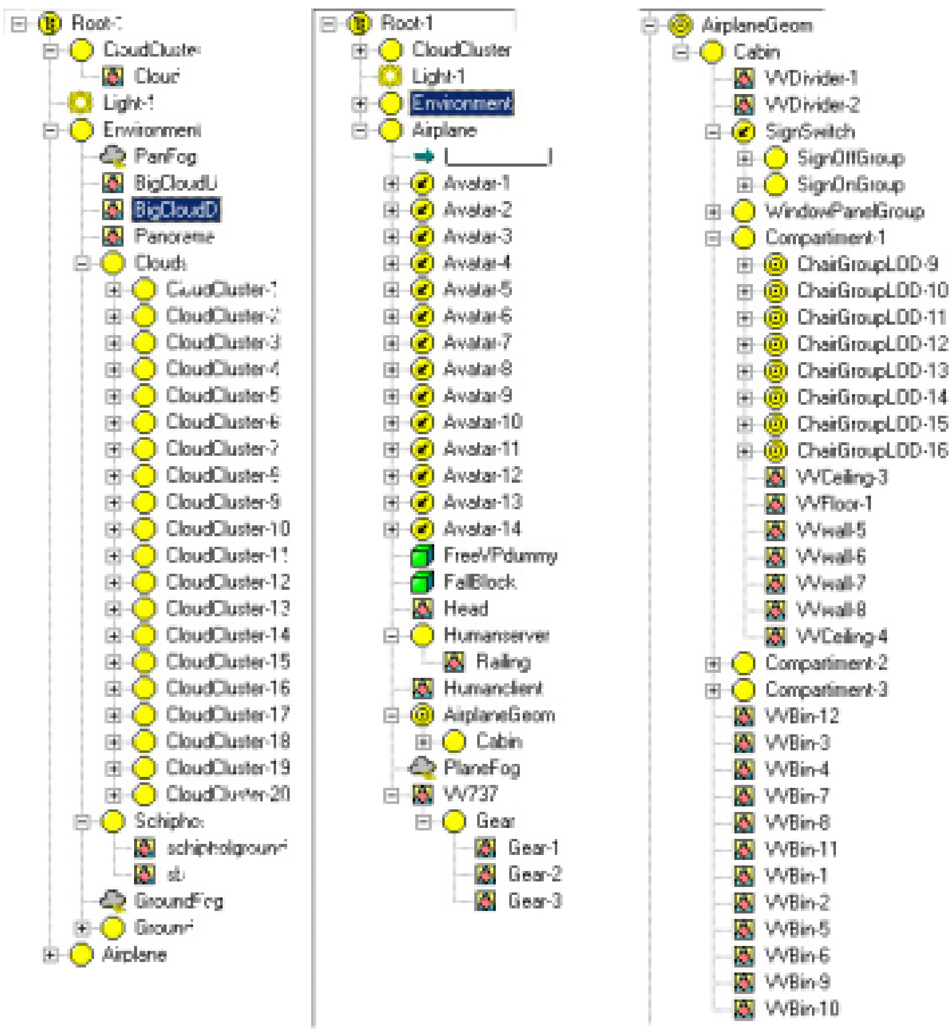


Figure B.1: *Fear of Flying World Stucture*

B.1.2 Avatar's Positions

No.	Name	ImageName	x	y	z
1.	Avatar-1	Woman05	45	38	-25
2.	Avatar-2	Man01	150	38	230
3.	Avatar-3	Woman05	-54	38	390
4.	Avatar-4	Man01	-146	38	-330
5.	Avatar-5	Man06	-135	38	150
6.	Avatar-6	Man04	146	38	-349
7.	Avatar-7	Man01	88	38	135
8.	Avatar-8	Woman01	55	38	300
9.	Avatar-9	Man04	145	38	130
10.	Avatar-10	Woman01	145	38	-100
11.	Avatar-11	Woman05	-145	38	-100
12.	Avatar-12	Woman01	-55	38	-330
13.	Avatar-13	Man04	-95	38	65
14.	Avatar-14	Woman01	40	35	-257
15.	*Avatar-15*[3]	*Man06*	*55*	*38*	*-430*
16.	*Avatar-16*	*Woman05*	*-95*	*38*	*-400*
17.	*Avatar-17*	*Man04*	*-145*	*38*	*-400*
18.	*Avatar-18*	*Woman05*	*45*	*38*	*-335*
19.	*Avatar-19*	*Man01*	*88*	*38*	*-225*
20.	*Avatar-20*	*Woman05*	*145*	*38*	*-190*
21.	*Avatar-21*	*Man04*	*88*	*38*	*-190*
22.	*Avatar-22*	*Man06*	*45*	*38*	*-190*
23.	*Avatar-23*	*Woman01*	*-50*	*38*	*-180*
24.	*Avatar-24*	*Man01*	*-105*	*38*	*-155*
25.	*Avatar-25*	*Man01*	*55*	*38*	*-90*
26.	*Avatar-26*	*Man06*	*100*	*38*	*60*
27.	*Avatar-27*	*Woman01*	*55*	*38*	*66*
28.	*Avatar-28*	*Woman05*	*-45*	*38*	*140*
29.	*Avatar-29*	*Woman01*	*-105*	*38*	*150*
30.	*Avatar-30*	*Man01*	*145*	*38*	*390*

Table B.1: *Avatars position in the airplane*

Avatars Rotation:

Pitch (x) = 0
Yaw (y) = -180
Roll (z) = 0

[3] Avatars in cursief are new

B.1.3 Scripts

Script	Object	Function
AVAirplane	HumanClient	This script calculates the behavior of the airplane based on the thrust, roll and angle of attack
AVCabinLight[4]	*Cabin*	*To handle the Cabin Light (On/Off)*
AVCloud	Clouds	This scipt deletes clouds behind the airplane and places new ones in front of the plane
AVEnvirontment	Environment	This script handles the content of the background panorama and transmitions from clouded to fair etc.
AVFlightControl	HumanClient	This script triggers the events in sequence in the virtual world. Based on the flight status, it triggers sounds and sets the thrust, angle of attack and roll of the airplane
AVGround	Ground	This script handles the display of the ground by showing only n by n grid-elements at a time. The textures for the elements are loaded in runtime from the grid directory
AVLastClientControl	-	*To control client*
AVLastEnvControl	*HumanClient, HumanServer*	*To control the environment*
AVLastServerControl	*HumanServer*	*To Control Server*
AVLastShutdown	*Universe Shutdown Script*	*Shutdown script*
AVLastStartup	*Universe StartUp Script*	*Startup script*
AVLoadAvatarsMan	*procedure*	*Procedure to load avatars*
AVPanorama	Panorama	To show the background sky and ground, a polygon is placed in front of the user's viewpoint at a large distance and the texture on this polygon is changed to show the part of the background the user is looking at. This script both positions this object and changes it's texture
AVPing	The Active Child action from object: SignSwitch	To play the sound 'ping' when fasten seatbelt sign on/off
AVServerFlightControl	HumanServer	This script synchronises the behavior of the airplance on the client computer with that on the server computer
AVShow_avatas	Avatar 1 – 30	

[4] Modified or new scripts are the scripts in cursief

Script	Object	Function
AVTimeofDay	*Environment*	*To change the panorama depends on the time of the day*
AVWindowpanelGroup	WindowpanelGroup	
AVWindowpanel	Windowpanel-1 sd 24	

Table B.2: *Scripts used in Airplane World.*

B.1.4 Environments State

Name	Value	Key	State	Attached to script
E1	0	S	Fasten sealbelt sign : Off	AVLastEnvControl
E1	1	S	Fasten sealbelt sign : On	AVLastEnvControl
E2	1	Q	Cloud Condition : Fair	AVLastEnvControl
E2	2	W	Cloud Condition : Cover Above	AVLastEnvControl
E2	3	E	Cloud Condition : Cover In	AVLastEnvControl
E2	4	R	Cloud Condition : Cover Under	AVLastEnvControl
E3	0		Flight status : Standing still	AVFlightControl
E3	1	1	Flight status : Taxiing	AVFlightControl
E3	2	2	Flight status : Further Taxiing	AVFlightControl
E3	3	3	Flight status : Take Off	AVFlightControl
E3	4	4	Flight status : Flying	AVFlightControl
E3	5	5	Flight status : Landing	AVFlightControl
E3[5]	*6*	*6*	*Flight status : Roll Left*	*AVFlightControl*
E3	*7*	*7*	*Flight status : Roll Right*	*AVFlightControl*
E4	0	[	Patient’s window : Close	AVLastEnvControl
E4	1	]	Patient’s window : Open	AVLastEnvControl
E5	0		Other window panel : Close	AVLastEnvControl
E5	1		Other window panel : Open	AVLastEnvControl
E6	0	0	Voice: None/Stop	AVLastEnvControl
E6	*1110*[6]	*Z*	*Pilot Douma Barcelona Welcome*	*AVLastEnvControl*
E6	*1111*		*Pilot Douma Barcelona Technical Delay*	*AVLastEnvControl*
E6	*1112*	*X*	*Pilot Douma Barcelona End Technical Delay*	*AVLastEnvControl*
E6	*1113*	*C*	*Pilot Douma Barcelona Crew Doors Automatic*	*AVLastEnvControl*
E6	*1114*	*V*	*Pilot Douma Barcelona Crew Take Seat*	*AVLastEnvControl*
E6	*1115*	*B*	*Pilot Douma Barcelona Height Info*	*AVLastEnvControl*
E6	*1116*	*N*	*Pilot Douma Barcelona Turbulence*	*AVLastEnvControl*
E6	*1117*	*M*	*Pilot Douma Barcelona Lightning*	*AVLastEnvControl*
E6	*1118*	*,*	*Pilot Douma Barcelona Crew Prepare Landing*	*AVLastEnvControl*

[5] Modified or new en/vironments are in cursief
[6] The complete announcements variable is in Appendix B.1.8: Sounds

Name	**Value**	**Key**	**State**	**Attached to script**
E6	*1119*	*.*	*Pilot Douma Barcelona Goodbye*	*AVLastEnvControl*
E6	*11110*	*/*	*Pilot Douma Barcelona Crew Doors Manual*	*AVLastEnvControl*
E6	*2110*	*K*	*Purser Douma Barcelona Welcome*	*AVLastEnvControl*
E6	*2111*	*L*	*Purser Douma FSI*	*AVLastEnvControl*
E6	*2112*		*Purser Douma Free Tax Stuff*	*AVLastEnvControl*
E6	*2113*		*Purser Douma Barcelona Approaching*	*AVLastEnvControl*
E6	*2114*		*Purser Douma Barcelona Goodbye*	*AVLastEnvControl*
E7	0		Seat : None	AVLastEnvControl
E7	1		Seat : 10, Side : Right	AVLastEnvControl
E7	2		Seat : 10, Side : Left	AVLastEnvControl
E7	3		Seat : 6, Side : Right	AVLastEnvControl
E7	4		Seat : 6, Side : Left	AVLastEnvControl
E7	5		Seat : 3, Side : Right	AVLastEnvControl
E7	6		Seat : 3, Side : Right	AVLastEnvControl
E7	7		Seat : 3, Side : Left	AVLastEnvControl
E8	0		Turbulence (Off)	AVLastEnvControl
E8	1		Turbulence (On)	AVLastEnvControl
E10	777		Alone without data from console	AVLastEnvControl
E11	*0*	*9*	*Cabin's Light : Off*	*AVLastEnvControl*
E11	*1*	*9*	*Cabin's Light : On*	*AVLastEnvControl*
E12	*0*	*8*	*Lightning & Thunder : Off*	*AVLastEnvControl*
E12	*1*	*8*	*Lightning & Thunder : On*	*AVLastEnvControl*
E13	*1*	*Y*	*Flying Time : Morning*	*AVLastEnvControl*
E13	*2*	*U*	*Flying Time : Day*	*AVLastEnvControl*
E13	*3*	*I*	*Flying Time : Afternoon*	*AVLastEnvControl*
E13	*4*	*O*	*Flying Time : Night*	*AVLastEnvControl*
E14	*0*	*D*	*Passengers : None*	*AVLastEnvControl*
E14	*1*	*F*	*Passengers : Few*	*AVLastEnvControl*
E14	*2*	*G*	*Passengers : Moderate*	*AVLastEnvControl*
E15	*0*	*H*	*FlapWings : Off*	*AVLastEnvControl*
E15	*1*	*H*	*FlapWings: On*	*AVLastEnvControl*
E16	*0*	*J*	*Landing Gear : Off*	*AVLastEnvControl*
E16	*1*	*J*	*Landing Gear : On*	*AVLastEnvControl*

Table B.3: *Environment states*

B.1.5 Flying Sequences

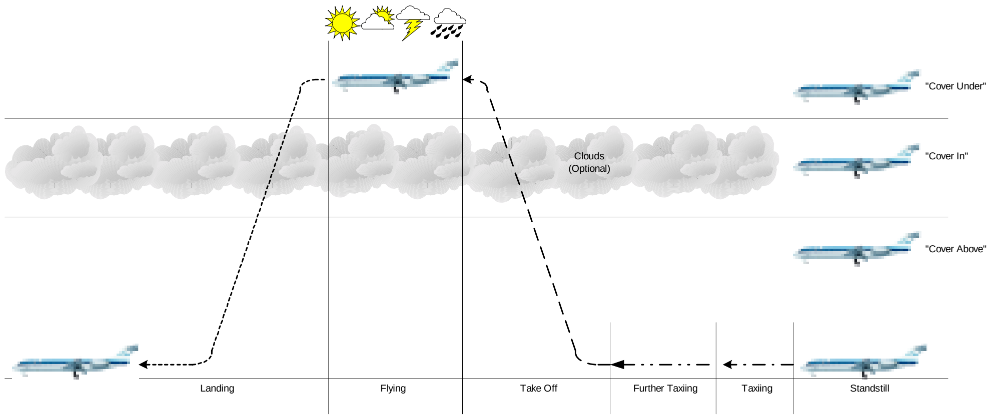


Figure B.2: *Flying Sequences Diagram*

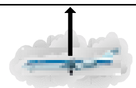
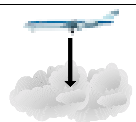
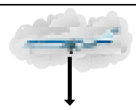
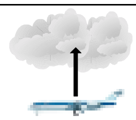
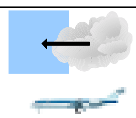
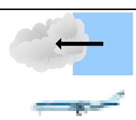
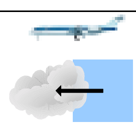
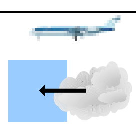
Sequence	Sts	Sub Sequence	Time	Sound Name	Sound Length	Sound File	Path
Standing Still	0		~	EngineTaxi	0:02	EngineTaxi.wav	-
Taxiing	1		5:17	EngineTaxi	0:02	EngineTaxi.wav	Taxi-1 (7318 elements)
Add. Taxiing	2		4:57	EngineTaxi	0:02	EngineTaxi.wav	Taxi-2 (6827 elements)
Taking Off	3	Run.Taxiing Take Off Rolling Flying	0:10 0:40 0:46 ~	TakeOff TakeOff EngineCruise EngineCruise	1:25 0:04.222 0:04.222	EngineTakeOffNo-Gear.wav EngineCruise.wav EngineCruise.wav	-
Flying	4	Flying Left Rolling Right Rolling Turbulence Lightning	~	EngineCruise EngineCruise EngineCruise Turbulence Lightning	0:04.222 0:04.222 0:04.222 0:16.796 0:16.514	EngineCruise.wav EngineCruise.wav EngineCruise.wav Turbulence.wav Lightning.wav	-
Landing	5	Approaching Touch Down Hard Taxiing Taxiing	3:22 at 3:22 0:10	EngineLanding	4:33.175	EngineLanding.wav	Landing-1 (6290 elements)
Note: Flapwings : Flapwings.wav (0:05.499) Gear up : Gear.wav (0:05.332)							

Table B.4: *Sequences and airplane's sound*

Sequence	Voice : Pilot	Voice : Purser	Turbu -lence	Light-ning	Left Roll	Right Roll	Cabin Light	Seat Sign	Win-dow
Standing Still	• Welcome (1:09) • Technical Delay (0:53) • End of Technical Delay (0:30) • Crew: Yellow door selection (0:02)	• Welcome (0:39)	×	×	×	×		✓	✓
Additional Taxiing	•	• Flight Safety Instruction (2:36)	×	×	×	×	✓	✓	✓
Taxiing	•	• Flight Safety Instruction (2:36)	×	×	×	×	✓	✓	✓
Taking Off	• Crew: Take Seat (0:01)	•	×	×	×	×	✓	✓	✓
Flying	• Height Information (0:38) • Bad Weather Turbulence (0:40) • Bad Weather Lightning (0:43)	• Tax Free Stuff (0:15)	✓	✓	✓	✓	✓	✓	✓
Landing	• Crew: Prepare Landing (0:01) • Goodbye (0:19) • Crew: Doors manual open (0:05)	• Approaching airport (0:42) • Goodbye (1:08)	×	×	×	×	✓	✓	✓

Table B.5: *Sequences and voice announcements*

B.1.6 Cloud Transition

Old Weather	Condition	Old State	Time	Early Progress	Middle Progress	Late Progress	New State	New Weather
CoverIn		Panorama = False ImageName = - BigCloudD = False Ground = False Planefog = True Clouds = False Schiphol = False	10 sec	Panorama = True Planefog = True Panfog = True (transition)		**Progress > 1** Progress = 1 Planefog = False Panfog = False (End of transition) Weather = "coverunder"	Panorama = True ImageName = "cloudsky" BigCloudD = False Ground = False Planefog = False Clouds = False Schiphol = False	Cover Under
Cover Under		Panorama = True ImageName = "cloudsky" BigCloudD = False Ground = False Planefog = False Clouds = False Schiphol = False	10 sec	Panfog = True Planefog = True		**Progress > 1** Progress = 1 Weather = "coverin" Panorama = False Panfog = False	Panorama = False ImageName = - BigCloudD = False Ground = False Planefog = True Clouds = False Schiphol = False	CoverIn
CoverIn		Panorama = False ImageName = - BigCloudD = False Ground = False Planefog = True Clouds = False Schiphol = False	5 sec	Groundfog = False Panorama = True Panfog = True Ground = True Clouds = True Schiphol = True Planefog = True		**Progress > 1** Progress = 1 Weather = "coverabove" Panfog = False Planefog = False Groundfog = True	Panorama = True ImageName = "skycover" BigCloudD = False Ground = True Planefog = False Clouds = True Schiphol = True	Cover Above
Cover Above		Panorama = True ImageName = "skycover" BigCloudD = False Ground = True Planefog = False Clouds = True Schiphol = True	5 sec	Groundfog = False Panfog = True Ground = True Clouds = True Schiphol = True Planefog = True		**Progress > 1** Progress = 1 Weather = "coverin" Panorama = False Panfog = False Groundfog = True	Panorama = False ImageName = - BigCloudD = False Ground = False Planefog = True Clouds = False Schiphol = False	CoverIn
Cover Above		Panorama = True ImageName = "skycover" BigCloudD = False Ground = True Planefog = False Clouds = True Schiphol = True	20 sec	GetTranslation GetTranslation BigCloudU = True SetTranslation (BigCloudU)		**Progress > 1** Progress = 1 Weather = "fair" BigCloudU = False	Panorama = True ImageName = "sky" BigCloudD = False Ground = True Planefog = False Clouds = True Schiphol = True	Fair
Fair		Panorama = True ImageName = "sky" BigCloudD = False Ground = True Planefog = False Clouds = True Schiphol = True	20 sec	GetTranslation GetRotation BigCloudU = True SetTranslation (BigCloudU)		**Progress > 1** Progress = 1 Weather = "coverabove" ImageName = "skycover" BigCloudU = False	Panorama = True ImageName = "skycover" BigCloudD = False Ground = True Planefog = False Clouds = True Schiphol = True	Cover Above
Fair		Panorama = True ImageName = "sky" BigCloudD = False Ground = True Planefog = False Clouds = True Schiphol = True	20 sec	GetTranslation GetRotation BigCloudD = True SetTranslation (BigCloudD)	**Progress > 0.9** ImageName = "cloudsky"	**Progress > 1** Progress = 1 Weather = "coverunder" BigCloudD = False Ground = False Clouds = False Schiphol = False	Panorama = True ImageName = "cloudsky" BigCloudD = False Ground = False Planefog = False Clouds = False Schiphol = False	Cover Under
Cover Under		Panorama = True ImageName = "cloudsky" BigCloudD = False Ground = False Planefog = False Clouds = False	20 sec	GetTranslation GetRotation Ground = True Clouds = True Schiphol = True BigCloudD = True SetTranslation (BigCloudD)		**Progress > 1** Progress = 1 Weather = "fair" BigCloudD = False	Panorama = True ImageName = "sky" BigCloudD = False Ground = True Planefog = False Clouds = True	Fair

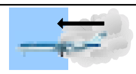
Old Weather	Condition	Old State	Time	Early Progress	Middle Progress	Late Progress	New State	New Weather
		Schiphol = False					Schiphol = True	
Fair		Panorama = True ImageName = “sky” BigCloudD = False Ground = True Planefog = False Clouds = True Schiphol = True	20 sec	GetTranslation GetRotation BigCloudD = True BigCloudU = True SetTranslation (BigCloudD) SetTranslation (BigCloudU)	**Progress > 0.7** Groundfog = False Panfog = True Ground = True Clouds = True Schiphol = True Planefog = True	**Progress > 1** Progress = 1 Weather = “coverin” Panorama = False Panfog = False Groundfog = True BigCloudU = False BigCloudD = False	Panorama = False ImageName = - BigCloudD = False Ground = False Planefog = True Clouds = False Schiphol = False	CoverIn
CoverIn		Panorama = False ImageName = - BigCloudD = False Ground = False Planefog = True Clouds = False Schiphol = False	20 sec	Panorama = True Ground = True Clouds = True Schiphol = True GetTranslation GetRotation BigCloudD = True SetTranslation (BigCloudD) BigCloudU = True SetTranslation (BigCloudU)	**Progress < 0.3** Groundfog = False Panfog = True Planefog = True	**Progress > 1** Progress = 1 Weather = “fair” Panfog = False Groundfog = True BigCloudU = False BigCloudD = False	Panorama = True ImageName = “sky” BigCloudD = False Ground = True Planefog = False Clouds = True Schiphol = True	Fair

Table B.6: *Clouds possible transitions*

B.1.7. Cloud Condition

	Fair	CoverAbove	CoverUnder	CoverIn
Panorama.Enabled	True	True	True	False
Panorama.ImageName	“sky”	“skycover”	“cloudsky”	-
BigCloudD.Enabled	False	False	False	False
Ground.Enabled	True	True	False	False
Planefog.Enabled	False	False	False	True
Clouds.Enabled	True	True	False	False
Schiphol.Enabled	True	True	False	False

Table B.7: *Clouds conditions*

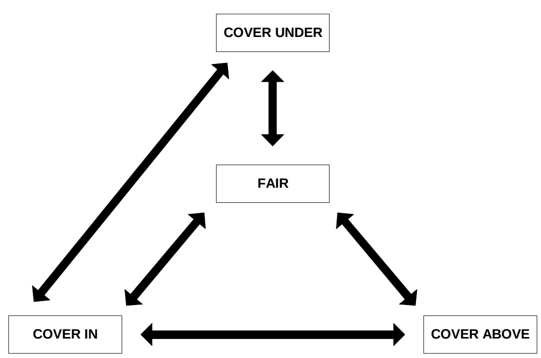


Figure B.3: *Cloud Condition Diagram*

B.1.8 Sounds

The E6 variable is contained:

First Digit	***Second Digit***	***Third Digit***	***Fourth Digit (Tag)***
1	1	1	0-10 (Pilot) 0-4 (Purser)
1 = Pilot 2 = Purser	Pilot ID / Purser ID	Destination Airport	

Tags for Pilot		
Tag	***Announcements***	***Tag Name***
0	Welcome	Welcome
1	Technical Delay	TechDelay
2	End of Technical Delay	TechDelayEnd
3	Crew: Yellow doors from Automatic	CrewDoorsAutomatic
4	Crew: Take your seat	CrewTakeSeat
5	Height Info	HeightInfo
6	Bad Weather (Turbulence)	BadWeatherTurbulence
7	Bad Weather (Lightning)	BadWeatherLightning
8	Crew: Prepare for Landing	CrewPrepareLanding
9	Goodbye	Goodbye
10	Crew: Door Manually Crew: Door may be opened	CreyDoorsManual

Table B.8: *Tags for pilot*

Tags for Purser		
Tag	***Announcements***	***Tag Name***
0	Welcome	Welcome
1	Flight Safety Information	FSI
2	Free Tax Stuff	FreeTaxStuff
3	Approaching	Approaching
4	Goodbye	Goodbye

Table B.9: *Tags for purser*

File Name: **“Pilot”/”Purser” + LastName + Destination + TagName . wav**
Example: PilotDoumaBarcelonaWelcome.wav, PurserDoumaMilanApproaching.wav

Pilot ID : Mame Douma = 1
Purser ID : Milly Douma = 1

Destination ID:
1 = Barcelona
2 = Paris
3 = Milan

B.2 Therapist’s User Interface

B.2.1 Output

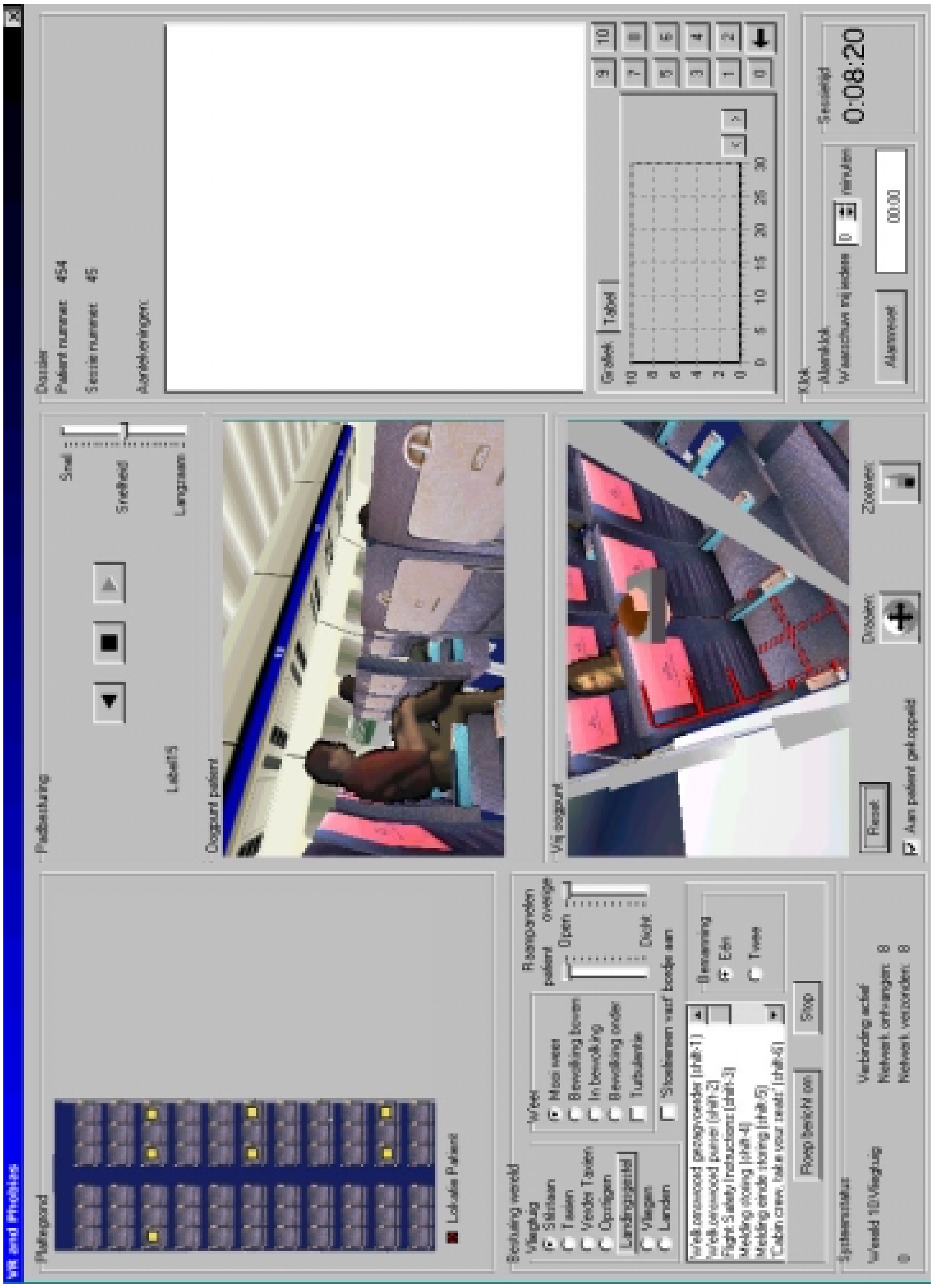


***Figure B.4**: The old therapist’s user interface*

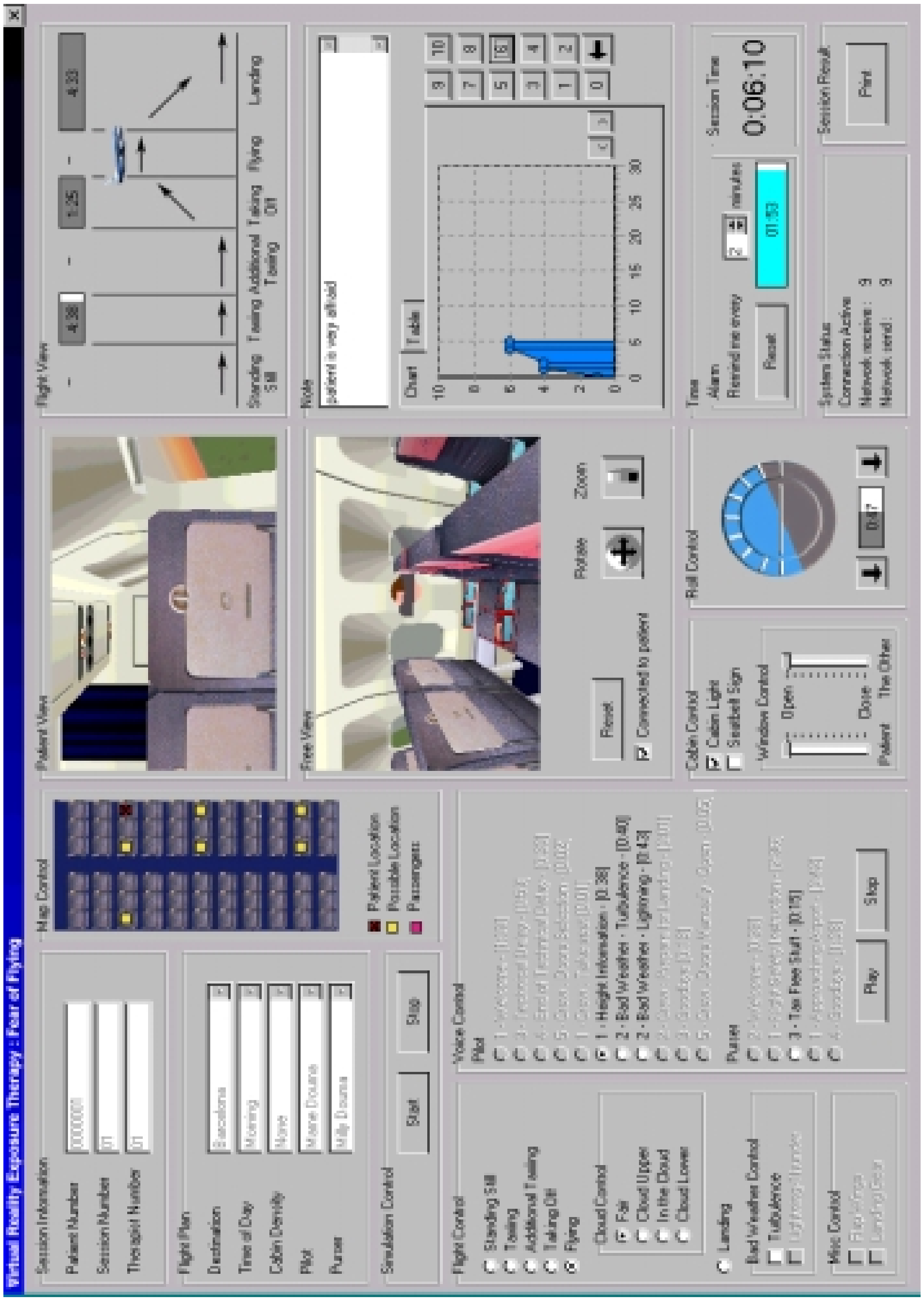
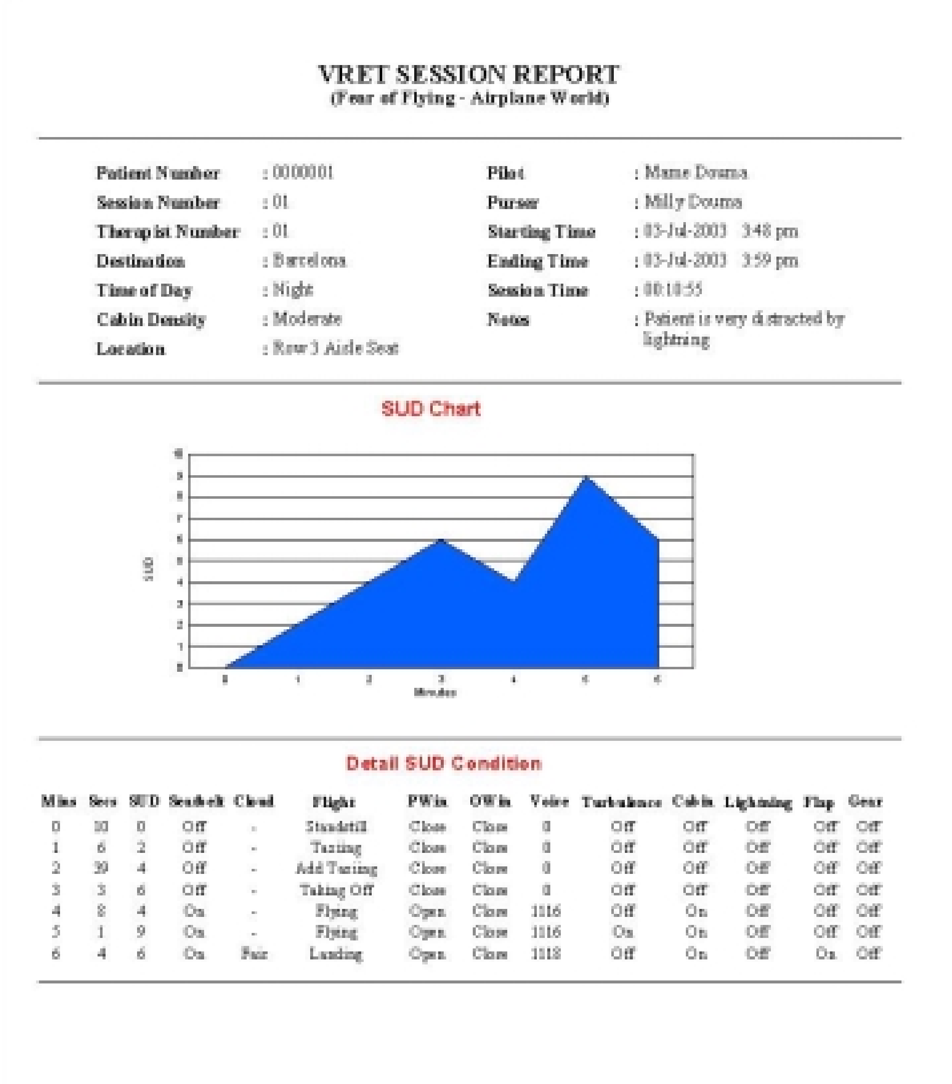


Figure B.5: *The new therapist's user interface*



VRET SESSION REPORT
(Fear of Flying - Airplane World)

Patient Number	: 0000001	Pilot	: Mame Douma
Session Number	: 01	Purser	: Milly Douma
Therapist Number	: 01	Starting Time	: 03-Jul-2003 3:48 pm
Destination	: Barcelona	Ending Time	: 03-Jul-2003 3:59 pm
Time of Day	: Night	Session Time	: 00:10:55
Cabin Density	: Moderate	Notes	: Patient is very distracted by lightning
Location	: Row 3 Aisle Seat		

SUD Chart

Detail SUD Condition

Mins	Secs	SUD	Seatbelt	Cloud	Flight	PWin	OWin	Voice	Turbulence	Cabin	Lightning	Flap	Gear
0	10	0	Off	-	Standstill	Close	Close	0	Off	Off	Off	Off	Off
1	6	2	Off	-	Taxiing	Close	Close	0	Off	Off	Off	Off	Off
2	39	4	Off	-	Add Taxiing	Close	Close	0	Off	Off	Off	Off	Off
3	3	6	Off	-	Taking Off	Close	Close	0	Off	Off	Off	Off	Off
4	8	4	On	-	Flying	Open	Close	1116	Off	On	Off	Off	Off
5	1	9	On	-	Flying	Open	Close	1116	On	On	Off	Off	Off
6	4	6	On	Fair	Landing	Open	Close	1118	Off	On	Off	On	Off

Figure B.6: *The report layout*

B.2.2 Miscellaneous

- The hardware and software spesification can be found separately.
- The user's manual also can be found separately.

B.3 Database

Database = Microsoft Access Database
File Name = Airplane.mdb
Tables =
- Sessions
- SUDs

Queries = Report

B.3.1 Structure Table Sessions

Key	*Field Name*	*Values*	*Field Type*	*Length*
*	PatientNumber		Text	7
*	SessionNumber		Text	2
	TherapistNumber		Text	7
	DestinationID	1 = Barcelona 2 = Paris 3 = Milan	Number	Byte
	TimeofDayID	1 = Morning 2 = Day 3 = Afternoon 4 = Night	Number	Byte
	CabinDensityID	0 = None 1 = Few Passengers 2 = Moderate Passengers	Number	Byte
	PilotID	1 = Mame Douma	Number	Byte
	PurserID	1 = Milly Douma	Number	Byte
	Location		Number	Byte
	StartingTime		Date/Time	
	EndingTime		Date/Time	
	Notes		Memo	

Table B.10: *Structure of Session Table*

B.3.2 Structure Table SUDs

Key	*Field Name*	*Values*	*Field Type*	*Length*
*	PatientNumber		Text	7
*	SessionNumber		Text	2
*	Minutes		Number	Byte
*	Seconds		Number	Byte
	SUD		Number	Byte
	E1	Fasten Seatbelt Sign	Number	Single
	E2	Cloud Condition	Number	Single
	E3	Flight Status	Number	Single
	E4	Patient’s Window	Number	Single
	E5	Other windows	Number	Single

Key	Field Name	Values	Field Type	Length
	E6	Voice Announcements	Number	Single
	E7	Seat	Number	Single
	E8	Turbulence	Number	Single
	E11	Cabin Light	Number	Single
	E12	Lightning	Number	Single
	E13	Flying Time	Number	Single
	E14	Cabin Density	Number	Single
	E15	Flap Wings	Number	Single
	E16	Landing Gear	Number	Single

Table B.11: *Structure of SUDs Table*

B.3.3 Query Report

```
SELECT Sessions.PatientNumber, Sessions.SessionNumber,
       Sessions.TherapistNumber, Sessions.DestinationID,
       Sessions.TimeofDayID, Sessions.CabinDensityID, Sessions.PilotID,
       Sessions.PurserID, Sessions.Location, Sessions.StartingTime,
       Sessions.EndingTime, Sessions.Notes, SUDs.Minutes, SUDs.Seconds,
       SUDs.SUD, SUDs.E1, SUDs.E2, SUDs.E3, SUDs.E4, SUDs.E5, SUDs.E6,
       SUDs.E7, SUDs.E8, SUDs.E11, SUDs.E12, SUDs.E13, SUDs.E14, SUDs.E15,
       SUDs.E16
FROM Sessions LEFT JOIN SUDs ON (Sessions.SessionNumber = SUDs.SessionNumber)
       AND (Sessions.PatientNumber = SUDs.PatientNumber);
```

Appendix C: Questionnaires

C.1 Evaluation Protocol

Evaluation Protocol for therapist and patient

Introduction
State name, institution and the name of the project (VRET for fear of flying using airplane world), as well as our partner, the University of Amsterdam and VALK Foundation.

Informed consent
'Any information you will provide during the experiment will be treated confidentially and will not be linked to your name but to a number. The sole purpose of the experiment is for system evaluation by researcher.'

Explain how to do the experiment
The purpose of this experiment is to evaluate 2 systems, A and B, two sessions will be conducted. The length of the experiment more or less will be 1 hour and there will be a small break, 15 minutes break, between sessions.
One participant become a therapist, the other become a patient. Decide amongst them, who will become a therapist or a patient by randomly assigned or flipped the coin. Questionnaires will be given to all participants, depending of what kind of actor they are, therapist or patient. Computer experience questionnaire will be given to all participants regardless as therapist or patient.

For Therapist

- Explain the therapist goal in curing the patient.
- The goal is to evaluate the usability of the therapist user interface for both systems, A and B.
- Filling Computer experience questionnaire
- Explain the detail of experiment will be conducted. (In separate sheet: Task for Therapist)
- Explain generally how the therapist's user interface works, using the printed version of therapist user interface for both systems, A and B. Let the therapist get used to with the user interface for a while (± 5 minutes).
- The therapist will evaluate using usability questionnaires, right away after each session.
- Measure the time for every task given
- Give assistance when needed; count this as error or difficulties.

For Patient

- Explain the condition of the patient that has fear of flying.
- The goal is to evaluate the sense of presence of the old and new system.

- The patient will experience the flight sequence from standing still, taxiing, taking off, flying and landing, with all the correspondences voices from pilot and purser.
- Also during the flight, patient will experience bad weather flying, turbulence or lightning.
- Filling Computer experience questionnaire
- Explain the detail of experiment will be conducted (In separate sheet: Task for Patient)
- The patient will evaluate the system using two kinds of questionnaires, IPQ questionnaires and SAM (Self-Assessment Manikin).
- The SAM questionnaires will be given 4 times, before and after the first session, also before and after the second session.
- The IPQ Questionnaires will be given 2 times, after each session.

Complains, comments and wishes
Ask for their free opinion about the system,

- General Remarks
- What need to be improved?
- Is there any obstacle to do something?
- How is the overall comparison of system?

Finishing
Thank you very much for your cooperation. Offer if the therapist wants to try the patient's seat and using the system.

C.2 Experiment 1

Task Instruction for Patient

Background
Imagine that you are a patient who has flying phobia. You want to be cured, and try a new virtual reality exposure therapy. You will be exposed to experience flying in virtual world.

Task
Sitting in the airplane, look around, to get used to with the environment. You will be asked every 3 minutes how big is your fear scale from 0 to 10.

Computer Experience Questionnaire[7]

Please rate the following question on a scale from one to five.

1.	How do you rate your overall computer skill	Very Bad	1	2	3	4	5	Very good

2.	How often do you use a computer	Never	1	2	3	4	5	Daily

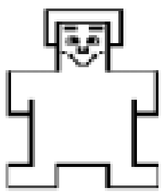
[7] This questionnaire was designed by Schuemie (2003)

3.	How often do you play 3D games on your computer	Never	1	2	3	4	5	Daily

4.	How often do you use 3D programs (excluding games)?	Never	1	2	3	4	5	Daily

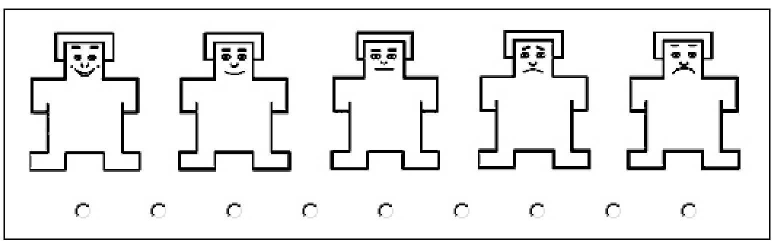
5.	Have you ever used a VR-helmet before?	Never	1	2	3	4	5	Often

SAM Questionnaires[8]

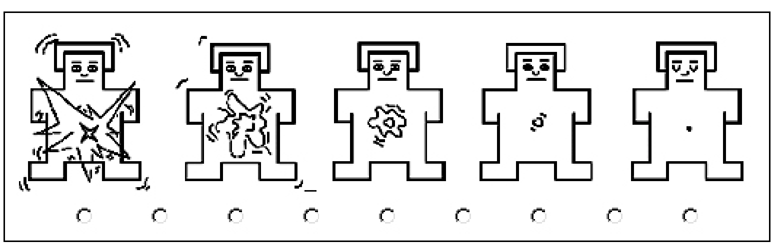


SAM stands for the Self-Assessment Manikin, a picture based scale, is used to measure a person's feeling or emotional response. It designed to represent the Pleasure (P), Arousal (A) and Dominance (D) with a graphic character arranged on a linear nine-point scale.
SAM will be used today to indicate your emotional response before and after each session. We want you to tell us how you feel before and after each session. Don't rate the system, but rate **your feelings**.

The first line goes from a very Big Smile to a very Big Frown (see picture below). This line represents feelings that range from completely **HAPPY** or **ELATED** to completely **UNHAPPY** or **SAD**.

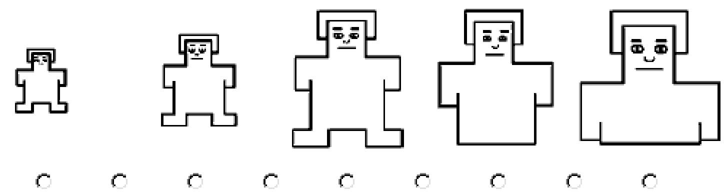


The second line of SAM represents feelings that range from very **EXCITED** or **INVOLVED** to very **CALM** or **BORED**.



[8] retrieved from AdSAM (2003)

The third line represents feelings that range from **BEING CONTROLLED** to **TAKEN CARE OF** or **BEING IN-CONTROL** or **ON TOP OF THINGS** (large figure).



Igroup Presence Questionnaires[9]

You will see some statements about experiences. Please indicate whether or not each statement applies to your experience. You can use the whole range of answers. There are no right or wrong answers, only your opinion counts.

You will notice that some questions are very similar to each other. This is necessary *for statistical reasons*. And please remember: Answer all these questions only referring to this *one* experience.

How aware were you of the real world surrounding while navigating in the virtual world? (i.e. sounds, room temperature, other people, etc.)?								
Extremely aware								Not aware at all
	-3	-2	-1	0	1	2	3	
	Moderately Aware							*64/inv1/0*

How real did the virtual world seem to you?								
Completely real								Not real at all
	-3	-2	-1	0	1	2	3	*48/real1/1*

I had a sense of acting in the virtual space, rather than operating something from outside.								
Fully disagree								Fully agree
	-3	-2	-1	0	1	2	3	*31/sp4/2*

How much did your experience in the virtual environment seem consistent with your real world experience?								
Not consistent								Very consistent
	-3	-2	-1	0	1	2	3	
	Moderately Consistent							*7/real2/3*

[9] Igroup Presence Questionnaire was developed by Schubert et. al. (1997) and downloaded from Igroup Presence Questionnaire Website.

How real did the virtual world seem to you?								
About as real as an imagined world								Indistinguishable from the real world
	-3	-2	-1	0	1	2	3	
								59/real3/4

I did not feel present in the virtual space								
Did not feel								Felt present
	-3	-2	-1	0	1	2	3	*28/sp3/5*

I was not aware of my real environment.								
Fully disagree								Fully agree
	-3	-2	-1	0	1	2	3	*37/inv2/6*

In the computer generated world I had a sense of "being there"								
Not at all								Very much
	-3	-2	-1	0	1	2	3	*62/g1/7*

Somehow I felt that the virtual world surrounded me.								
Fully disagree								Fully agree
	-3	-2	-1	0	1	2	3	*44/sp1/8*

I felt present in the virtual space.								
Fully disagree								Fully agree
	-3	-2	-1	0	1	2	3	*33/sp5/9*

I still paid attention to the real environment.								
Fully disagree								Fully agree
	-3	-2	-1	0	1	2	3	*48/inv3/10*

The virtual world seemed more realistic than the real world.								
Fully disagree								Fully agree
	-3	-2	-1	0	1	2	3	*47/real4/11*
I felt like I was just perceiving pictures.								
Fully disagree								Fully agree
	-3	-2	-1	0	1	2	3	*30/sp2/12*

I was completely captivated by the virtual world.								
Fully disagree								Fully agree
	-3	-2	-1	0	1	2	3	*38/inv4/13*

Do you have additional comments?

C.3 Experiment 2

Task Instruction for Therapist

General Instruction

In the next 20 minutes or so, you will be carrying out 3 or 4 tasks within the system. Note that we intentionally leave out some of the detailed task steps so that we can determine how well the system can guide your interactions with it. If you are confused at any point, first, please make your best guess about how to proceed, using the information that you have been given. We will intervene if necessary to help you make progress.

At the start of each task, please say out loud: “Beginning Task” followed by the number of the task. When you are done, please say: “Task Complete”

Background

Imagine that you are a therapist, who wants to cure the flying phobia patient. Instead of in vivo therapy, you are using new virtual reality exposure therapy. Basically you will expose the patient to sequence in flying in virtual world.

Task 1:

Loading the correspondence world (The A system is opvliegtuig08, the B system is opvliegtuignew01)

Task 2:

Start the simulation after fill in all the information needed.

Patient Number = 00000XX

Therapist Number = XX

The session number is 01 or 02 depending which one you conduct first.

Put the patient in window seat.

Task 3:

Set the alarm to remind every 3 minutes

Gradually expose the patient to flying sequences, standing still, taxiing, additional taxiing, taking off, flying, flying in bad weather, and landing. Also play the correspondences voices of pilot and purser.

Try to use every feature in the system (Bad weather, Cloud, Seatbelt sign, Window control, etc)

When the alarm fired, ask the patient to measure his/her fear (scale 0 - 10) and put this information to the SUD Chart.

Task 4 (Only for the B system):

Stop the simulation

Print the Session Report.

Computer Experience Questionnaire

Please rate the following question on a scale from one to five.

1.	How do you rate your overall computer skill	Very Bad	1	2	3	4	5	Very good
2.	How often do you use a computer	Never	1	2	3	4	5	Daily
3.	How often do you play 3D games on your computer	Never	1	2	3	4	5	Daily
4.	How often do you use 3D programs (excluding games)?	Never	1	2	3	4	5	Daily
5.	Have you ever used a VR-helmet before?	Never	1	2	3	4	5	Often

Usability Questionnaire for Therapist

Please indicate with a check mark from -3 to + 3 whether you agree with the following statements. -3 = Completely Disagree
+3 = Completely Agree

Nr.	**Question**	**-3**	**-2**	**-1**	**0**	**1**	**2**	**3**
1.	I had quickly learned how to use the system							
2.	I found the system to be easy to use.							
3.	I (subjectively) like to use the system							
4.	I found it easy to control the virtual world using the interface given.							
5.	It was easy to control what I wanted to do							
6.	I could do all things that I wanted to do							
7.	It was immediately clear what I could and what I couldn't do in the system							
8.	I felt like I was in complete control during the session							
9.	I like using the controls of the system							
10.	I found the error message is easy to understand							
11.	I found it was easy to correct the mistake I have made							
12.	Sometimes I feel I lost my orientation in controlling the Virtual World, like often forget 'In which stage I am' or 'When this stage will be over'							
13.	I could estimate how long the session will last and could plan the session precisely							

Nr.	Question	-3	-2	-1	0	1	2	3
14.	Language used is easy to understand and to memorized							
15.	I found it easy to fill the session and patient Information							
16.	I found the map to be clear and unambiguous							
17.	I found the flight control to be easy to use							
18.	I could see what I wanted to see on the patient's viewpoint							
19.	I could see what I wanted to see on the free viewpoint							
20.	I found the controls of the free viewpoint easy to use							
21.	I found it easy to use the cloud control							
22.	I found the SUDs recording is easy to use							
23.	I found the size of SUD chart size is big enough							
24.	I found that alarm clock easy to use							
25.	It was easy to control the voice of pilot and purser							
26.	I found the Notes size is reasonable							
27.	I found the user interface is used efficiently.							

Only for system B

Nr.	Question	-3	-2	-1	0	1	2	3
28.	I found it easy to control the Flight plan							
29.	I found the Cabin Control is easy to use							
30.	I found the Roll Control is easy to use							
31.	I found the Flight View is very helpful							
32.	I found the Print Function is very useful							
33.	I found the report is easy to understand							
34.	The timer provided help so much							
35.	I found it easy to start and end the session							

What three things did you like most about the system? Why?

What three things did you like least about the system? Why?

What do you suggest?

Protocol Interview therapist

Questions

'I would like to read to you some statements regarding the system. I would like you to rate for each statement, whether you agree with it on a scale 1 (completely disagree) to 5 (completely agree). I also would like you to motivate your answer.'
Use a display of the UI to indicate which part you're talking about. If subjects asks what you mean by 'often', respond with: 'often means more than five times per session.'

(Roll controls)
1. 'I often used the roll controls.'
2. 'I found the roll controls to be easy to use.'

(Bad Weather Control)
3. 'I often used the bad weather control.'
4. ' I found the bad weather control to be easy to use.'

(Flight view)
5. 'I often see to the flight view'
6. 'The flight view give me overview of the sessions'
7. 'The timer given is very helpful'
8. ' In the therapist control condition, I have overview over the whole situation.'

(Report)
9. 'The report feature is very useful', why?

'Finally, I have some questions about the system in general:'
10. Which type of input you preferably choose to work with? (Session information in separate form, or the same user interface)
11. Which session information input system is easier to use?
12. Do you like the flight plan control?
13. Is this help you with planning a session?
14. Giving the limitation to you to control the system, is this a very good idea, or it makes you feel didn't free to do something?
15. For overall, in which system is easier to use?
16. In which system is easier to learn?
17. Do you like the new added features?
18. Which new feature is the most you (subjectively) like? Sort them!
19. Which new feature is the most helpful? Sort them!
20. How do you like the composition of therapist user interface? Is it well organize? Or too complicated? Which one is your preference?
21. 'Suppose you had to treat someone in VR again tomorrow. Which system would you choose to use?' (System A or System B)
22. Is the improved world is like you expected when you give some requirements? Define it in percentages. (Give the documents when they give some requirements and suggestion)