A Participatory Design Study of User Requirements for a Shared Virtual Meeting Space

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Main Contributions

A participatory design study of user requirements for a shared virtual meeting space showed the importance of the following factors in aiding effective communication and developing a heightened sense of presence and copresence:

- *Environment*: once participants had mastered the interface controls, solutions to environment issues were preferred which did not forfeit the sense of realism or the geometry of the space.
- *Talker identification and turn-taking*: participants wanted to identify their own protocols for meeting control (e.g. turn-taking) rather than having such protocols imposed.
- *Avatar personalisation*: increasing the number of personalisation options for avatars served to heighten the association of an avatar with its user. Participants indicated that while desiring a high degree of realism for some aspects of avatar representation, they required a degree of generalisation in others.
- *Avatar gesture control*: One-click, visual buttons for gesture control were preferred over pull-down menus. Literal descriptions for gesture labels (e.g. 'nod') were favoured over interpreted descriptions (e.g. 'agree').
- *Symbolic acting*: The use of avatar animations to indicate user actions outside the shared space proved to be effective for assisting group dynamics.

Abstract

This paper summarises the results of a study of user habituation, usage and involvement with a shared virtual 3D environment acting as a meeting space. Employing a participatory design process, the study investigated the effectiveness of a range of design features aimed at enhancing communication, discussion and social interaction among a group of four users of the shared space for six sessions during which participants carried out specified communication tasks. The role of a wide range of design features that contribute to the perception of presence and copresence were investigated. These included the environment, methods for talker identification and turn-taking, avatar personalisation options, gesture control and symbolic acting.

1 Introduction

Presence and copresence in shared virtual meeting spaces (SVMS's) are complex social and psychological constructs which are heavily influenced by a variety of interface characteristics such as the environment, controls for navigation and avatar gestures, avatar personalisation options and life signs (Hendrix and Barfield, 1996a & 1996b; Lombard and Ditton, 1997; Steuer, 1995; Tromp, 1995). These factors are not independent; they interact in complex and subtle ways through the demands they place on users' attention, cognitive resources and screen space. Fundamentally, SVMS's are used to express message content, users' personalities and appearance through the facilities available in such a way as to maintain engagement and 'suspension of disbelief'. A key issue for the development of design principles for shared spaces which encourage heightened sense of presence is therefore the need to deepen understanding of users' perceptions of their own requirements in relation to other users and task outcomes.

The study reported in this paper addressed this key issue through an investigation of the contribution to the sense of presence and copresence of a range of design factors as measured by the participants' own perception of their success in achieving defined tasks within an SVMS. A participatory design methodology was adopted (Reich, Suresh and Levy, 1995) which involved four users engaged in a series of communication tasks over six sessions. This procedure allowed users to contribute directly to the definition of the shared space features for the support of effective and efficient communication. Between sessions, modifications to the SVMS and the avatars were made with their effectiveness being assessed using post-session group discussions. The following design factors were examined during the study: the virtual environment, methods for talker identification and turn-taking, the effects of avatar personalisation options, gesture control and symbolic acting. Modifications to the shared space and its avatars were implemented and assessed on the basis of feedback from the users and from observations made during the study sessions.

2 Study Methodology

A longitudinal study was carried out which involved participants using a customised shared space environment for six sessions over a seven-week period. Each session consisted of approximately 40 minutes collaborative use of the shared space followed by a 30-minute group discussion to elicit participants' views on current features together with suggestions for improvements to the environment and the avatars. Four post-graduate students from non-

computing disciplines took part in the study -- two male, two female, all between twenty and thirty years of age. They all had basic computing skills although none had experience with shared spaces, conferencing systems or avatars. All were native speakers of English. Participants were fully aware that they were being observed and that their conversations were being recorded.

Five offices, each containing a PC client connected to a central server, were allocated for the study, one for each participant and one for a researcher who accessed the shared space during the sessions as an invisible (and silent) user in order to monitor interactions and usage. The only means of communication between participants was via the shared space software. At the start of each session, the current features of the meeting space were explained to the participants as a group. They were then asked to read editorials from a selection of that morning's newspapers, to discuss the editorials within the meeting space, and to reach a consensus on the most interesting or important story to be carried forward for inclusion in 'a Sunday newspaper'. This task was repeated (with different editorial materials) for five of the six sessions. For the sixth session the task was enriched to explore issues raised by the private messaging facilities that had been requested. This modified task involved participants working in pairs to present and discuss their point of view, based on one topical issue.

An observation log was kept during each session which included the types and variety of interactions that occurred, and the content of any discussions relating to the technology being used. This information was then used to structure the group discussion which immediately followed use of the meeting space, during which participants were reminded that, where possible, their feedback would be used to modify the virtual environment for the following session.

3 System Architecture

The custom-built SVMS employed an open-source audio conferencing tool (*Robust-Audio Tool* v3.0) in combination with a multi-user VR client-server package. The latter was implemented using *DeepMatrix*, an open-source Java-based application which operates in conjunction with a standard VRML plug-in. *RAT* ran invisibly in the background during the study sessions so that the participants were only aware of the shared space interface. The availability of public domain and open-source software for these resources allowed rapid modification of features and facilities in the shared space in response to feedback from participants. All visual events within the virtual environment were logged by the software for later analysis.

4 Evolution of the Meeting Space Design

The key design features provided for users in each of the six sessions are summarised in Table 1. The characteristics of the SVMS for the first session were based on user preferences obtained during a set of informal interviews with volunteers who did not take part in the final study.

Session	Meeting Space Features
1	Eight differently coloured chairs around a circular table were offered in the conference room for the four users. The interface included a head-up display with buttons to control close-up and wide-angle views. A small self-image of the user's avatar was also

	included. A moveable microphone object was available on the table, to be used as an aid to turn-taking. A pull-down menu for three gestures ('agree', 'disagree', 'greeting') was available, as was direct avatar 'transport' to a chair by mouse-click on the chair. The audio connection was continuously active whether or not participants were logged-in to the shared space. Navigation was controlled via both mouse and keyboard. Simple avatar life signs (blinking and breathing) were implemented as well as lip movements activated by the user's speech. Personalisation options were limited to gender, clothing style (formal/informal) and colour.
2	The microphone object was removed, along with four of the chairs. All avatar life signs were disabled but the mouth movements to indicate the talker were made more prominent by totally closing the mouth on each cycle.
3	Avatar life signs were re-enabled for this session but with the breathing motion reduced from 5% chest expansion to 1%. Automated arm and hand gesticulations were added to complement the role of the mouth movements for talker identification, and an alternative means of gesture invocation was added via a pop-up menu enabled by clicking on the avatar self-view. Enhanced avatar personalisation (carried out prior to logging in) was added to allow selection of hair colour and clothing colours, as well as to allow preview of the avatar prior to entering the shared space.
4	The four extra chairs were re-introduced. The avatar breathing motion was increased to a chest expansion of 2%, and avatar personalisation options to allow choice of build, height, hair style and facial hair were introduced. The available gestures were re-labelled ('yes', 'no', 'greeting') and the pull-down menu was replaced by a row of three labelled buttons.
5	Avatar personalisation was extended to include choice of skin tone. An automatic head-turning facility was introduced to make a user's avatar turn to face whichever avatars were talking. This could be activated and de-activated at any time during the session. An additional hand gesture (labelled 'hand up') was added as an aid to turn-taking. The waving arm gesture was relabelled 'bye' and an open-armed gesture was introduced. A private text-based messaging facility was introduced together with associated symbolic actions to represent the writing, reading, saving or discarding of messages.
6	A second room was added to act as a pre-meeting ante-room. The gesture buttons were re-labelled with more generic names ('nod', 'shake', 'hand up', 'bye', 'shrug'). The audio connection (input and output) at each client was modified to be enabled only when the user was logged on.

Table 1: Evolution of the Meeting Space Design

By the end of Session 6 the participants felt that they had arrived at a working set of features which supported their communication needs within this particular virtual shared space. The study was therefore concluded at that point. Figure 1 illustrates the design of the shared meeting space as it was at the end of the study.

Figure 1: Final Design of the Shared Virtual Meeting Space

5 Discussion

5.1 The Virtual Environment

In the first session, a problem arose because participants chose seats from which they could not see (simultaneously) all of the other participants. This led to confusion as participants rapidly changed seats in order to see the current speaker. After considering various solutions, the participants asked to have only four equally-spaced chairs. Once participants had mastered the zoom and head-turning controls, problems of the seating arrangements for the meetings were resolved without forfeiting the sense of realism -- which all participants demanded -- or the geometry of the space. Over time, all the participants exhibited a high degree of immersion within the environment.

An ante-room was added as a 'pre-meeting gathering point' because the participants did not like the idea of 'beaming' directly into the meeting room. The fact that one participant retired to the ante-room during what she described as "an intense meeting" highlights the high degree of identification with the space that the participants had developed.

5.2 Talker Identification and Turn-Taking

The microphone device used in the first session was rejected as an aid to turn-taking: it was considered to be confusing and distracting. Instead, the participants elected to develop their own protocols for turn-taking, such as (1) a hand-raising gesture and (2) turning to face away from speakers to indicate boredom or disagreement.

The avatar mouth animation, activated when the users were talking, was found to be helpful for identifying those talking but hard to discern from a distance. Therefore, the avatars were enhanced to exhibit hand and arm gesticulations during prolonged periods of speaking; this was

considered to be an effective solution and served to further increase avatar-user association. Participants also found that an automatic head-turning facility helped talker-identification.

5.3 Avatar Personalisation

Comments regarding the customisation of the avatars centred around the idea of 'selective realism'. On the one hand, the participants wanted to personalise their avatars to a certain degree of *accuracy* in order to aid self-identity and identification by others. On the other hand, the participants also require a degree of *generalisation* so that the role of the avatar as a 'mask' could be maintained. This was achieved by means of approximate and relative category descriptors (e.g. 'medium', 'taller' or 'shorter' height). For similar reasons, texture-mapped photo-realistic faces were rejected.

As noted in the previous section, enhanced personalisation options were added in response to participants' requests. The degree to which personalisation increased avatar-user association was indicated by one particular incident. In early sessions, participants frequently logged out during sessions to change their avatar sessions. In a later session, however, one participant was reprimanded by the others for doing so; he was told, "It's just rude, because we know who you are now."

5.4 Avatar Gesture Control

Ease of activation was deemed to be paramount, hence the initial pull-down menus were replaced by push-buttons with associated 'hot keys'. A small set of general and relatively ambiguous gestures was favoured over a larger selection of specialised ones. Participants preferred literal descriptions of the gestures (e.g. 'nod') to which they could apply their own interpretations, rather than semantic descriptions (e.g. 'agree'). A hand-raising gesture was also requested as an aid to turn-taking.

5.5 Symbolic Acting

A facility to send private text messages to one or more users was added in Session 5 in response to participants' requests. The participants added that they wished to know *when* and *by whom* the feature was being used, and this was achieved via symbolic acting, i.e. avatar animations suggestive of writing, reading, saving and discarding messages, initiated automatically by the corresponding user action. The participants unanimously expressed their appreciation of the symbolic acting, and its effectiveness was evidenced when its absence resulted in confusion and frustration for the users.

6 Conclusions

The participatory design methodology used in this study enabled the factors that influence presence and copresence to be identified and isolated based on the participants' own experiences. The results were then used to determine the on-going design of the interface. The study lasted for six sessions over seven weeks, at the end of which time the four participants felt they had an effective working environment, mastery of the controls needed for navigation and

communication (which they had themselves suggested) and an appropriate range of avatar customisation facilities. This combination of facilities enabled the crucial sense of realism -- which is such an important element of presence -- to be maintained by the four participants during the final sessions.

7 References

Hendrix, C. and Barfield, W. (1996a). "Presence within virtual environments as a function of visual display parameters". *Presence* 5(3): 274-289.
Hendrix, C. and Barfield, W. (1996b). "The sense of presence within auditory virtual environments". *Presence* 5(3): 290-301.
Lombard, M. and Ditton, T. (1997). "At the Heart of it All: The Concept of Presence". *Journal of Computer Mediated Communication* 3(2).
[http://www.ascusc.org/jcmc/vol3/issue2/lombard.html]
Reich, Y., Suresh, L. and Levy, S. N. (1995). "Varieties and Issues of Participation and Design", *Design Studies*, 17(2): 165-180.
Steuer, J. (1995). "Defining virtual reality: Dimensions determining telepresence". In Frank Biocca & Mark R. Levy (eds.), *Communication in the age of virtual reality* (pp. 191-218). Hillsdale, (NJ: Lawrence Erlbaum Associates).
Tromp, J. (1995). "Presence, telepresence and immersion: the cognitive factors of embodiment and interaction in virtual environments". *Proceedings of FIVE '95: Framework for Immersive Virtual Environments, London 1995*. London: University of London, pp. 39-51.