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Videoconferencing Offers More than Audio and Video – Making Creative Animation Artists Collaborate between Remote Offices

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Abstract

For more than forty years, since videoconferencing was introduced for telecommunication, researchers and market analysts have been predicting a new era of communication, that distance might soon become insignificant in human communication, and forecasting a virtualisation of work places and communities. Today, the shortcomings of telecommunication systems have been acknowledged: people still travel to meet each other face to face in order to improve the perception of sharing time and space, the establishment of common ground, awareness and presence perception. However, this paper suggests that for specialised purposes in confined environments, technology does indeed offer the promise to allow people collaborate intensively over a distance. We present a user study about how creative digital animation artists collaborate in a current co-located situation in the digital media production industry before we enter a discussion of hardware choices and user control interface design for the purpose of creating a non-intrusive, spontaneity-enabling high-quality videoconferencing system between their workspaces.

Keywords

Virtual Media Office, Intense Creative Collaboration, High-quality videoconferencing, Hardware, User Control Interface, Awareness

INTRODUCTION

AT&T introduced the world first picture phone, offering more than text and voice communication in the 1960's. The introduction of videoconferencing in both one-on-one and group conferencing had originally triggered much enthusiasm and the prediction that workplaces might soon become completely virtual, removing the importance of place altogether (Cairncross, 1997). However, many consumers were concerned about their privacy, as the article (BBH, 2004) exemplifies: … *"the more a product requires consumers to change their behavior, the harder it is to accept it. It must also address and overcome fears about privacy: users not wanting to be seen by certain people or not at certain times*."

Today we see a certain consolidation in the product development of videoconferencing tools. Whilst the video-enabled telephone in private households was not commercially viable, most global companies have set-up their meeting rooms with videoconferencing facilities for business communication. The communication technology itself has seen some major improvements: From ISDN conferencing (64kbps to 384 kbps), via experimental Multicast Backbone tools (MBone) to the H.26x line of video standards. Recently, purpose-built high-quality videoconferencing systems have seen major attention in the media (Teliris, 2005; The Age, 2005; eWeek, 2006).

Sixteen years ago, Olson and Olson (Olson et al, 2000) suggested in an elaborate study of distance communication that…"*There are several broad reasons why distance will persist as an important element of human experience. […] Our findings in these settings fall into two categories: behaviour that will change for the better when technology achieves certain qualities we think are possible in the next 20 years, and behaviour that will never change.*" In December 2005, The Age (The Age, 2005) comments on the Halo videoconferencing project (Sandow, 2006) between Hewlett Packard and Dreamworks, that… "*HP's Halo Collaboration Studio offers a nearly immersive environment where people can see each other, talk and collaborate remotely as if they were in the same room*". This statement seems to indicate that we have, indeed, reached the required level of technical improvement so that human perception and, with this, human interaction with the technology, is on the verge of changing.

At the CSIRO ICT Centre, we have built a high-quality multicast-enabled videoconferencing system, the *Virtual Tearoom* that streams standard definition DV-encoded audio and video at 30Mbps between remote sites (Hogan et al, 2004; Schremmer et al, 2005a). Our underlying experimental gigabit research network, CeNTIE, supports native IP multicast routing, where data packets are replicated as the need arises within the network. The CeNTIE experimental network has been specifically designed to develop and test high bandwidth telecollaboration applications and as such does not carry corporate or commodity internet traffic, thus enabling line rate gigabit throughput at all connected sites.

The communication platform of the Virtual Tearoom is the base technology for a prototype system that the CSIRO is currently developing in cooperation with a Sydney-based Digital Media Production company. The digital media production industry competes internationally with their key value proposition being the quality of their productions. Hence, economical considerations on a global scale see the Australian digital media production industry investigating various possibilities that allow access to creative talent in a timely manner regardless of location. This means that the industry needs to be able to have access to digital animation artists for new projects, without necessarily having to physically move an artist into the Sydney headquarters.

In August 2005, we conducted an observation series to gain a better understanding of how digital animation artists work today, how they have currently set up their workplaces, what their tasks and scheduling are like, and – most importantly – to observe how the artists interact with each other today (Schremmer et al, 2005b; Schremmer, 2006). These observations have influenced the design of our industry project the *Virtual Media Office*. The Virtual Media Office aims at enabling an animation artist in one physically co-located team to interact with a team member at a remotely co-located team as casually and spontaneously as if they were not separated by distance.

It is important to note that the Virtual Media Office, though containing two or more separate physical workplaces, specifically refers to *teams* of animation artists at either location. Hence, in this setting, animation artists still go to a specific office as their regular workplace. It is not our aim to investigate the social implications involved with people working by oneself from home. Instead, in the Virtual Media Office, the animation artists attend a regular workplace where they have colleagues physically sharing their workplace. However, the animation artists in the Virtual Office work in teams where parts of the team members are located in a separate office.

We are convinced that the underlying technology allows for the needs of the animation artists for spontaneous, casual, or scheduled communication over a distance. We have, indeed, reached the level of technological quality that Olson et al (Olson et al, 2000) referred to as…"*when technology achieves certain qualities we think are possible in the next 20 years.*" However, the challenge today lies in the *subtle* factors: choice of hardware, its set-up, and its user control interface. This paper summarizes our workplace observations at the Sydney-based digital media production company. It then discusses some requirements for intense remote collaboration, before focussing on the choice of hardware and user control interface. The last section offers an outlook of intense creative remote collaboration in the not so distant future.

OBSERVATIONS IN DIGITAL MEDIA PRODUCTION INDUSTRY

This section summarizes our workplace observations at a Sydney-based digital media production company that uses creative talent to produce digital film sequences and animations, a study that we conducted in August 2005. It highlights some interactions that we observed and that, we believe, apply generically for many businesses and industries. More details of this study can be found in (Schremmer et al, 2005b; Schremmer, 2006).

The company we are focusing on produces digital video sequences. The employees we observed were mainly young males (20-30 years of age) who use computers for their creative work. In our case study, animation artists were reporting to lead artists in charge of the composition of their single digital artefacts into an overall artistic production. Since precise representations of colours are of importance in the staffs' artwork, the workplace is devoid of natural light, and is instead lit by indirect artificial light sources. The artists work in open spaces, their desks arranged so that they can often see their co-workers' monitors. Each artist is encouraged to set-up their computers according to personal preferences; generally, we observed two monitors per person (one as a control and scheduling screen, the second one for the actual artwork).

In the observed industry, the individual's contributions to a project are tightly coupled. It is not uncommon to have one artist allocated to a certain task for a couple of hours, or even a couple of minutes only, before his/her contribution is used by another animation artist for further refinement. Therefore, the artists require a strong awareness of what their colleagues are currently working on, how they are progressing, and what are the reasons for a possible delay. An open space setup of the individual workplaces encourages the animation artists to share their ideas, information, and news (see Figure 1 for in impression of the open plan work environment).

We believe that the interactions we have observed in this particular industry apply to many other industries that are: project-driven, computer-centric, creative, and collaborative. Therefore the following discussion, though based on our specific observations, applies generically for many industries.

Figure 1. An open plan work place facilitates and encourages casual interaction and awareness. In this photo, three animation artists are discussing a digital artefact (photo taken in Aug 2005).

The work of the animation artists that we observed was strongly computer-focused and was performed individually. On the other hand, the staff tended to have strong social bonds within their own working groups or across projects. Roughly, we observed two different categories of interactions, formal and informal. Organised interactions consisted of group discussions of certain duration (longer than 5 mins), where few (3-6) people were situated in the office space and discussed digital artefacts or project-related matters. In our study, we focussed on the observation of informal and spontaneous interactions. In this category, we observed three different types of communication:

- Over the partition (< 10 sec duration): one-to-one, anytime, specific questions/ acknowledgement
  - "Is frame x ready yet?"
  - "Oh, that's nice!"
  - "I heard you saying …"
- Broadcasting to office (< 10 sec duration): one-to-all, anytime, specific question
  - "Who has done …?"
- Increased engagement (< 5 min duration): one-to-few, often sitting down, focus mainly on the screen
  - "Let's discuss this image…"

The challenge for any remote setting of collaboration is to enable these informal interactions.

VIRTUAL OFFICE FOR ANIMATION ARTISTS – "CONNECTING CUBICLES"

SPONTANEOUS CASUAL INTERACTIONS

Many creative ideas are developed by spontaneously interacting with other people, asking questions, brainstorming, or seeking feedback on an interesting idea. As shown above, these unscheduled casual interactions might be one-to-one or one-to-many. One way to encourage this form of interaction in a remote setting is to offer a facility to allow for colleagues to virtually chat over the cubicle partition. This could be achieved by placing an LCD monitor on one wall of the cubicle and allowing dynamic selection of the person that should "sit on the other side of the partition". This goes beyond the possibilities of existing workplaces and takes advantage of the technology mediating communication. We denote such a set-up of high-quality videoconferencing in a person's workspace as *Connected Cubicles*.

The user control interface for *Connected Cubicles* should allow random audio-visual access between one person and a list of authorised colleagues. Figure 2 depicts three different physical interaction spaces, where animation artists interact with their colleagues. Figure 3 sketches a vision of *Connected Cubicles* where an artist X and a (remote) artist Y use large displays and audio-visual technology to communicate over the distance.

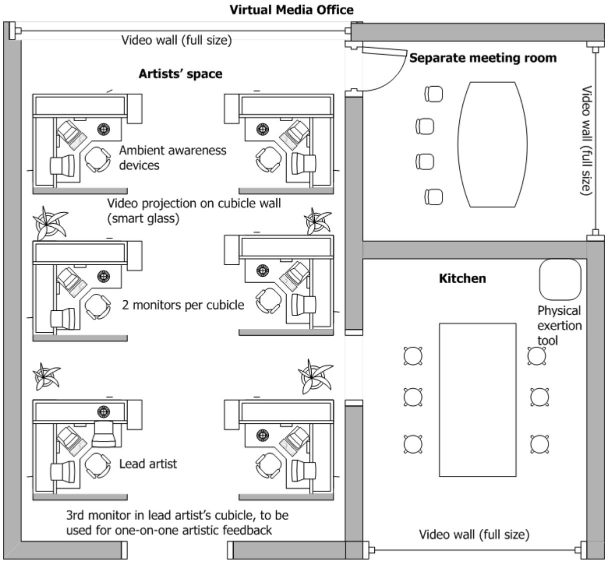

Figure 2. Communication and interaction spaces for a digital animation artist: Meeting rooms for scheduled appointments, the kitchen for social gatherings, and the open plan office space for spontaneous interactions. Together they form the spaces of physical interaction with work colleagues.

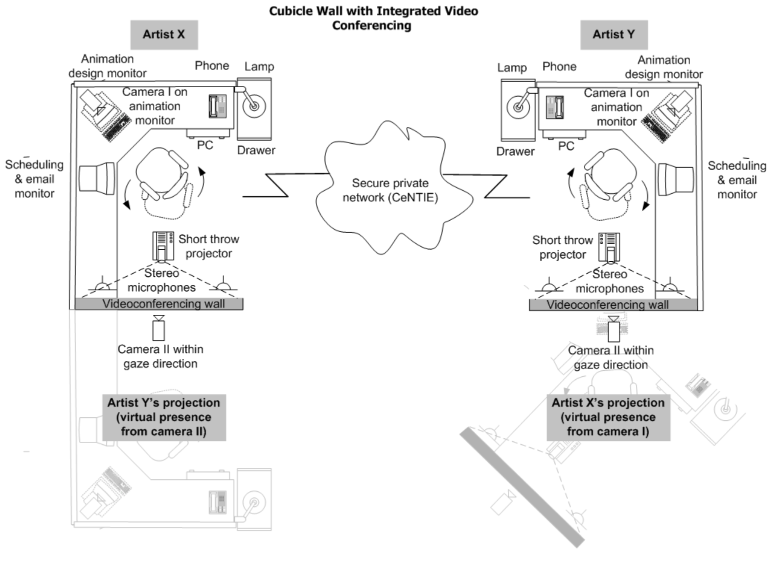

Figure 3. Detailed view of an artist's work place with integrated video conferencing facility in a *Connected Cubicles* setup.

In the work environment we are discussing in this paper, people often multi-task. Whilst working on a digital frame, they might be interrupted by a phone call, a meeting, or a spontaneous chat. Many of the cues we register about another person when we are physically close provide us with ambient information on their current work load, well being, or mood (Olsen et al., 2000). When physically separated it is sometimes difficult to know if a colleague's deliverable that was due hours ago is delayed because the colleague is busy or because he is not concentrating on the job. A collaboration space for remotely located creative people has to satisfy a range of considerations, many of them derived from aspects of human factors. However, these aspects are often subtle: the quality, size, and physical arrangements of the telecommunication hardware play as much a role in a person's perception of their remote counterpart, as the quality and reliability of the transmitting medium (i.e., the network and the codecs).

We will discuss hardware and user control challenges in the following two sections.

HARDWARE

The hardware deployed for our project had to meet certain quality requirements: The display of the remote site shall be life-size and sharp, microphones and speakers have to allow for natural speech playback without any quality compromises. Life-size video displays require a good video capturing device, but the display is also influenced by the transmitting video codec (which is in our case standard definition DV). This section details some of the hardware choices made in the design of *Connecting Cubicles*.

Our choice of speakers was a set of Tannoy Reveal 5a amplified speakers. They are perhaps oversized for a cubicle workspace, however, their quality is convincing. In Figure 3 above we depicted the use of two cameras per workplace to capture two different views of the scene. Within our project restrictions of standard definition DV quality and life size displays, we had no need for a high definition camera. However, the standard definition cameras to be deployed shall offer three charge-coupled devices (3CCD), and at least one camera shall also offer pan and tilt functionality in order to easily adjust the transmitted image to a specific need. Our choices were a JVC GR-X5AA 3CCD consumer handheld camera that allows zoom and a Sony BRC-300P 3CCD camera with tilt, pan, and zoom. With these two cameras at different quality levels, the Sony camera is deployed as the default main camera, and the JVC camera allows for a second, alternative view of the workspace, see Figure 4.

Figure 4. Some of the hardware choices in the videoconferencing setup *Connected Cubicles*. (a) Tannoy Reveal 5A amplified speakers, (b) Sony BRC-300P 3CCd tilt, pan, and zoom camera, and (c) JVC GR-X5AA 3CCD zoom camera.

When it comes to the display of "*the person that should 'sit on the other side of the partition'*" that we mentioned above, some research went into the two display technologies, Plasma and LCD. The following paragraph briefly summarizes our findings.

A general comparison of Plasma versus LCD monitors in our context takes into account the weight of the display, its mountability on a desk, the sharpness of the image, and the latency of the display. For the first three parameters, LCD monitors far outperform plasma monitors: LCD monitors are much lighter, they generally come on stands that allow a direct mounting on a desk, and the image is clear. LCD screens have traditionally suffered problems with the viewing angle, that allowed for a sharp image at right angle, but a false-colour image if seen at an angle, seem to have been addressed with the current generation of products: neither the Mitsubishi 40" LCD monitor nor the NEC 46" monitor that we tested showed a problem with the viewing angle. See Figure 5 for an impression of the display in the *Connected Cubicles*.

Figure 5. A snapshot of the projection of a remote worker onto a workplace desktop. The remote person is displayed in full-size on a 46” monitor mounted on the desk.

The major discrepancy between plasma and LCDs was the latency between the reception of a video signal, and its actual display on the screen. Low latency is crucial in our setup of interactive real-time communication between remotely located people. The following paragraph briefly outlines our testing of latency in various displays.

For the monitor latency test setup, we connected three monitors under consideration with a video recorder and played back a purpose-built video tape. This tape contained all black frames, interrupted with a single white frame once every second. A photo diode was held onto the screen that registered the regularly flashing white frames. We attached an oscillator to both the video recorder and the photo diode, measuring the latency between both signals. This set-up measures the latency directly produced by the monitor hardware, ie., the time delay between the reception (video tape send signal) and display (photo diode registers signal) of a signal. Table 1 presents our results on the latency measurements.

Latency in [ms] at different locations on the screen	**Mitsubishi 40" LCD**	**NEC 46" LCD**	**Fujitsu 42" Plasma**
Upper left corner	68.75ms	87.5ms	50ms
Centre of screen	75ms	100ms	50ms
Bottom left corner	87.5ms	118.75ms	50ms
Comment	Difference between top and bottom of screen of ~20ms.	Difference between top and bottom of screen of ~40ms.	Constant latency across the screen. Generally much lower that LCD.

Table 1: Results of latency measurements of two large LCD monitors and one large plasma monitor.

In an interactive session, latency has a strong impact on human perception. The 1996 ITU Recommendation G.114 for one-way end-to-end transmission time limit is (ITU):

- < 150 ms: acceptable for most user applications;
- 150 - 400 ms: acceptable provided administrators know of the transmission time impact on the quality of user applications; and
- > 400 ms: unacceptable for general network planning purposes.

Our latency measurements in Table 1 relate to the latency of the monitor hardware only. For a setting of high-quality videoconferencing, the latency of the network, and the latency of the codec will have to be added to above figures. Therefore, the latency aspect clearly indicates the usage of a plasma monitor for our purpose.

USER CONTROL INTERFACE

The single most important difference between remote communication in a meeting room and remote communication at a person’s desk is the physical embodiment involved in the preparation for such conversation. If a person gets up from their work place and walk over to a dedicated meeting room for the purpose of communicating with somebody in a different location, this person leaves their current tasks, signalling that the communication with the remote person has priority at this particular moment.

The scenario we have presented above, however, enables high-quality videoconferencing, “on a person’s desk”, where the remote person is displayed at life size in an animation artist’s private workplace. This subtle difference in the usage of a video communication has important implications on the design of a user control interface for this technology.

The following paragraph reviews the user control interface for the meeting room scenario, such as it is currently implemented in CSIRO’s Virtual Tearoom (Hogan et al, 2004). The Virtual Tearoom is enabled for multicast transmission, which allows an arbitrary number of sites to connect to an active session. Each site maintains a distributed list of available sites. If site X wants to connect to site Y, it simply calls the “connect” function. Since the list of possible sites is maintained offline, there is no information available on whether or not that other site actually exists, and if the connection parameters in the list are correct. Assuming that the information that site X maintains for site Y is correct, the connection is simply established: audio and video between both sites is displayed instantly. At site Y, people realize that site X is connecting to them by the fact that the screen suddenly displays the remote video, and the speakers play back the sound from site X. If a third site Z wants to connect to site Y, it automatically enters the active session, finding itself in a group session with both sites X and Y, instead of only with site Y.

In our *Connected Cubicles* scenario, a direct unaltered deployment of this meeting room interface would connote that the video monitor on an artist's desk lights up with a video from a remote artist; without prior warning. At the same time, the audio connection also establishes, irrespective of whatever ongoing conversation it might interrupt. As previously indicated in our observations in the Digital Media Production industry, the animation artists don't have much privacy at their work places, however, they do have a lot of awareness about their colleagues, including presence and absence at the desk, engagement in conversations, and concentration on tasks. Some of this awareness should be integrated into a user control interface for our setting, in order for the technology to be accepted as a valid communication tool. Accepting Olson and Olson's suggestion that…"*distance will persist as an important element of human experience*" (Olson et al, 2000), we don't claim that the near future will offer technology that affords full awareness as in a co-located environment. However, telecommunication will continue to be deployed, and therefore user interfaces need to integrate at least some aspects of awareness for the collaborator at the remote end. The next paragraph discusses some user control awareness features for our purpose. These features are currently being implemented into the user control interface of the Virtual Media Office.

User Status

In a co-located situation, people are provided with certain cues about what activity their colleagues are currently engaged in: if the colleague is away, busy, on the phone, or in a discussion. For a useable system this awareness about a (remote) person's availability for interruptions needs to be maintained. Many applications (e.g., Instant Messenger) make use of the idea of a "user status" that communicates over a distance whether a user is present or absent form their workplace, whether activity at the computer has occurred during the last x minutes, or whether a user might have explicitly said that they do not wish to be interrupted. This user status is communicated to the person who wants to "tele-connect" to his peer at a remote site.

The status of a remote co-worker, while a simple feature in the user interface, provides an important cue in a team of intensely coupled animation artists that reduces wasted time and unnecessary interruptions.

Ambience.

In its simplest form, the videoconference as a "window to a remote cubicle" can have two statuses: "on" and "off". If the videoconference is switched on, high-quality full-size video is displayed on the large plasma monitor, and the audio is enabled. However, we believe that sometimes, a user might only want to have a rough perception of activity between their colleagues at the remote end, without full quality audio and video connection. An idea building on work by Roussel at al. (Roussel et al, 2004) is the use of a proximity sensor combined with a blurring of the image depending on the proximity of that person to the display for a videolink (measured by the proximity sensor).

In our setting, a blurring of the remote video will be realised in software if a connection is active and the user status on at least one site shows no activity for a certain period of x minutes, indicating that the person active in a video-connection will most likely have left their workplace.

Auditive Interface.

In a co-located setting, people receive many social cues about their peers via auditory information. Without looking up from the computer screen, we can tell if the person sitting behind us is on the telephone. Similarly, when a person approaches our own workspace, we often perceive auditory cues: the opening of a door, or the approaching of steps. The research area of multimodal interfaces investigates how the combination of two or more modes of interaction enhances people's interactivity and collaboration. Building on the two above interface features, we plan to integrate an auditory interface into the Virtual Media Office providing:

- An auditive awareness feature (e.g., sound of tapping, approaching steps) when a remote peer attends to establish a video connection.
- Taking the idea of an awareness display by a "blurring" of the projected video of an established videolink with a remote peer after a certain amount of time x a step further, the same ambient "blurring" shall occur when no (auditive) activity has been detected for a certain duration of time.

CONCLUSION AND OUTLOOK

The project we presented in this paper aims to develop a prototype communication system. It is being developed as a collaboration between the CSIRO and a digital media production partner that allows animation artists to be distributed over two or more physical locations. It aims to support intense collaborations between peers in remote offices allowing spontaneous, casual interactions, tight coupling, and awareness of availability and progress, as if they were co-located. This project is based on workplace observations of how digital animation artists collaborate with their peers in a co-located setting.

This paper has outlined our hardware choices and design considerations for software development in user control interface design. Three main development threads resulted from this discussion, namely the integration of a user status, (display) ambience, and auditory interfaces into our current framework. This work is currently being undertaken and will be ongoing until mid-2007 under the connotation “Connecting Cubicles interface”.

Still missing at this stage is a systematic evaluation of the Virtual Media Office to validate our suggestion that high-quality video and audio codecs, a careful choice of hardware, as well as user-friendly communication interfaces indeed enable people to creatively and intensely collaborate across multiple sites. We envisage conducting these evaluations during a trial of the technology with our industry partner early in 2007.

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