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D 4.1 Presence requirements for group work in a rich Virtual Environment

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TABLE OF CONTENTS

TABLE OF CONTENTS	3
EXECUTIVE SUMMARY	4
1. INTRODUCTION.....	5
2. PRESENCE.....	6
2.1. What's Presence.....	6
2.2. Presence measurement	7
2.2.1. Subjective measurements	8
2.2.2. Objective measurements	10
3. PRESENCE IN FIFTH FRAMEWORK PROGRAMME.....	12
4. PRESENCE IN DIFAC.....	16
4.1. Presence in training VE.....	17
4.1.1. Perceptual features.....	17
4.1.2. Individual factors	17
4.1.3. Content characteristics	18
4.1.4. Interpersonal, social and cultural context	18
4.2. Presence in Product Development VE.....	19
4.3. Presence in Factory Design VE.....	19
5. PRESENCE QUESTIONNAIRE.....	20
5.1. Presence Questionnaire 1	21
5.2. Presence Questionnaire 2	22
APPENDIX A – PRESENCE QUESTIONNAIRE 1:PPS	33
APPENDIX B: PRESENCE QUESTIONNAIRE 1: PRIMA.....	41

EXECUTIVE SUMMARY

This deliverable wants to investigate the sensation of Presence in Collaborative Virtual Environments.

After a first analysis and State of the Art of Presence definition and concept and measurements we linked the psychological theories to the objectives of the project.

We immediately found a problem: presence measurements are done during the use of the VE or just after the experience. On the contrary, the title of the deliverable is really clear: "Presence requirements for group work in a rich VE" (Virtual Environment), it means understand the needs in terms of Presence for a more effective design of the environments. This is the reason why we thought to use interactive questionnaires to investigate industrial partners needs. And we planned to have one more at the end of the project. The first one is reported in this deliverable with the requirements as conclusions we found. The second one will be illustrated in the T2.4 and it will be used during the validation phase testing the Virtual Environment.

After a first definition of the environment from our industrial partners, we identified the objective, the task, the persons and their duties inside the VE. Using the questionnaire we asked the industrial partners to defining the presence characteristics for each of the duties inside the environment. In the "analysis of the Presence questionnaire 1" chapter there's a compendium of the Presence requirements for each of the environment to be developed inside the project and the conclusion of this deliverable is a list of prerequisite and some comments in using them.

1. INTRODUCTION

This document presents the activities of the Task 1.4: Definition of presence requirements for group work in a rich virtualised environment.

After a first definition of what Presence is, and the landscape of Presence in different environments and sectors, the deliverable displays the methodologies for Presence measurements, on subjective and objective point of view. This will help the reader in better understand the meaning of Presence in environment that are presented in common life.

Further step into the concern of the project is the analysis of the Presence in DiFac three areas of action: Training, Product Development and Factory Design.

The Presence measurement methods illustrated are two different types: on one side there's one defined objective that takes into account physical observation as eye movements or the sweat, on the other hand there's another measurement method that measures the sense of presence in a VE asking for the subject about his feeling to be into the environment and the sense stimulus.

After a view of both classes of methods we illustrate the reasons for choosing the questionnaire approach. Since the questionnaire should be submitted after the usage of the environment, the decision is to create a first questionnaire in this stage of the project for discovering the industrial partners' requirements in creating the environment, and a second one during the validation phase.

Finally some requirements for group presence are presented and conclusions with further developments are lined up.

2. PRESENCE

In this section there's a brief identification of the Presence term, a sort of definition following the different theories and currents of thoughts.

After a common understanding of Presence, we focalised on the different approach of the individual and social presence, going through the focus on CWE.

2.1. What's Presence

Marvin Minsky (1980) used the term "telepresence" to refer to teleoperation technology that gives to the user a "remote presence" being in a different location via feedback systems that allow him to "see and feel what is happening" there. In 1991, the term changes in written form when a journal about Presence (MIT Press) was founded with this among its aims "current research and advanced ideas on teleoperators and virtual environments."

By 1997 Lombard and Ditton identified six different concepts of Presence:

1. presence as social richness (the "warmth" or "intimacy" possible via a medium)
2. realism (perceptual and/or social)
3. transportation (the sensations of "you are there," "it is here," and/or "we are together")
4. immersion (in a mediated environment),
5. social actor within medium (e.g., parasocial interaction)
6. medium as social actor (e.g., treating computers as social entities).

A definition was coined: "**the perceptual illusion of nonmediation.**"

Perceptual is a term that indicates a continuous (real time) responses of the human sensory, cognitive, and affective processing systems to objects and entities in a person's environment. An "illusion of nonmediation" occurs when the user fails to recognize the existence of a medium in his communication process and responds in a natural way, as the medium was not there.

Although the literature suggests that presence is a multi-dimensional concept. Further, the lack of a consensus regarding a conceptual definition of presence is one of the reasons that there is no standard technique or instrument for measuring presence responses.

Virtual Reality Environment can be defined as set of devices and technological tools that allow a peculiar interaction man/machine (Steuer, 1992; Ellis, 1994). The interaction between the human being on one hand and the technological side on the other, realized an experience that can be significant.

Lee Adams (1994) experience theory speaks of two different levels of experience based on different technologies:

- Passive experience: path and surfing into the environment are defined by the software. The user is an observer in front of something that is happening, he can decide the beginning and the end of the experience.
- Exploration experience: the user can decide different paths and movements inside the environment, but he can't interact with objects.
- Interactive experience: the user can select a path, the view point and he can interact with objects in the environment.

During the interactive experience the user can manipulate directly and act in, the virtual world, he can freely move, reach and interact with objects in the environment. Immersive sensation is produced by the multisensorial involvement. The body interface the VE using sensorial devices, and the view point of the subject is completely immersed into the space generated by the pc.

Interaction with the environment is possible using systems as: touch-feedback, visual and auditory. As Frank Biocca (1992) tells: the interaction is physical, is centred on the body and his movements relieved by the sensors that codify movements and gestures directly into the system using input disposals that can pick up natural capacities and intuition of the body. The capacities re-create situations of the real world.

Another possible definition of VR is an environment where the people can interact with the surrounding environment, but also among other users just like in a real environment, where the relation between subject, action and environment is a kind of circle. (Riva 2004)

Interacting with the VE the user's actions can modify the environment and create a new experience that requests new series of behaviours with a continuous definition of actions and opportunities. When the user can find into the environment space for action and opportunity that can answer to his expectations and this

path guides the subject through the interaction, and the interaction can create new opportunities, then, the user perceives the sense of the environment.

Roy Kalawsky (1993) detected that after using a VE people's feelings where: on one hand to be part of a synthetic experience (lower immersion), on the other hand to be immerse in an experience. The users have a different psychological status that can be a Presence condition.

In lower immersion sensation, the people maintain stronger link with the physical surrounding world instead of the VE: one of the problematic element can be the poor interaction, for limits of the software or limits of the single person. When the subject fails to be immerse in the environment, the attention on the physical world surrounding is limited or totally absent. Roy Kalawsky (1993) immersion is a gradual process, it can be faster as the environment is involving. The immersion scale is directly proportional to the experience time.

Steuer (1992) defines the Presence as the natural perception of a physical environment, he distinguishes the concept by the Telepresence, Presence experienced by a communication media, as a perception through the environment itself.

Factors that determine the Presence status can be divided in two groups:

1. External (technological characteristics)
 - image quality: resolution, dimension of the view field
 - elaboration and refresh of the image answering the user's movements
 - visualization of an icon represent the user
 - logical order and stability of the environment for which the user can't be lost
 - level of movement and manipulation into the environment
 - level of multisensorial input
 - characteristics on the duty to be done
2. Internal (personal characteristics)
 - individual characteristics
 - stress and motivation of the subject
 - motion sickness caused by time-lag
 - knowledge and expectation with the technological tool
 - psychological tendency to the involvement
 - immersion time

2.2. Presence measurement

Sheridan (1996) presents the concept of presence as 'natural (expected) responses of human and environment to each other'. This concept has been developed into assessing physical responses by movement or sound into a measure of presence, for example would the human react to a loud noise or swift movement in a virtual environment (VE) as they would in the real world? The measure of reflexive responses as an indicator of presence is studying the response of the subject in comparison with a real life reflex response, for example avoiding an object which is coming towards the face (explored in Nichols et al., 2000). It has been suggested that this indicates a feeling of presence as the participant reacts to the situation as they would in the real world suggesting they feel to some extent that they are 'there' in the virtual world.

Barfield and Weghorst (1993) acknowledged the need for a set of metrics that can be used to measure performance within VEs and to quantify the level of presence experience by participants of virtual worlds. Potential indicators of presence were suggested that include virtual world task performance, subjective assessment and degree of disorientation although they do not consider them conclusive. Within this paper it is noted that subjective rating of presence is not entirely dependable but is used in lieu of a suitable and more reliable alternative and provides a good initial indicator for initial exploration. Alternative 'more robust' metrics that are being developed and researched are commented on, for example physiological indicators such as posture, muscle tension and cardiovascular responses to virtual events, such as heart rate evoked by looming of virtual objects. It was also noted that speed and accuracy on tasks performed solely within the VE might also be influenced by the sense of virtual presence. The possibility of using a secondary task method for measuring presence similar to that used to measure mental workload is considered, where the quality of performance of the secondary task is an indication of the presence experienced by the subject (i.e.

poor performance indicates high presence as resources are concentrated on the environment not the secondary task).

Bystrom, Barfield and Hendrix (1999) present the Immersion, Presence, Performance (IPP) model for the measurement of presence. It provides a guide determining the factors that influence presence, aid research into the relationship between immersion, presence and performance in VEs and to help designers of virtual worlds select appropriate display features when they design VEs. Immersion in this case is defined as 'the quantifiable aspect of display technology, primarily determined by the extent to which displays are:

- Inclusive, stimuli from the real world is excluded from the user;
- Extensive, the number of sensory modalities accommodated by the system;
- Surrounding, how panoramic the displays are; and
- Vivid, the resolution of the displays.

Slater and Wilbur (1995) argue that a sense of presence in a VE will contribute to user behaviour that closer matches real world behaviour, such as reflex responses to suitable stimuli. For example, an object looming towards the user's head and even to the extent of the user avoiding obstacles even though intellectually they know they do not actually exist.

Freeman (1999) assesses presence by using a hand held slider and participants were asked to continually rate their feelings of presence with continually changing display stimulus.

In Kalawsky, Bee and Nee (1999) it is suggested that the measurement of presence involves dealing with the following range of measures:

- Objective measures – task demands, task results, correlated measures (e.g. error numbers, achieved task levels, etc.)
- Subjective measures – on-line evaluations, post-test evaluation, questionnaires, explanation of high stress
- Physiological measures – heart rate, blood pressure, respiration rate, ECG
- Task performance
- Learning efficiency

This is one of the most inclusive lists of possible measurement methods of presence and although a combination of all these measures may provide the most comprehensive measure of the concept of presence that can be achieved realistically it is not possible to measure all these variables with respect to every system. As a result of this most research in the area has concentrated in the use of subjective questionnaires for such a measure or the use of other measures to corroborate the effectiveness of a subjective questionnaire.

Of particular note, Van Baren and Ijsselsteijn (2005) provide a compendium of presence measurements highlighting the variety and complexity of the subject. These measures are divided into subjective and objective corroborative and currently there are 69 listed.

2.2.1. Subjective measurements

It has been suggested that subjective assessment, while typically problematic 'can be useful for initial exploration and hypothesis generation' (Barfield and Weghorst 1993). Slater and Usoh (1993) assessed 'internal' (factors affecting individual's responses and perceptions to identical external stimuli) and 'external' (parameters of the VE i.e. field of vision) factors on the reported level of presence in a post experiment questionnaire, participants were asked to rate:

- Their sense of 'being there' (in the VE);
- The extent to which there were times during the experiment when the computer generated world became 'reality' for the participants (i.e. almost forgot the real world outside); and
- Whether they thought the computer generated world as something they had seen or somewhere they had visited.

Ratings were on Likert scales (1-7). A presence score for each participant was a count of the number of 6 or 7 ratings for the response to the three questions, so had a range of 0 to 3. It was found that there was some 'association between a participant's dominant representational style (internal factors i.e. visual, auditory and kinaesthetic) and their reported sense of presence'. In this case questionnaires successfully showed that individual's characteristics influence their experience of presence when using a VE.

Hendrix and Barfield (1996) used the effect of display parameters on presence ratings within VEs; the same method was used for perceptions of presence within auditory VEs. The two questions used to determine the participant's levels of presence were:

- 'If your level of presence in the real world is '100' and your level of presence is '1' if you have no presence, rate your level of presence in this virtual world.'
- 'On a scale of 1 to 5, how strong is your sense of presence, 'being there,' in the VE? (Where 1 = very much so, and 5 = not at all).'

They found that responses to the questions were relatively consistent and concluded that 'direct subjective evaluation of presence is an adequate means of assessment'.

Welch (1996) asks for the comparison of paired, visually different VEs (one of high realism and one of low realism) to rate which created the greater sense of presence. On a rating scale of 1 – 100 the participant rated their perceived difference in presence felt within the two environments. Presence was defined as the participants feeling of being physically located within the visual world.

Witmer and Singer (1998) produced two questionnaires with the aim of measuring levels of presence within VEs. These were the Presence Questionnaire (PQ), that measures the degree that the individual's experiences presence in the VE and the influence of possible contributing factors, and the Immersive Tendencies Questionnaire (ITQ), that measures the capability or tendency of individuals to be involved or immersed in the VE. The questions have a seven point scale format as used in Slater and Usoh (1993), each item being anchored by opposing descriptors and include a mid-point anchor all based on the content of the question. The main question categories (relating to factors that influence presence) were: control factors, sensory factors, distraction factors and realism factors. The sub-scales within the questions for the PQ were; involvement/control, natural, auditory, haptic, resolution and interface quality. It was concluded that these factors formulate a base in establishing what influences presence and that the questionnaires are internally consistent with high reliability. Slater (1999) disputes the validity of the questionnaire stating that 'we cannot separate out two different types of entity: a measure of presence and independently a measure of factors that might influence it. Changes in the latter automatically cause changes in the measured response because that is how the measured response is constructed'.

Barfield and Weghorst (1993) devised a '10 point questionnaire', questions used a 10 point scale anchored at each end and including an 'embedded sub-scale' that covered the three areas: sense of being there, sense of inclusion in the virtual world; and sense of presence in the virtual world. Areas of questioning included: ease of navigation, overall enjoyment and comfort; and display clarity. They found that 'ease of interaction and indicators of display comfort and quality were shown to be slightly more predictive of the sense of virtual presence than other factors studied given a navigation task.'

Nichols, Haldane and Wilson (2000) used observational measures, recall and self-report to assess levels of presence. Nine questions were produced that used a rating scale of 1 – 7 for the self report, three questions were selected from Slater, Usoh and Steed (1994) that are known to directly relate to presence 'being there', 'somewhere visited or somewhere seen' and 'became more real or present than the real world'. The remaining questions covered areas which could possibly influence presence such as: awareness, depth of world, enjoyable, distraction of the controls, attention and exhilaration.

In Prothero et al. (1995) presence was measured in relation to changes in visual display. Ratings of presence were made on five questions that related to:

- If the participant felt they were in a room using the VE or they were within the environment.
- How real the environment felt.
- To what extent the virtual world become reality and the real world was forgotten.
- If the virtual world felt more like somewhere seen or somewhere visited.
- If the virtual world felt more like a picture or a scene looked at through a window.

Answers were on 1 – 7 rating scales, with larger response values indicating greater presence. Possible options related to the main component in each environment. The results obtained were established to be valid and reliable. It was suggested that the strongest evidence for the validity of subjective measures of presence is the fact that similar questionnaires often lead to predictable results from many studies in a variety of areas of research.

Schubert, Friedmann and Regenbrecht (1999) used a three-dimensional computer game and 75 questions to establish that three components related to presence: 'spatial presence', 'involvement' and 'realness' comparing the VE to the real world. Lessiter et al. (2001) created a general cross-media presence questionnaire this was a 44 item questionnaire using a five part Likert rating scale. Content areas included; a sense of space, involvement, attention, distraction, control, manipulation (i.e. autonomy), realness, naturalness, time, behavioural realism, para-social presence, co-presence, personal relevance, arousal and

negative affects. Freeman (1999) recorded responses to questions ‘on-line’ during the experiment via a hand-held potentiometer.

In summary, while there is no acknowledged reliable measure of presence within VEs, questionnaires are the most used, though little agreed method of measurement. Questions that require the subject to write a sentence i.e. open ended questions, (Slater and Usoh 1993) provide broader answers but may reduce the number, and relevance, of the responses and as with most qualitative data it is difficult to analyse accurately. The main themes that questionnaires have been based on to date that are used to measure presence are as follows (Marshall, 2005):

THEME	AUTHOR
Sense of being there	(Barfield and Weghorst 1993; Slater and Usoh 1993; Hendrix and Barfield 1996; Slater 1999; Lessiter et al. 2001)
Reality of the VE	(Slater and Usoh 1993; Slater, Usoh and Steed 1994; Prothero et al. 1995)
Involvement in the VE	(Witmer and Singer 1998; Schubert, Friedmann and Regenbrecht 1999; Lessiter et al. 2001)
Belief of the VE	(Prothero et al. 1995)
Was the environment able to startle or distract	(Witmer and Singer 1998)
Enjoyment of the VE	(Barfield and Weghorst 1993; Nichols, Haldane and Wilson 2000; Lessiter et al. 2001)
The environment was like a place visited rather than images seen	(Slater and Usoh 1993; Prothero et al. 1995; Slater 1999)
Extent VE becomes dominant and users respond to VE events not RW	(Slater 1999)

A rating scale of possible answers to questions is the most regularly used method of designing a questionnaire, most of which have provided significant results with respect to presence. Ratings tended to range from ‘not at all’ to ‘totally’ with 5 –7 options in relation to the most common themes as noted above.

The main problem in establishing a suitable set of factors to base a questionnaire on, that will be valid and reliable according to previous research, is that few researchers use the same set of measures so comparison across studies is difficult. Even so there are a few presence questionnaires which have been and are currently being developed that may be valid and reliable across different participant groups, experimental conditions and stimuli (Witmer and Singer 1998; Freeman et al. 2000; Lessiter et al. 2001).

2.2.2. Objective measurements

Presence is a subjective mental state and because of this it could be said that subjective measures are a more appropriate method of measuring levels of presence experienced within a VE. With this in mind it has still proven difficult to find a reliable subjective method of measurement and as a result objective measures are now slowly being developed that can be used as indicators of presence. As noted by Welch (1996) ‘neither of the two types of measures is sufficient by itself’ and ‘Ideally, then, one should employ both measures in order to avoid the limitations of either by itself.’

In Nichols, Haldane and Wilson (2000) a pre-programmed startle event was randomly timed to occur during the experiment and the participants response was classified into three categories – no reaction, verbal report of a reaction or a physically noticeable reaction. The experiment indicated statistically that there was some correlation between direct measure of this reaction and self-report measures of presence.

Barfield and Weghorst (1993) noted that subjective measures, though useful, will eventually be supplanted by more robust metrics which may include physiometric indicators (posture, muscle tension, ocular responses). 'The basic idea behind these measures is as follows: Just as humans experience changes in physiological parameters in response to novel or unusual stimuli, as the sense of presence increases within a VE, the participant should experience similar physiological changes.' It is suggested an example of measuring the blink response to an object on a collision course with the participant's virtual eye, though they do not use any such measures in the experiment that they conducted. It was also suggested that the introduction of a secondary task (as in the measurement of mental workload) and measuring the performance of that task indicates the level of attentional resources allocated to the primary task and therefore level of presence (i.e. lower performance means a higher level of presence).

Slater, Usoh and Steed (1994) made the point that within their experiment almost all the participants carefully avoided collisions with virtual objects even though they knew there were no real objects, and as a result most of the participants were feeling a strong sense of presence but did not exhibit or report it as they did not see anything out of the ordinary in what was happening. This aspect of possible discrepancy between presence shown and presence reported can be reduced by observing the behaviour of the participant within the environment and taking this into account when assessing the level of presence that was experienced.

In Freeman (1999) participants were required to rate their level of presence continually using a hand held slider with respect to varying television picture quality and a feeling of presence. This introduces the concept of measuring presence continually during the experiment but not disturbing the participant and their possible level of presence by asking questions or requesting continual verbal protocol. This theory can be adapted for objective measurement during experimentation.

Slater and Usoh (1993) suggested approaches of measuring presence that included observations of the user's behaviour, stating 'this takes observational reactions to certain situations as confirmation of the user's presence, for example moving away from looming objects or replying to a 'hello' message.' Informal investigations were performed into objective measures of presence by studying reactions of participants when simulated objects flew towards their face, though no conclusions were drawn from the data collected. The data did not correlate well; those that had an adverse effect to being on a plank over an abyss in part of the environment tested did not rate themselves as being present. It was suggested that this may be as the participants were rating their overall impression and their sense of presence varied over time.

A proposed measure discussed in Nash et al. (2000) is the direction of conflict resolution when two separate stimuli (one from the real world and one from the virtual world) present different information. This type of measure may entail the ability to recall and describe the event and the speed of reaction to an event. Slater and Usoh (1993) looked informally at how people reacted to someone dropping a cup in the background in the real world and the participants reaction when asked the time whilst wearing a HMD so could not see their wrist (i.e. natural reaction would be to look at their wrist), no conclusive results were reported. Draper, Kaber and Usher (1998) suggest measuring objective or physiological and subjective measures to see how much they correlate.

It is clear that there are currently no established methods of objective measurement, even less so than those of subjective measurement. This considered many of the leading researchers within this area, have suggested that it is an important area to consider when deciding how to assess the levels of presence experienced. As suggested by Welch (1996) using both subjective and objective methods to assess presence would improve the validity of the results. The main methods of achieving this are observing participants with respect to their responses, and if the responses are as they would respond in the real world. This can be separated into vocal and visual responses to stimuli within the environment as shown in Nichols, Haldane and Wilson (2000).

3. PRESENCE IN FIFTH FRAMEWORK PROGRAMME

It has been suggested that the reason presence has no universally accepted measures is that like other subjects such as mental workload and mental models it is multi-factorial and may be physiologically displayed in different ways to different people and consequently it is 'not easily amenable to definition, physiological measurement and even self-report' (Nichols et al. 2000). The issue of presence however, has been the subject of much research in the area of virtual reality and virtual environments (VR/VEs). It has been significant enough to be a proactive initiative in the fifth framework programme (1998 – 2002) in the future and emerging technologies (FET) area which supported numerous research projects including the following:

ADAPT (IST-2001-37173) Artificial Development Approach to Presence Technologies

The sense of presence arises from the perception of the relationship between our body and the environment and originates from our senses as well as from our past experiences. The main objective of ADAPT will be to study how the perception of self in the environment emerges during the early stages of human development and to implement an artificial instance of such developmental processes in an embodied artefact. In particular we propose to investigate the process of building a coherent representation of visual, auditory, haptic sensations. To achieve this, a twofold strategy is pursued. On one side we aim to realize an artificial system capable of building internal representations. On the other side we will investigate when and how the developing brain starts to produce a unique experience-based repertoire of intentional percepts and actions.

BENOGO (IST-2001-39184) Being There - Without Going

The project will investigate and further develop novel camera technologies into an innovative mediation system that allows close to photo realistic 3D real-time visualisation of REAL (and possibly known) places for a moving observer. The visualisation will provide a high degree of impressiveness and support new types of empirical studies of the feeling of presence in a REAL scenario that is made artificially available for perceptual inspection. This is hard or impossible with conventional VR. Using this new technique in varying combinations with advanced versions of augmented reality, the project will contribute with empirical evidence to the development of a general multilevel interpretation of presence, on the basis of a context otherwise not available. The interpretation will provide a reference for empirical studies to optimise the technology in respect of aspects of presence found important for observation.

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EMMA (IST –2001-39192) Engaging Media for Mental Health Applications

EMMA project is focused on how to create and enhance presence, how to measure it, how presence mediates or generates emotional responses, how emotional responses can be manipulated to control the extent and nature of presence, and how to use presence and emotions effectively in clinical and non clinical settings. EMMA will develop 'mood devices' able to induce and enhance several moods on clinical and non clinical subjects. We will investigate the use of engaging media for the development of 'new vital narratives' with high emotional impact. Our 'mood devices' will use new technological tools up to now never used as determinants of presence (based on tele-immersion, intelligent agents, augmented reality and wireless devices). These future and emergent technologies will provide innovative ways of coping with distressful emotions for different users: with psychological problems, with acute restricted mobility and also for the general population.

I-Learning (IST-2001-38861) Imagery Enhanced Learning

Sports trainers have shown that mental rehearsal ('motor imagery') can facilitate motor task acquisition. The goal of this project is to build on the results of this work to develop a completely new technique for the teaching of complex motor skills. In the new I-Learning approach the trainer will be replaced by a virtual

reality system, designed to create a sense of presence, which evokes motor imagery in the mind of the trainee and therefore facilitates the acquisition of the task.

The project includes laboratory research into the relationship between motor imagery and learning; investigation of the use of virtual reality to evoke motor imagery, as well as practical laboratory evaluation of learning effectiveness. This will be based on Virtual Environments developed by the project. The new approach will be tested in two areas with high societal impact: the rehabilitation of neurological patients and the teaching of safe driving. Sports trainers have shown that mental rehearsal ('motor imagery') can facilitate motor task acquisition. The goal of this project is to build on the results of this work to develop a completely new technique for the teaching of complex motor skills. In the new I-Learning approach the trainer will be replaced by a virtual reality system, designed to create a sense of presence, which evokes motor imagery in the mind of the trainee and therefore facilitates the acquisition of the task. The project includes laboratory research into the relationship between motor imagery and learning; investigation of the use of virtual reality to evoke motor imagery, as well as practical laboratory evaluation of learning effectiveness. This will be based on Virtual Environments developed by the project. The new approach will be tested in two areas with high societal impact: the rehabilitation of neurological patients and the teaching of safe driving.

MEC (IST-2001-37661) Measurement, Effects, Conditions

MEC (Presence: Measurement, Effects, Conditions) has three objectives. The first is to compare different methodologies that measure Presence experiences from a psychology-based theoretical model. Secondly, questionnaire, think-aloud, distraction-paradigm, eye-movement recording and functional magnetic resonance imaging (fMRI) methodologies will be tested in different media settings. The role of Presence experiences in media-based learning processes will be investigated in the contexts of educational hypertext and VR/multimedia systems. MEC's third goal is to investigate the influence of users' motivational dispositions and skills on the development of Presence experiences. MEC will advance the methodology of Presence research, investigate interactive and immersive educational media and the psychological determinants of Presence that have been neglected in past research. MEC (Presence: Measurement, Effects, Conditions) has three objectives. The first is to compare different methodologies that measure Presence experiences from a psychology-based theoretical model. Secondly, questionnaire, think-aloud, distraction-paradigm, eye-movement recording and functional magnetic resonance imaging (fMRI) methodologies will be tested in different media settings.

The role of Presence experiences in media-based learning processes will be investigated in the contexts of educational hypertext and VR/multimedia systems. MEC's third goal is to investigate the influence of users' motivational dispositions and skills on the development of Presence experiences. MEC will advance the methodology of Presence research, investigate interactive and immersive educational media and the psychological determinants of Presence that have been neglected in past research.

OMNIPRES (IST-2001-39237) Omnibus Presence Technology Assessment and Measurement Groups

Advances come from integrating presence engineering, theory & measurement. Many good projects may seek to 'engineer presence' (e.g., interfaces, services). Unfortunately, they may be:

- less focused on theoretical understanding of the causes and correlates of presence;
- limited to too few variables to fully explain how the engineering is advancing;
- evaluation may not be independent or rigorous.

OMNIPRES will be looking at the initiative as a whole to compare presence performance across the cluster and across the disciplines. The project objectives are:

- 1) Project-Wide Theory and Measurement Support. Integrated technology assessment, evaluative, and measurement support;
- 2) Project Wide Models, Metrics and Comparisons: Overall comparison of the relative effectiveness of technological developments on telepresence and social presence;
- 3) Presence Theory and Measurement Integration: Theoretical integration spanning design and measurement across all Presence Research projects.

PeLoTe (IST-2001-38873) Building Presence through Localization for Hybrid Telematic Systems

The goal of the PeLoTe project is to design novel methods for building presence through integrating and coordinating autonomous collaborative entities in a telematic application, comprising nonliving systems and human actors. Special focus will be made on solving particular aspect of building presence and integration of autonomous entities of different kinds in a tele-operated task. Development of a global framework concept capable to integrate novel methods in telemaintenance/ diagnostic system will be developed. This will result

in suggesting an advanced unifying methodology for incorporation of multiple entities of both kinds: physically mobile and human ones. The goal of the PeLoTe project is to design novel methods for building presence through integrating and co-ordinating autonomous collaborative entities in a telematic application, comprising nonliving systems and human actors. Special focus will be made on solving particular aspect of building presence and integration of autonomous entities of different kinds in a tele-operated task.

Development of a global framework concept capable to integrate novel methods in tele-maintenance/diagnostic system will be developed. This will result in suggesting an advanced unifying methodology for incorporation of multiple entities of both kinds: physically mobile and human ones.

• **POEMS (IST-2001-39223) Perceptually Oriented Ego-Motion Simulation**

In most existing VR applications, we lack the intuitive feeling of being "spatially present", resulting in a reduced performance for spatial tasks. POEMS pursues a human-centred approach to solve this problem. POEMS will develop reliable multi-level measurement methods for perceived spatial presence and ego-motion. These methods will be used to establish and model optimal auditory, visual, and vibrational rendering parameters and cross-modal, synergistic interactions. This will enable us to outline a lean and cost-effective VR set-up that allows for convincing simulation of ego-motions without actually moving the observer, by combining auditory, visual, and vibrational cues. Future VE platforms optimise from both a perceptual and technical point-of-view based on the POEMS concept, will ultimately be compact, easily transportable, quiet, low-cost, and safe, since they just use projected 3D graphics, 3D sound, and vibrations, without any potentially dangerous moving parts.

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PRESENCIA (IST-2001-37927) Presence: Research Encompassing Sensory Enhancement, Neuroscience and Cognition, with Interactive Applications

This project aims to develop a theory of presence in virtual environments (VEs) based on empirical observations from neuroscience and other experimentation. The data will go far beyond the usual subjective questionnaires that have been at the root of presence research to date, and will include brain imaging studies, physiological measures, eye tracking, behaviour and subjective reporting. The second aim is to extend 'presence' beyond similarity of response between virtual and real stimuli, in order to exploit the capability of virtual reality for sensory enhancement and the plasticity of the brain in learning to carry out actions in new ways. This will enable carrying out of activity by 'thought'. Another application will be communications between remotely sited people sharing a VE. The goal is to portray not just the geometry of individuals, and their motor actions, but a range of other information such as empathic responses and physiological condition. This will explore how communication is affected by visualisation of as much as the total state of a person as is possible (and desirable). The impact of such sensory enhancement on presence will be explored. This project aims to develop a theory of presence in virtual environments (VEs) based on empirical observations from neuroscience and other experimentation. The data will go far beyond the usual subjective questionnaires that have been at the root of presence research to date, and will include brain imaging studies, physiological measures, eye tracking, behaviour and subjective reporting. The second aim is to extend 'presence' beyond similarity of response between virtual and real stimuli, in order to exploit the capability of virtual reality for sensory enhancement and the plasticity of the brain in learning to carry out actions in new ways. This will enable carrying out of activity by 'thought'. Another application will be communications between remotely sited people sharing a VE. The goal is to portray not just the geometry of individuals, and their motor actions, but a range of other information such as empathic responses and physiological condition. This will explore how communication is affected by visualisation of as much as the total state of a person as is possible (and desirable). The impact of such sensory enhancement on presence will be explored.

TDIS (IST-2001-38862) Three-Dimensional Imaging System based on integral photography for precise simulation of 3d perception and enhancement of the telepresence effect

We intend to develop a 3D imaging system based on Integral Photography technique, consisting of a 3D display prototype and a 3D image capturing system prototype. The proposed 3D imaging system simulates precisely 3D perception and enhances the Telepresence effect. The technology underlying the proposed system involves our innovations in the field of advanced mathematical modelling, algorithms and software, and optical hardware. Psychophysical research in the field of 3D vision in humans will allow the development of basic requirements for natural perception of 3D images and the corresponding adjustment of 3D display. Our innovations allow a complete analysis, synthesis, and optimisation of the integral photography scheme and super-fast rendering and processing of images, which leads to the possibility of real-time 3D applications contributing to the fields where the experience of presence is important (learning, entertainment, training, telemedicine).

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Touch-Hapsys (IST-2002-38040) Towards a Touching Presence: High-Definition Haptic Systems

This project envisages establishing a new generation of high-fidelity haptic display technologies. The newly developed systems will not only cover haptic interaction but also attempt to complement haptic information by visual and auditory input.

To achieve these goals, two main threads will be followed:

On one side, the consortium will explore and develop new technologies, which will be used to significantly improve haptic displays. On the other side the psychophysical basis of human haptic perception will be investigated. One goal is to exploit haptic illusions to overcome fundamental technological limitations.

Four demonstrators covering typical application scenarios with a critical technological challenge will be developed: Haptic interaction with biological tissues, haptic texture rendering and recognition, the simulation of rigid objects with clearly defined, sharp edges, and multi-modal volumetric exploration systems. This project envisages establishing a new generation of high-fidelity haptic display technologies. The newly developed systems will not only cover haptic interaction but also attempt to complement haptic information by visual and auditory input.

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In addition the EC funded a 15 month project to establish a **Presence Research Working Group** (IST-2000-31014). The working group had two main objectives. The first was to perform a critical assessment of the opportunities for research and development based on experts' knowledge of the state-of-the-art of presence research from the viewpoint of their discipline. Secondly, they were to create a forum for the interdisciplinary exchange of knowledge and ideas to stimulate discussion on fundamental, innovative research proposals.

These objectives were met through a series of focus groups and workshops, and the results were disseminated through the project website www.presence-research.org.

4. PRESENCE IN DIFAC

From the review (Sadowski and Stanney 1998) of factors that influence presence, general guidelines can be provided that, if effectively implemented, should enhance users' presence in virtual environments. For each task (Training, Product Development, Factory Design) there are specific elements much more important than others. After a State of the Art of the Presence concept and measures we present here a review of Presence elements that are strictly linked with the three action areas of DiFac. In each of following paragraph will be given Presence requirements taking into account researches and paper done.

Guidelines for supporting Presence:

	GUIDELINE	ISSUE	REFERENCES & RESEARCHES
Ease of Interaction	Provide seamless interaction such that users can readily orient in, traverse in, and interact with the virtual environment.	Poorly designed interaction takes focus away from the experience and places it instead on motion/mechanics.	Weghorst and Billinghamurst (1993); Sutcliffe et al. (2005).
User-initiated control	Provide immediacy of system response, correspondence of user-initiated actions, and a natural mode of control.	Delays, discordance of users' versus effectors actions, and unnatural control devices hinder engagement in the VE.	Witmer and Singer (1994); Sheridan (1992); Stanney et al. (2002).
Pictorial Realism	Provide continuity, consistency, connectedness & meaningfulness in presented stimuli.	Poorly designed visual interaction hinders engagement in the VE.	Welch et al. (1996); Nunez and Blake (2003)
Length of Exposure	Provide sufficient exposure time to provide VE task proficiency, familiarity with the VE, and sensory adaptation.	Avoid unnecessarily prolonged exposures that could exacerbate cybersickness.	Witmer and Singer (1998); Stanney et al. (1999); Marshall et al. (2004)
Social Factors	Provide opportunities to interact with and communicate with others verbally or by gestures. Provide confirmation that others recognize one's existence in the VE.	If one's presence in the VE is not acknowledged by others it may hinder the perception that they "exist" in that environment.	Steuer (1992); Heeter (1992); Bailenson et al. (2006).
Internal Factors	Identify the types of individuals who will use a VE system and their preferred representational system (i.e., visual, auditory, kinesthetic).	Individual differences can render VE systems differentially effective.	Slater and Usoh (1993); Nunez and Blake (2003); Jurnet et al. (2005).
System Factors	Providing stereopsis, head-tracking, a large field of view, increasing update rates, multi-modal interaction, and ergonomically sound sensors/ effectors facilitate presence.	Poorly designed systems can degrade the users' experience. Note: This does not suggest that the "ultimate" experience is required, but rather what is provided should be well designed and developed.	Hendrix and Barfield (1996); Meehan et al. (2002);

4.1. Presence in training VE

For some training tasks, presence may be desirable. For other training tasks, facilitating presence may be an asset by increasing realism and potentially aiding the positive transfer of training. Mantovani and Castelnuovo (2003) analyze the main correlate aspects between presence and training. There are a lot of conditions (such as attention, motivation, interaction, etc.) VEs' designers have to consider in order ensuring a sense of presence in virtual environments. Factors connected with presence in learning environments could be included in four areas: perceptual features, individual factors, content characteristics and interpersonal, social and cultural context.

4.1.1. Perceptual features

Perceptual realism: graphic vividness of VEs and other “technological” features

In learning virtual environments graphic realism is important in applications where the visual channel is critical: in high-defined scenarios used for flight or drive simulations for example, the sense of presence could “break down” in case of not high graphic realism. On the other hand, in the cognitive and affective domains of learning high visual fidelity is not always required, such as situations where the focus of training is more on attitudes or values.

Interactivity and control

In learning contexts these issues are critical where training is based on the exchange of information, *stimuli*, movements, words, etc. between different subjects or between a subject and an object represented in VEs: the feedback from a virtual body in surgical simulations or the answer from a group of persons in multi-users environments during a role playing are only two examples of the importance of receiving feedback in some learning situations. In other contexts, such a VE developed for spatial (positioning) abilities, interaction could be absent or moved to another step of the training once finished the virtual experience.

4.1.2. Individual factors

Imagination and suspension of disbelief

In training situations this issue is important in applications where virtual environments could only provide a starting stimulus or cue for the subject: a great part of the learning process is represented by the work of reconstruction subjects make following the guidelines provided by VEs. This is the case of the most abstract abilities, such as leadership, managing or complex cognitive ones. In this applications a too structured situation, without undefined spaces, could not allow persons to adapt and modify it towards their real needs: subjects do not reach the fixed goal of acquiring a new skill because situations provided during the training are too forced by VR designers. The state of “suspension of disbelief” is the sense of non mediation subjects could perceive using technological tools: the ideal condition is represented by “forgetting the medium”. The technological hyper-mediation new tools allow could lead to a sense of immediacy and transparency called remediation. But not only a high-level of technology allows a high sense of “suspension of disbelief”:

According to Jacobson, one critical question could be whether virtual worlds combining graphics and sounds foster more or less “suspension of disbelief” than simple text-based ones. Schroeder remarks that the participants feel more involved in graphic worlds than in text-based virtual environments, but there are no data to support this idea. On the other side, Schiano and White note that people could prefer text-based environments (and not audio and video ones) in order to represent themselves.

Identification

In learning environments this factor plays a key role where subjects have to assume a defined role in virtual situations. Overall during social skills training or role playing, subjects have to recognize themselves as persons with a social position, role, identity, occupation, etc... in virtual experiences too. Without identification it is very difficult the transfer of knowledge between “virtual” and “real”. It offers trainees the opportunity to become leading actors in their learning and training process, enhancing the emotional impact and relevance of the virtual experience.

Motivations and goals

The level of motivation and the link between virtual training and own goals are two critical issues to consider. Learning experiences may be organized in the best way (good VEs, enough time for training, possibility to discuss after virtual experiences, etc.), but if they are not related with the actual needs and goals of subjects,

they are not likely to achieve a suitable level of presence. So it is necessary to adjust all the technological devices and the training procedures to what subjects really want and need in their everyday professional contexts and situations.

At the same time, due to the complex relationship between these two factors, sense of presence could have an impact on motivation. Too similar and repetitive VEs could reduce the degree of interest in trainees (especially if they are high sensation-seekers) after the first experiences with virtual reality.

On the other hand, Romano and Brna noted “virtual reality has a great potential as an educational tool precisely because it can gain and keep students’ attention” and enhance their motivation. These issues explain and justify the use of a lower level of technology where necessary according to the fixed goals: for some types of skills, such as spatial skills, Romano suggests to use a desktop solution because this system and HMD-based VEs allow very similar kinds of learning but HMDs can trigger nausea, dizziness and visual difficulties that lead to consider a desktop approach more appropriate. The ideal scenario is represented by the possibility of users to perceive the virtual situations as very motivating and connected with their real interests and needs.

Emotional state

In order for the virtual learning-by-doing to be effective, the experience must seem real and engaging to the participants, as “if they were in there”: they should feel (emotionally and cognitively) present in the situation.

According to cognitive-behavioural approach and constructionism, the emotional component is a basic feature to allow a sense of presence and an efficient and effective learning process. Different authors have noted that virtual experiences could allow subjects to experience the same emotions and psychological states obtained in real situations.

Another theoretical framework very useful to understand the subjective and emotional experience of presence is Csikszentmihalyi’s theory of flow, where “presence refers to a merging of action and awareness, during which a person loses self-consciousness and a sense of time, focusing on the present, and blocking out the past and the future” . In this approach particular balances between “challenges” and “skills” VR could offer produce emotional states that have many common features with psychological sensation of presence. An integrated approach should consider the *quality of the subjective experience* as another core characteristic that VR designers have to consider in order to develop functional synthetic worlds in education and training. The sense of presence depends also on the perceived and subjective characteristics of the experience. According to Csikszentmihalyi’s theory of flow, the possibility to reach optimal experiences plays a key role during subjects’ different activities: also in virtual sessions it is important to create and tune the environments allowing users to potentially reach this kind of psychological state. This framework can be extremely relevant in learning, where challenges and difficulties need to be carefully managed, together with motivation and learning goals. This issue is clearly connected with the level of motivation: in fact it is not just evoked by engagement, but also by an optimal balance between perceived challenges and skills.

4.1.3. Content characteristics

Plot, story, narration and dramaturgy

Also the characteristics of the “story” created when a subject is exploring a VE plays a key role in enhancing the sense of presence: to be a part of a narration, to play a more or less defined role in the story could influence the sense of identification and the state of presence during a virtual experience.

4.1.4. Interpersonal, social and cultural context

Interpersonal dimension

In learning virtual environments the “sense of being part of a group” (group composed by interactive *avatars* or others real persons), is important in applications where the skill to consider in training can be learnt only with more persons interacting (or not) between them. Social abilities, coping skills and all the similar training areas have to consider this presence factor.

Social, cultural and ecological validity

The possibility to reproduce the subjects’ social and cultural context is a key issue to consider in enhancing presence in VEs. In some cases the possibility to create a social interaction is more important than realism to enhance a sense of presence. Low levels of presence are usually connected with the low importance dedicated to the reconstruction of a world socially and culturally perceived as correct by users: in these

situations extra-individual characteristics seem no so relevant in comparison with technological and individual ones. Considering again the “suspension of disbelief”, in order to achieve this state, features such as interaction or perception of being involved in a real social and cultural context are more important than reconstruction with high level of visual fidelity.

According to Riva , “multi-user VR can be considered as a particular form of computer-mediated communication (CMC)” and the focus moves from technological aspects of VEs to the consideration that “virtual” is a media that belong to a particular culture in which persons are not isolated individuals but actors involved in an interpersonal, social and cultural context. “In this sense, emphasis shifts from quality of image to freedom of movement, from the graphic perfection of the system to the actions of actors in the environment”. In virtual environments used in different applications (psychotherapy, assessment, learning, etc...) “the criterion of the validity of presence does not consist of simply reproducing the conditions of physical presence but in constructing environments in which actors may function in an ecologically valid way”.

4.2. Presence in Product Development VE

The complement of haptic cue would be considered to be of benefit to the engineering field. In engineering simulation, there is an essential need to manipulate virtual objects in 3D space. Therefore, a glove-type input and output device with haptic feedback would be a better choice.

An experiment study (Sallnas, Rasmus-Grohn and Sjoström) demonstrates that haptic force feedback gives added support to people performing collaborative tasks in a multimodal interface. When all other variables remained constant, haptic force feedback significantly improved task performance, increased perceived task performance, and increased perceived virtual presence. Both the objective measure of time to perform tasks and the subjective measure of perceived task performance improved in the condition with haptic force feedback. It is reassuring that the subjective and the objective measures show the same result. Subjects’ perception of better task performance suggests that it was easier to manipulate and understand the interface when the interaction was supported by haptic force feedback. It was also easier to perform specific tasks like lifting cubes. The results showing shortened task completion time are consistent with the results in the Gupta et al. [1997] study where performance improved when subjects received haptic force feedback. Furthermore, the results demonstrate that the subjects’ perceived virtual presence in the collaborative virtual environment increased when haptic force feedback was provided. This means that the subjects to a higher degree felt as if they were present in the virtual environment when they received haptic information.

The more important factors connected with presence in Product Development environments are:

- Perceptual features (Perceptual realism: graphic vividness of VEs and other “technological” features; interactivity and control)
- Individual factors (Imagination and suspension of disbelief; motivations and goals)

4.3. Presence in Factory Design VE

Literature does not specifically examine the importance and the relation of the sense of presence in Factory design VE. The guidelines to create sense of presence will be constructed by the analysis of the questionnaires.

5. THE PRESENCE QUESTIONNAIRE

The objective of this activity is to evaluate user's needs in Presence field in virtual environments for different tasks and different objects of interest.

In order to get different opinions on this subject a presence questionnaire shall be created to identify different presence requirements for different tasks and objects within the DiFac application scenario. These results will then be used to optimize the user's interaction and the interface presented to the user in terms of presence.

For the creation of the questionnaire, literature was evaluated and different items for presence evaluation were identified. These shall be treated in the questionnaire.

The DiFac application scenario consists of three main activities:

- product development
- factory design
- training.

For each of these activities tools and services still have to be developed and hence the presence evaluation can only be realized for the conceptual stage.

Therefore two presence questionnaires will be prepared.

A first one to evaluate the needs for presence at a preliminary stage by looking at general tasks and objects within the three DiFac activities. And a second one to examine the requirements for presence during the architectural design or even the testing phase when the tools and services for the different activities are really implemented and used. (=> feedback, Living Lab concept)

Objective of the Presence observations are:

1. Optimize the action, the duty to be done
2. Optimize the interface and the realism for creating an high level of involvement

For creating a better single Presence in the way of looking of collaborative environment, the first questionnaire asks for suggestions of Presence sense to the industrial partners for completing the requirements that are basis for the environments developing. The second questionnaire will follow the Presence level measurement with a series a questions during and after the experience of use the VE itself.

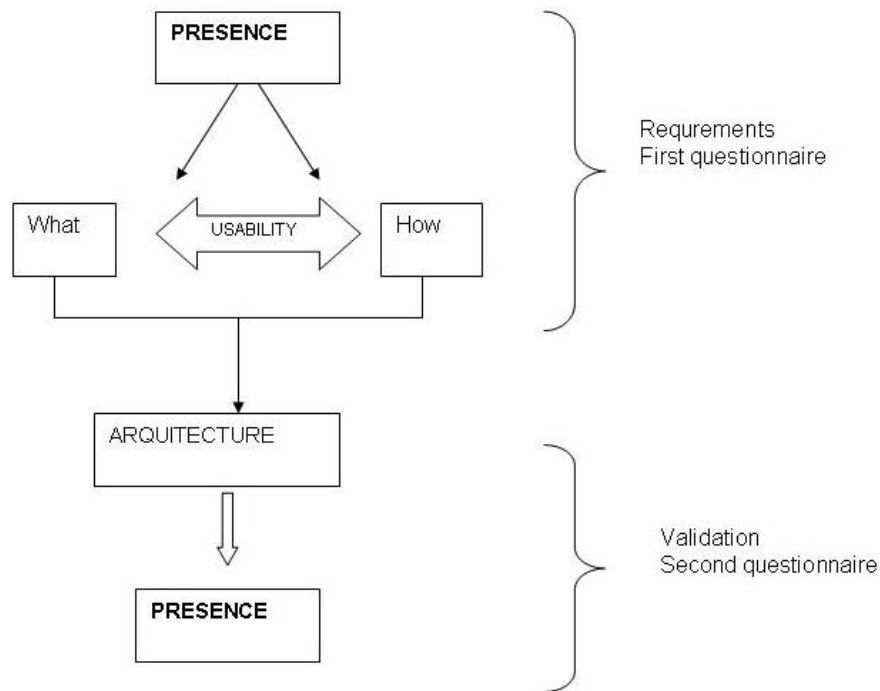


Figure 1. Presence questionnaire scheme

5.1. Presence Questionnaire 1

The first questionnaire will be based on the approach of Witmer et al. (Witmer et al. '98: Measuring presence in virtual environments: A presence questionnaire), where presence is evaluated by looking at the amount of immersion and involvement the user experiences in different tasks and locations.

Witmer et al. define several factors which influence presence:

CONTROL FACTORS	SENSORY FACTORS	DISTRACTION FACTORS	REALISM FACTORS
Degree of control	Sensory modality	Isolation	Scene realism
Immediacy of control	Environmental richness	Selective attention	Consistency of information with the objective world
Anticipation of events	Multimodal presentation	Interface awareness	Meaningfulness of experience
Mode of control	Consistency of information		Separation anxiety / disorientation
Modifiability of the physical environment	Degree of movement perception		
	Active search		

Aim of the questionnaire is to analyse what kind of presence is needed or desired for different tasks. The list of tasks should be a general classification for activities within collaborative environments. Elements from the DOW and the classification of interfaces of Bowman et al. (Bowman et al. '04: 3D User interfaces) were combined to form the list below.

1. Being there
2. Moving around

3. Selecting things
4. Manipulating things
5. Demonstrating
6. Evaluating
7. Searching
8. Discussing / Communicating

Following by an overall summary.

We determined a list of

- Task
- Person
- Thing

from the requirements that the industrial partners gave inside the Project and for each of the specific task we asked a series of questions about the Presence for completing the requirements landscape.

This questionnaire is the first stage of a larger survey for better understand the sense of presence into the VE that DiFac is developing.

The work will be divided in two main stages:

- 1) At the early stage for analysing the requirements in presence matter. This phase will be divided in three different passages:
 - understanding the industrial partners' requirements
 - give the conclusion to the software developers
 - check of the results with the literature and eventually with experts in Presence
- 2) During the test phase of the VE for checking the effectiveness of the sense of presence in environment.

5.2. Presence Questionnaire 2

After a literature review appears common to measure the sense of Presence during or after the use of the single environment monitoring the involvement grade and (consciousness or non-consciousness) reactions.

This task, opened with a series of questions determined the requirements in terms of Presence for better developing DiFac environments for Training, Product Development and Factory Design, will close its duty with a measurement questionnaire during the validation phase.

There are many different questionnaires for measuring the Presence in a VE, some are objective, others subjective (see chapter 4.2). Since the human being is a complex universe, psychology is a science that investigates the different aspects of such a "world" starting from different psychological contemporary theories, there's no common view on the matter of Presence measurements.

We decide to work on objective measurements level, since the subjective have to take in account a series of physical dimensions that are no so easy to recreate for each single subject to be tested.

In the next months, during the development of the environments, to create new parameters for proving the Presence level during and immediately after the use of VE.

6. QUESTIONNAIRE 1: RESULTS

Not easy to have general results from two questionnaires that investigate different tasks for end-users who work in such different fields, but the consortium is going to learn and understand from the differences too. For a more complete vision of the answers, see Annexes 11 and 12.

TASK

PPS → is interested in developing VE for facing Product Demonstration and Development and Factory Design and Evaluation.

PRIMA → is looking for implementation of the Product Development and Training.

PERSONS

PPS → since PPS is looking for an environment that permits the communication along the production lifecycle, persons involved are not only designers, technicians and engineers, but also final users of a common product as a carpet can be, it means that final users are general people without any specific knowledge of the product characteristics or technical facilities.

PRIMA → his specific target is another industry who will buy and assemble a machine. Peculiarity in the people involved into the training activity is to have “non-expert technicians” to be trained by more expert people.

THINGS

Things to be done are very different because the two industrial realities are different.

PRESENCE REQUIREMENTS for persons and things

PPS and PRIMA → Both needs instant message system for exchanging speech, written message or file (different format). Both needs a 3D visualization (360°) with a zoom function on particulars of the product for interacting with the product for changing and evaluating the product itself or some parts of it. Both of the industrial partners would have a repository of the changes made to the product.

BEING THERE: How shall the environment look like, how shall the users be represented in the environment

PPS → The visual sense is essential for every duty to be done, haptic is second in importance, and auditory the third. For sure the possibility to exchange message using the voice and consequently the possibility to listen to the others becomes important for customer interaction (since it's a more immediate way of communication with end users without technical preparation) and for group decision making for it's immediate. No differentiation by different sense the environment should provided.

PRIMA → Sight and voice is essential for training and product development. If the touch is not a priority, the assembler should be represent by the possibility to touch things in the environment.

For both partners the question: “Should different types of persons (customer, sales person, ...) be represented differently? And how?” has no answer.

MOVING AROUND: What kind of movements are necessary, nice to have, ..., how shall the movement be done

PPS → Having a multiple view point is very important for technicians who has to examine and to act on certain parts of the product and for demonstration to end users, for the same duties it's important for users, sales people and designers have a common view and be able to make changes immediately and together the only activity for which the importance is low is for customer interaction and for group decision making.

The interface needed is visual and a group of possible interfaces¹ are listed: magnifying lens, 2D direction arrows, windows hand, 3D orbit arrow.

PRIMA → Very important is to have multiple viewpoints for the Product Assembly and the Training for Maintenance, on the same level is important to go closer to the product to see particulars because the maintenance of such big machineries needs to go deeply into the mechanical components.

¹ The partners listed an amount of VR possible interfaces without limits from the State of t

The immediate answer is very important for training (having fast answers during learning moments is crucial to keep the section interactive), but rather important for assembly. No interfaces are listed, PRIMA's never used VR before, and he's not so informed in technological possibilities.

SELECTING THINGS: What kind of selections are needed, what kind of interaction is necessary to achieve the needed / desired collaboration

PPS → Selecting single object is very important for Product Demonstration and Real Time Collaboration consequently it's very important to be allowed to multiselect objects in the same tasks for visual products comparison, speed design of a group of objects. The selection is less important for the customer negotiation and the group decision making.

PRIMA → Single object selection is very important for the training, but rather for the assembly moment, parallel the importance of multi selection.

Selection is important for highlight a part to the device in order to transmit information both for maintenance or for training activity.

Both partners would select object by "point and click" action with the mouse. The feedback of the selection action should be changes in physical appearance of the object with a visual perception in colour transformation or object enlargement.

MANIPULATING THINGS: What kinds of operations shall be possible, with what kind of interfaces shall the manipulation be done

PPS → Manipulating things is central for Product Demonstration and Real-time Collaboration actions, not important for the shop floor visualization and evaluation.

PRIMA → Very important is manipulating things and components of the device for training the non-expert technicians.

Here a list of possible manipulation operations:

- zooming,
- colouring,
- texture,
- 3D rotation,
- 2D moving,
- resizing/scaling,
- adding text,
- trimming,
- lighting,
- copy/paste/cut objects.

And possible interfaces to be developed:

- windows hand,
- 2D direction arrows,
- 3D rotation arrow,
- magnifying lens,
- toolbar with colour, texture and shapes palettes,
- text boxes.

DEMONSTRATING: What kind of demonstration possibilities are required, with what kind of interface shall it be realized

Have a VE for demonstration activity is very important, and it's important having the possibility to present the same information on different point of view.

Here a list of actions important for demonstration tasks:

- view project in different backgrounds/surroundings and graphical representation of the surrounding environment
- manipulate
- web conference
- select things and part of the object
- instant messaging
- repository of the track changes
- print files
- send files

Information of different tasks should be present to the user in different way with different interface:

PPS →

SENSE	Way of presentation	Interface
Visual information	1° 2D/3D product models, 3D visualization of background/surroundings, tables with specs, text (very important)	PC, HMDs, active stereo glasses, PDA, mobile
Auditory information	2° Speeches, sounds	headsets, mobile/phone
Haptic information	3° Texture, surface, geometry	simulate a “brushing” visual effect, data gloves

PRIMA →

SENSE	Way of presentation	Interface
Visual information	1° Visual information to designer	2° Visual to expert technician
Auditory information	2° Auditory information to designer	3° Auditory information to both
Haptic information	3° Haptic information to in-field engineer	1° Haptic information to non-expert technician (most important)

EVALUATING: How shall the information for evaluation be available, what kind of interaction is needed to do the evaluation, how important are factors like...

Information about the demonstration activities are part of the previous tasks Presence requirements.

DISCUSSING/COMMUNICATING:

The most important action for a better communication through VE is “choosing partners for discussion” and messaging with them. For this reason the interface needed is visual (written) and auditory (speaking).

The discussion at group level starts and it is maintained by discussion initialisation.

SUMMARY:

The most important sense to be stimulate through all tasks is the sight, after that the auditory and the haptic. And the most important Presence element common to the different activities and tasks is the Information Presentation and interaction with others. Then the possibility of object manipulation.

In the table here presented, we asked to connect diverse actions and sense used for better performed the action.

Senses	Visual	Auditory	Haptic
Action			
Being there		✓✓	
Moving	✓ ✓		✓
Selecting	✓	✓	✓
Manipulating	✓✓		✓
Demonstrating	✓✓	✓	
Evaluating	✓	✓	
Discussing		✓✓	

7. PRESENCE REQUIREMENTS FOR GROUP

Presence is determined by the interaction of the user with the environment and the action he can do in the same environment communicating and collaborating with others.

Here some guide lines for the group requirements based on the questionnaire results.

Product Interaction

Visual:

- 3D
- 360° (multi angle)
- Detailed particular (for maintenance, training and evaluation)
- Same point of view for different users
- See files repository for checking changes
- See the product with different scenarios and ambient around

Haptic:

- With the product
- With part of the product (detailed)
- With instruments for maintenance

Auditory:

- Signal for selection of object or single part of the product
- Signal for selection of instruments for maintenance

The haptic sensation is essential for interaction with product, part of it for maintenance or training, but not important for interaction with other people in the same VE who are not supposed to touch each others. Important to keep track of any file and message exchanged to have the possibility of going back to the product history.

Person interaction

Visual:

- See different users into the same environment
- Watch them and their actions
- See instant text/file messages

Haptic:

- Selecting person for start a discussion

Auditive:

- Immediate oral message exchange with others users
- Signal for appearing of other user into the VE
- Signal for initialisation of group interaction

People involved in the environment use are:

- Technicians (engineers)
- Designers
- End users

The three of them has different technological prerequisites and different duties.

Auditory signals are important as announcement of other persons' presence or precise actions on the product, but essential is immediate exchange of vocal information among different users of the same environment. Possibility of speaking and listening is even more important when one of the involved subjects is the customer, final user of a carpet industry who is not prepared to interaction with technology.

8. CONCLUSION

The identification of a set of requirements about Presence was not so easy and fixed, but with Industrial Partners help we arrived to determine some inputs for a better design of the environments taking into account the objectives of such situation.

Important was the identification of the task to be done and the persons who are called to do it, since the sense of Presence depend from many different factors. Step further through the conclusion of this task will be the second questionnaire that will measure the sense of Presence

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www.presence-research.org

www.ispr.info

APPENDIX A – PRESENCE QUESTIONNAIRE 1:PPS

INFORMATION FROM PPS – USE-CASE-CONTRIBUTION

Summary of the use-case-contribution

The DiFac system shall provide tools with the following characteristics:

- interactive web-based product demonstration, virtual show-room
- graphical environment for product design (properties and characteristics) with interaction possibilities
- combination of design phase with process planning (Collaborative Manager, Collaborative Prototype Designer and Factory Constructor): creation of alternative combinations of product designs/process plans
- Factory Constructor: check existing plan layouts, create new production facilities, evaluate alternatives (based on criteria with weighted factors), intelligent documentation

Expected output and acceptance criteria:

- Product Demonstration: collaborative visual desktop with precise presence modeling
- Product Development, Factory Design and Evaluation:
 - o collaborative VR system to enable online and regular collaboration and allow to undertake rapid changes in product requirements and organizational changes, user-friendly
 - o web-based collaborative product and process design and evaluation in a rich virtualized environment, share 3D models of the final products

Tasks and Objects for the three activities

List of Tasks

- Product Demonstration
 - o product demonstration
 - o customer negotiation
- Product Development
 - o real-time collaboration in product development
 - o group decision making in product design
- Factory Design and Evaluation
 - o formation of product designs/process plans alternative combinations
 - o material flow simulation
 - o shop-floor visualization and quantitative evaluation of alternatives

Persons

- Product Demonstration
 - o customers
 - o sales personnel
 - o company representatives
- Product Development
 - o sales personnel
 - o designers
 - o customer
 - o production engineers
- Factory Design and Evaluation
 - o production schedulers
 - o designers
 - o production manager

Things

- Product Demonstration
 - o Virtual representations of products and/or parts of it

- Virtual representation of particulars (internal or external) of the product
- Virtual representation of the surrounding environment
- Product Development
 - Carpets with different attributes and characteristics
 - 3D Objects with Textures, Colours, Size,
- Factory Design and Evaluation
 - blend carpets
 - resources for producing these carpets
 - stations throughout the production process (Job Shops and Work Centers)

Objects involved in the different tasks

	Nr	Task	Persons and Presence requirements		Things and Presence requirements	
Product Demonstration	1	Product demonstration	Customer, sales personnel, company representatives	Visual representation, speak, exchange instant messages, files, interact with product	Carpets	Select, 3D orbiting, 2D manipulation, zooming, projection in different backgrounds/s surroundings
	2	Customer negotiation		Speak, exchange instant messages and files	Selected carpets	Print, send image, chat history enabled
Product Development	3	Real-time collaboration in product development	Sales personnel, designers, customer, production engineers	Visual representation, speak, exchange instant messages, files, interact with product	Carpet designs	Design, render, toolbars with e.g. colour/texture palettes, scaling, reflections, surroundings
	4	Group decision making and agreement in product design		Discuss, exchange instant messages, files	Approved carpet designs	Save, print, send designs, track changes
Factory Design and Evaluation	5	Formation of product designs/process plans alternative combinations	Production schedulers, designers, production manager	Visual representation, speak, interact with the plant layout, evaluate results	Factory layout model/manufacturing resources mapping	Visualization of production facilities
	6	Material flow simulation		-/-	Process plans	Routings, flow diagrams

	7	Shop-floor visualization and quantitative evaluation of alternatives		-//-	Evaluation lists	Performance indicators, ergonomic factors, documentation etc.
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For each task we would like to find out your presence requirements for the involved persons and objects. Please consider the following questions to find out about your requirements.

QUESTIONNAIRE

Please, answer to the following questions:

Being there

How shall the environment look like, how shall the users be represented in the environment

- 1) Which sensors should be stimulated by the environment?
- 2) Please rate the importance of the different information sensors: (1 is most important, 3 is less important)
 - a) visual
 - b) auditory
 - c) haptic
- 3) Through which sensors shall different users be represented in the environment?
- 4) Should different types of persons (customer, sales person, ...) be represented differently?
 - a) How?

Question / Task	1	2a-c	3	4	4a
1	visual & haptic	a1-b2-c3	haptic & auditory	No	N/A
2	visual & auditory	a2-b1-c3	auditory	No	N/A
3	visual & haptic	a1-b3-c2	haptic & auditory	No	N/A
4	visual & auditory	a2-b1-c3	auditory	No	N/A
5	visual & haptic	a1-b3-c2	haptic & auditory	No	N/A
6	visual & haptic	a1-b3-c2	haptic & auditory	No	N/A
7	visual & haptic	a1-b3-c2	haptic & auditory	No	N/A

Moving around

What kind of movements are necessary, nice to have, ..., how shall the movement be done

- 1) How important is it to examine objects from multiple viewpoints?
- 2) It's important to be closer to see and examine objects?(1 is most important, 3 is less important)
- 3) How important is the immediate reaction of the system on your action? (1 is most important, 3 is less important)
- 4) What kind of interfaces would you like to use for moving around the environment?
 - a) List examples of interfaces

Question / Task	1	2	3	4	4a
1	crucial	1	1	visual	magnifying lens, 2D direction arrows, windows hand, 3D orbit arrow

2	low	3	3	visual	-//-
3	crucial	1	1	visual	magnifying lens, 2D arrows, hand
4	low	2	3	visual	-//-
5	fair	3	2	visual	2D direction arrows, hand, 3D orbit arrow
6	fair	3	2	visual	-//-
7	fair	3	2	visual	-//-

Selecting things

What kind of selections are needed, what kind of interaction is necessary to achieve the needed / desired collaboration

- 1) How important is the possibility of selecting single objects with the notification of other users?
- 2) How should the process of selecting an object be realized?
 - a) With what kind of interface?
 - b) Is ownership important for you (e.g. should one user own the object when selected?) (1 is most important, 3 is less important)
- 3) How important is the possibility of multi-selection? (1 is most important, 3 is less important)
- 4) In which situations would it be necessary?
- 5) How should the action of selection be propagated to the selector, to the other users? List examples in order of most to least importance.
(by visual, auditory, haptic feedback?, by symbols or text or ...?)
- 6) How should selected objects be presented / highlighted to the user? List examples in order of most to least importance.
(by colour, by text, by ...?)

Question / Task	1	2a-b	3	4	5	6
1	very	single mouse click (arrow), hand grip	1	visual comparison products	by visual means, text, haptic feedback, auditory	enlarged, framed, coloured, brightened
2	low	-//-	2	-//-	-//-	-//-
3	very	-//-	1	speed the designing process	-//-	-//-
4	low	-//-	2	apply 3D objects	-//-	-//-
5	fair	-//-	2	copy, delete, move, resize, rotate a group of objects	-//-	-//-
6	fair	-//-	2	-//-	-//-	-//-
7	fair	-//-	2	-//-	-//-	-//-

Manipulating things

What kinds of operations shall be possible, with what kind of interfaces shall the manipulation be done

- 1) How important is the manipulation of objects? (1 is most important, 3 is less important)
- 2) What kinds of manipulation operations are needed / desired. List examples in order of most important to least important.
(Moving, rotating, scaling, merging, deforming, colouring, removing, dividing, adding text...)

3) What kind of interface should be used to realize the operations above?

Question Task	1	2	3
1	1	zooming, 2D moving, 3D rotation, resizing/scaling, lighting	windows hand, 2D direction arrows, 3D rotation arrow, magnifying lens
2	2	zooming, 2D moving, 3D rotation, resizing/scaling, lighting	-/-
3	1	zooming, colouring, texture, 3D rotation, 2D moving, resizing/scaling, adding text, trimming, lighting	windows hand, 2D direction arrows, 3D rotation arrow, magnifying lens, toolbar with colour and texture palettes, text boxes
4	2	zooming, colouring, texture, 3D rotation, 2D moving, resizing/scaling, adding text, trimming, lighting	-/-
5	2	2D moving, 3D rotation, zooming, resizing/scaling, aligning, copy/paste/cut object	windows hand, 2D direction arrows, 3D rotation arrow, magnifying lens, grid, text boxes, toolbar with basic shapes etc.
6	2	2D moving, 3D rotation, zooming, adding text	-/-
7	3	2D moving, 3D rotation, zooming, adding text	-/-

Demonstrating

What kind of demonstration possibilities are required, with what kind of interface shall it be realized

- 1) What kinds of actions are important during information demonstration? List examples in order of most important to least important.
(View, object selection, object manipulation, ...)
- 2) How important is it to have several different ways of presenting the same information (at once)?
- 3) How should information be presented to the user? (Rate the importance of the sensors and list examples in order of most important/useful to least important/useful.)
 - a) Visual information: symbols, texts, 3D – 2D, charts, tables ...
 - b) Auditory information: sounds, signals, speeches ...
 - c) Haptic information: shape, surface, ...
- 4) What kind of interfaces should be used to present / demonstrate information? List examples for the different sensors in order of most important/useful to least important/useful.
 - a) Visual information: displays => PC, wall, table, PDA, mobile ...
 - b) Auditory information: headsets, mobile ...
 - c) Haptic information: data gloves ...

Question Task	1	2	3a-c	4a-c
1	view, manipulate, project in different backgrounds/surroundings, web conference, select, instant messaging	very important	a) Visual info (very important): 2D/3D product models, 3D visualization of background/surroundings, tables with specs, text b) Auditory info (important): speeches,	a) Visual info: PC, HMDs, active stereo glasses, PDA, mobile b) Auditory info: headsets, mobile/phone

			sounds c) Haptic info (important): texture, surface, geometry	c) Haptic info: simulate a "brushing" visual effect, data gloves
2	view, manipulate, web conference, instant messaging, print, send file	very important	-//-	-//-
3	view, manipulate, project in different backgrounds/surroundings, graphical representation of the surrounding environment, web conference, select, instant messaging	very important	-//-	-//-
4	view, manipulate, web conference, instant messaging, track changes, save design, print, send file			
5	view, move, web conference, instant messaging, select, save alternative product designs/process plans and factory layouts, print, send file	very important	-//-	-//-
6	view, web conference, instant messaging, save design, print, send file	very important	-//-	-//-
7	view, web conference, instant messaging, disseminate evaluation lists, save, print, send file	very important	-//-	-//-

Evaluating

How shall the information for evaluation be available, what kind of interaction is needed to do the evaluation, how important are factors like...

- 1) What kinds of actions are important during an evaluation process? List examples in order of most important to least important.
- 2) How important is consistency of information in comparison in the process of evaluation (compared to other actions)?
- 3) What kind of interaction possibilities are needed during the evaluation process? List examples.
- 4) How should information be presented (compared to the presentation in other activities)?

Question / Task	1	2	3	4
1				
2				
3				

4				
5				
6				
7				

Discussing/Communicating

- 1) What kinds of actions are important during the process?
 - a) choosing partners for discussion
 - b) selecting things with feedback (partner ok)
- 2) What kind of interfaces should be used for discussion?
 - a) Visual (written text)
 - b) Auditory (speaking)
 - c) Haptic (touching)
- 3) How should communication between a group of two or more people start and work?
 - a) Discussion initialisation
 - b) Discussion leader

Question Task	1	2	3
1	choosing partners for discussion, messaging	visual & auditory	Discussion initialisation
2	-//-	visual & auditory	Discussion initialisation
3	-//-	visual & auditory	Discussion initialisation
4	-//-	visual & auditory	Discussion initialisation
5	-//-	visual & auditory	Discussion leader
6	-//-	visual & auditory	Discussion leader
7	-//-	visual & auditory	Discussion initialisation

Overall summary

- 1) What kind of senses should be stimulated during the different tasks?
- 2) How should a precise presence modelling for the different tasks be realized in general according to your opinion?
- 3) Rate the importance of the following elements for each of the different tasks:
 - a) Information presentation
 - b) Information consistency
 - c) Possibilities of object manipulation
 - d) Possibilities of interaction with other person
- 4) For which actions (being there, moving around, ...) are which senses most important?

Question Task	1	2	3a-c
1	visual & haptic		a2 - b4 - c1 - d3

2	visual & auditory		a1 - b2 - c4 - d3
3	visual & haptic		a2 - b4 - c1 - d3
4	visual & auditory		a1 - b3 - c4 - d2
5	visual & haptic		a2 - b4 - c1 - d3
6	visual & haptic		a1 - b2 - c3 - d4
7	visual & haptic		a1 - b2 - c4 - d3

Senses Action	Visual	Auditory	Haptic
Being there		✓	
Moving	✓		
Selecting		✓	
Manipulating	✓		
Demonstrating	✓		
Evaluating		✓	
Discussing		✓	

APPENDIX B: PRESENCE QUESTIONNAIRE 1: PRIMA

INFORMATION FROM PRIMA USE-CASE-CONTRIBUTION

Summary of the use-case-contribution

The DiFac system shall provide tools with the following characteristics:

- Tool for remote joint design/assembly
 - o VR system for remote designers and technicians
 - o Allowing remote support inform design to assembly phase
 - o Share information in mechanical assemblies and sw
- Tool for remote joint maintenance
 - o VR/AR system
 - o Portable and wireless device
 - o Supporting training and maintenance
 - o Allowing remote expert guidance for difficult maintenance tasks
 - o Share information in mechanical assemblies and sw

Expected output and acceptance criteria:

- Product and Factory Design and Assembly:
 - o
- Maintenance and Training:

Tasks and Objects for the three activities

List of Tasks

- Product Development
 - o Assembly of product
- Factory Design and Evaluation
- Training
 - o Remote training for Maintenance

Persons

- Product Development
 - o Designer
 - o Engineer, assembler
- Factory Design and Evaluation
- Training
 - o Non-expert technician
 - o Expert technician

Things

- Product Development
 - o Product model
 - o Real product
- Factory Design and Evaluation
- Training
 - o Product model
 - o Real product

Objects involved in the different tasks

	Nr	Task	Persons and Presence requirements		Things and Presence requirements	
Product Development	1	Assembly of product	Engineer, Assembler Designers	Interaction with machinery, and part of the machine, listen and speak immediately with people in another place, exchange parts of the project, designs and files	Machines and single parts of the machine, instruments for assembly	Selecting parts of the machine, view in 3D of the machine, its components and instruments for assembly, give immediate feedback to the designer, keep track of the previous file in a kind of repository
Training	3	Training for non-expert technician for remote Maintenance	Expert technicians Non-expert technician	Interaction with machinery, and part of the machine, listen and speak immediately with people in another place, exchange parts of the project, designs and files	Machines and single parts of the machine, instruments for assembly	Selecting parts of the machine, 3D view of the instruments for machine maintenance, and the actions on the machine

For each task we would like to find out your presence requirements for the involved persons and objects. Please consider the following questions to find out about your requirements.

QUESTIONNAIRE

Please, answer to the following questions:

Being there

How shall the environment look like, how shall the users be represented in the environment

- 5) Which sensors should be stimulated by the environment?
- 6) Please rate the importance of the different information sensors: (1 is most important, 3 is less important)
 - a) visual
 - b) auditory
 - c) haptic
- 7) Through which sensors shall different users be represented in the environment?
- 8) Should different types of persons (customer, sales person, ...) be represented differently?
 - a) How?

Question	1	2a-c	3	4	4a
Assembly of product	Sight, voice. Possibly touch	Sight 1, voice2, touch 3	Every user to have sight and voice. Perhaps engineers/assemblers to have touch as well.	Not required	-
Training for non-expert	Sight, voice	Sight 1, voice 2	Sight and voice for both persons	N.A.	-

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Moving around

What kind of movements are necessary, nice to have, ..., how shall the movement be done

- 5) How important is it to examine objects from multiple viewpoints?
- 6) It's important to be closer to see and examine objects?(1 is most important, 3 is less important)
- 7) How important is the immediate reaction of the system on your action? (1 is most important, 3 is less important)
- 8) What kind of interfaces would you like to use for moving around the environment?
 - a) List examples of interfaces

Question Task	1	2	3	4	4a
Assembly of product	Very important (1)	Very important (1)	Rather important (2)	Not real ideas	-
Training for non-expert technician for remote Maintenance	Very important (1)	Very important (1)	Very important (1)	Person moves around the environment; no moving devices required	

Selecting things

What kind of selections are needed, what kind of interaction is necessary to achieve the needed / desired collaboration

- 7) How important is the possibility of selecting single objects with the notification of other users?
- 8) How should the process of selecting an object be realized?
 - a) With what kind of interface?
 - b) Is ownership important for you (e.g. should one user own the object when selected?) (1 is most important, 3 is less important)
- 9) How important is the possibility of multi-selection? (1 is most important, 3 is less important)
- 10) In which situations would it be necessary?
- 11) How should the action of selection be propagated to the selector, to the other users? List examples in order of most to least importance.
(by visual, auditory, haptic feedback?, by symbols or text or ...?)
- 12) How should selected objects be presented / highlighted to the user? List examples in order of most to least importance.
(by color, by text, by ...?)

Question Task	1	2a-b	3	4	5	6
Assembly of product	Rather important (2)	a) Point and click? B) Less important (3)	Rather important (2)	Highlighting a part of the device to be maintained in order to transmit info.	Visual feedback	Colour and text?
Training for non-expert	Very important (1)	a) Point and click? B) Less	Very important	Highlighting a part of the device to be maintained	Visual feedback	Colour and

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Manipulating things

What kinds of operations shall be possible, with what kind of interfaces shall the manipulation be done

- 4) How important is the manipulation of objects? (1 is most important, 3 is less important)
- 5) What kinds of manipulation operations are needed / desired. List examples in order of most important to least important.
(Moving, rotating, scaling, merging, deforming, coloring, removing, dividing, adding text...)
- 6) What kind of interface should be used to realize the operations above?

Question Task	1	2	3
Assembly of product	Less important (3)	No idea	No idea
Training for non-expert technician for remote Maintenance	Very important, but local	Report of manipulations being performed by non-expert technician to expert technician	Visual? Tactile?

Demonstrating

What kind of demonstration possibilities are required, with what kind of interface shall it be realized

- 5) What kinds of actions are important during information demonstration? List examples in order of most important to least important.
(View, object selection, object manipulation, ...)
- 6) How important is it to have several different ways of presenting the same information (at once)?
- 7) How should information be presented to the user? (Rate the importance of the sensors and list examples in order of most important/useful to least important/useful.)
 - a) Visual information: symbols, texts, 3D – 2D, charts, tables ...
 - b) Auditory information: sounds, signals, speeches ...
 - c) Haptic information: shape, surface,
- 8) What kind of interfaces should be used to present / demonstrate information? List examples for the different sensors in order of most important/useful to least important/useful.
 - a) Visual information: displays => PC, wall, table, PDA, mobile ...
 - b) Auditory information: headsets, mobile ...
 - c) Haptic information: data gloves ...

Question Task	1	2	3a-c	4a-c
Assembly of product	View, message exchange, feedback to engineer in field	No idea	a) Visual information to designer b) Auditory information to designer c) haptic information to in-field engineer	a) PC screen b) headphones c) Augmented reality portable terminal

Training for non-expert technician for remote Maintenance	View, message exchange, data sharing	No idea	a) Haptic information to non-expert technician; b) Visual to expert technician c) Auditory information to both	a) PC screen b) Augmented reality terminal c) headphones?
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Evaluating

How shall the information for evaluation be available, what kind of interaction is needed to do the evaluation, how important are factors like...

- 5) What kinds of actions are important during an evaluation process? List examples in order of most important to least important.
- 6) How important is consistency of information in comparison in the process of evaluation (compared to other actions)?
- 7) What kind of interaction possibilities are needed during the evaluation process? List examples.
- 8) How should information be presented (compared to the presentation in other activities)?

Question Task	1	2	3	4
Assembly of product	Actions listed in detailed evaluation scenario t.b.d.	?	All envisioned	?
Training for non-expert technician for remote Maintenance	Actions listed in detailed evaluation scenario t.b.d.	?	All envisioned	?

Discussing/Communicating

- 4) What kinds of actions are important during the process?
 - a) choosing partners for discussion
 - b) selecting things with feedback (partner ok)
- 5) What kind of interfaces should be used for discussion?
 - a) Visual (written text)
 - b) Auditory (speaking)
 - c) Haptic (touching)
- 6) How should communication between a group of two or more people start and work?
 - a) Discussion initialization
 - b) Discussion leader

Question Task	1	2	3	4
Assembly of product	Both	Both visual and auditory	Discussion initialization	?
Training for non-expert technician for remote Maintenance	Both	All listed	Discussion leader (Expert technician)	?

Overall summary

5) What kind of senses should be stimulated during the different tasks?

Product Development Sight and voice. Possibly touch feedback for remote engineer.

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Training.....Sight and voice

6) How should a precise presence modeling for the different tasks be realized in general according to your opinion?

7) Rate the importance of the following elements for each of the different tasks: (1 most important, 3 less important)

- a) Information presentation
- b) Information consistency
- c) Possibilities of object manipulation
- d) Possibilities of interaction with other person

Question Task	3a	3b	3c	3d
Assembly of product	1	1	2	1
Training for non-expert technician for remote Maintenance	1	1	3	1

8) For which actions (being there, moving around, ...) are which senses most important?

Senses Action	Visual	Auditory	Haptic
Being there		X	
Moving	x		X
Selecting	x		x
Manipulating	x		X
Demonstrating	x	X	
Evaluating	X		
Discussing		X	