



Why HP People Do and Don't Use Videoconferencing Systems

Sandra Hirsh, Abigail Sellen¹, Nancy Brokopp
HP Laboratories Palo Alto
HPL-2004-140(R.1)
February 4, 2005*

E-mail: sandra.hirsh@hp.com, abigail_sellen@hp.com, nancy.brokopp@hp.com

videoconferencing,
collaboration, user
behavior

In this report we discuss the findings of a Web-based questionnaire aimed at discovering both patterns of use of videoconferencing systems within HP and the reasons people give for either not using, or for using such systems. The primary motivation was to understand these issues for the purpose of designing new kinds of technology to support remote work rather than as an investigation into HP's internal processes. The questionnaire, filled out via the Web by 4532 people across HP, showed that most participants (68%) had not taken part in a videoconference within the last 3 years, and only 3% of the sample were frequent users. Of those who had used videoconference systems, the main benefits were perceived to be the ability to: see people they had never met before, see facial expressions and gestures, and follow conversations with multiple participants more easily. The main problems that users of videoconference technology perceived were: the high overhead of setting up and planning videoconferencing meetings, a lack of a widespread base of users, the perception that videoconference technology did not add value over existing communication tools, and quality and reliability issues. Non-users indicated that the main barriers were lack of access to videoconference facilities and tools and a perception that they did not need to use this tool because other tools were satisfactory. The findings from this study in a real work setting are related to findings in the research literature, and implications for system design and research are identified.

* Internal Accession Date Only

¹ Now at Microsoft Research Centre, Cambridge, UK, ASellen@microsoft.com

Why HP People Do and Don't Use Videoconferencing Systems

Sandra Hirsh, Abigail Sellen¹ & Nancy Brokopp
sandra.hirsh@hp.com, abigail_sellen@hp.com, nancy.brokopp@hp.com
Hewlett Packard Laboratories

ABSTRACT

In this report we discuss the findings of a Web-based questionnaire aimed at discovering both patterns of use of videoconferencing systems within HP and the reasons people give for either not using, or for using such systems. The primary motivation was to understand these issues for the purpose of designing new kinds of technology to support remote work rather than as an investigation into HP's internal processes. The questionnaire, filled out via the Web by 4532 people across HP, showed that most participants (68%) had not taken part in a videoconference within the last 3 years, and only 3% of the sample were frequent users. Of those who had used videoconference systems, the main benefits were perceived to be the ability to: see people they had never met before, see facial expressions and gestures, and follow conversations with multiple participants more easily. The main problems that users of videoconference technology perceived were: the high overhead of setting up and planning videoconferencing meetings, a lack of a widespread base of users, the perception that videoconference technology did not add value over existing communication tools, and quality and reliability issues. Non-users indicated that the main barriers were lack of access to videoconference facilities and tools and a perception that they did not need to use this tool because other tools were satisfactory. The findings from this study in a real work setting are related to findings in the research literature, and implications for system design and research are identified.

INTRODUCTION

Since the 1960s, videoconferencing systems have consistently failed to live up to the high hopes held out for their uptake in everyday life. Forty years ago, predictions were that, in the future, we would all be looking at the people we talk to on the phone. Further, this would be commonplace not only in working life, but in our personal and social lives too. And yet, in the decades that followed these earliest efforts, we have still to see widespread use of videoconferencing technology either in working life or in home life. This is the case despite technological developments which have not only increased the

¹ Now at Microsoft Research Centre, Cambridge, UK, ASellen@microsoft.com

reliability, quality and capabilities of such systems, but have also introduced new spins on the now old-fashioned notion of a simple one-to-one audio and video link.

So, for example, in the last four decades we have seen many advances in the speed, quality, and reliability of networks, as well as better integration and interoperability across different hardware and software platforms. Not only can we connect more easily with people across the world, and send and receive more and different kinds of data than ever before, but advances in software and infrastructure also mean better integration with other existing applications and services. Videoconferencing has also progressed from the use of expensive fixed line systems intended for use in specialized conferencing rooms, to more affordable systems such as software and hardware which can be used in conjunction with a desktop computer, or stand-alone portable units which can be plugged into any phone line.

More recently, other more radical developments have promised to take videoconferencing in new directions, though most efforts are still largely confined to the research world. These include the integration of real time audio and video with virtual reality systems (Baker et al., 2003), the use of remotely controlled video “robots” to represent remote participants (Jouppi, 2002), and real time videoconferencing through mobile phones and other handheld devices.

Despite both the improvements and diversification in videoconferencing technology, for most people, it has yet to find a place in day to day life in the way that other kinds of communication technologies have (such as the mobile phone). Having said that, videoconferencing technology is available to some extent in many work settings, especially larger organizations which buy such technology in order to support remote working and geographically distributed teams. In HP, as in many other similar organizations, there are a variety of such systems in use ranging from desktop applications using Webcam devices, to mobile systems for connecting from site to site, to dedicated videoconferencing rooms. There are also indications that the use of Webcam technologies and inexpensive devices that plug into the phone line (such as the Beamer) may be beginning to find a place within domestic life.

But what is the real frequency of use of such systems? What are the reasons that such systems get used, and what do people perceive to be the main benefits and drawbacks of using them? By the same token, what are the main reasons people do not use these systems? Are the reasons primarily due to lack of need or lack of availability of the technology, or are there other reasons for not using them?

This paper reports on a study in which we explore these questions in more depth, using, as a sample population, a random selection of HP employees. The primary motivation was to understand more generally the perceived value of such systems by the people who use them, as well as the perceived barriers to use of different kinds of videoconferencing systems so that we can design better technologies for supporting remote communication.

We decided to begin with an exploration of these issues using an internal HP audience not because we were particularly concerned with understanding HP's internal processes, but because HP is a large, globally distributed organization. As such, if any organization should show systematic use of these technologies, then one might expect that HP should. If this is not the case, then such a study should provide important insights into the reasons why. Some of these reasons may suggest the directions in which the designers and developers of technologies to support distributed work might fruitfully concentrate their efforts.

PREVIOUS RESEARCH

Since the late 1970s, there has been a great deal of research into the behavioral aspects of video-mediated communication, and the ways in which it is different from (or similar to) face-to-face talk, or talking over a telephone. Much of this stemmed from early research that showed the importance of visual cues in conversational situations. When people communicate in face-to-face situations, many kinds of information have been shown to be important. These include not only what is being said, and how things are being said, but also facial expressions, gestures, and gaze. Perhaps it is unsurprising, therefore, that to date, most videoconferencing systems, in an attempt to mimic the properties of face-to-face conversations, have focused on conveying not only the talk, but also the visual information conveyed by conversants' body language and gaze. Video systems therefore largely are designed not only to optimize transmission of audio, but to present mainly the head and shoulders of co-participants.

In research over the past decade or so, however, it has been widely recognized that such "talking heads" video systems are fundamentally different from conversing face-to-face, and in some ways seem lacking in the interactivity and spontaneity characteristic of face-to-face meetings. For example, studies which have compared conversations mediated by technology (whether through a video system, or an audio-only system) with face-to-face conversations have found them to be more formal, stilted, and less interactive (Sellen, 1995).

Another unexpected set of findings has to do with the failure to support the "richer is better" hypothesis that seems to underlie much of the design effort in this area. This refers to the belief that video plus audio systems must be better than audio-only systems, because, de facto, they must be more like the face-to-face situation. Extrapolating from this, the richer and more realistic we can make the communicational context, the better will be the experience for users, and the more like face-to-face such experiences will be.

However, studies so far have shown that this hypothesis is too simplistic. For example, much of the literature has failed to show that people using video plus audio systems perform any better on objective measures (such as time to complete a shared task) than people using only an audio connection (e.g., Frohlich, 2001; Fussell, Kraut & Siegel, 2000). The structure of their speech is similar, the speed and accuracy with which they do tasks is no better, and some research has even found the addition of video to make the experience worse (Matarazzo & Sellen, 2000).

The only kinds of tasks where the addition of a video channel seems to benefit is for tasks which involve elements of emotion (such as conflict, bargaining, or negotiation) however, even in such cases, the evidence is not strong (Short et al., 1976). Video also seems to be helpful for non-native speakers in certain kinds of tasks (Veinott et al., 1999) and to help people disambiguate speech (Anderson et al., 1997). Finally, video has been shown to help support people's understanding of the broad membership of a group in a meeting, and the general attentiveness and activities of people in a distributed group (Sellen & Harper, 1997). However, in such cases, high quality video is largely unnecessary.

So what is going on? Are videoconferencing systems no better than a phone line for supporting remote communication? Why are videoconferences so different from face-to-face meetings? And what are the implications of all of this for the design of video systems?

If we look to the behavioral literature, it appears there are three main reasons why videoconferencing systems fail to deliver a "just like being there" experience for people. These aspects have to do with the fact that face-to-face conversations depend in a number of important ways on a shared physical frame of reference. This frame of reference consists not only of the shared space or environment, but also the physical objects in that environment, including the conversants themselves. It is this shared frame of reference that allows such things as gaze and gesture to be interpreted. It is this shared frame of reference that allows each individual in a conversation to design their actions for others (albeit unconsciously), and to derive meaning from what other people do. Let us be more specific:

The Value of Sharing Work-Related Objects

Some research studies have found that, for some kinds of tasks, face-to-face views are less important than views of work-related objects (Gaver et al., 1993). Specifically, Gaver and colleagues found that, for a 3D design task, participants spent more time looking at a view of the work area, a desk view of shared documents, and specific views of task-related objects themselves than the face-to-face view, which was used only 11% of the time. This is backed up by work by Anderson and colleagues (Anderson et al., 2000) which shows that when there are task-related objects present in a discussion, gaze at other participants occurs less than 7% of the time, and mutual gaze is almost non-existent.

Similar results have been found for tasks which center on shared work spaces such as collaborative design and editing tasks (Whittaker et al., 1993), telemedicine (Nardi et al., 1996), collaborative visual puzzles, map reading, and so on. In such cases, images of the workspace and work objects play a central role in coordinating team work, enabling co-workers to check the status of work and anticipate what is needed to be done next, often reducing the need for talk.

The big question that remains with respect to this issue is, for what kinds of tasks are work-related objects important? It is clear that, for many kinds of tasks, an audio-only channel will do. Most obviously, we know that a great deal of work is accomplished by telephone, without the need for supporting artifacts. Studies of telephone banking (Martin & Rouncefield, 2002) have shown that people use strategies to substitute for the fact that people talking over the phone can not look at the same objects or documents together. It may not be as efficient to do so, but they find ways around it. In addition, there is some indication that certain types of tasks such as brainstorming can be done without the need for access to shared artifacts (Whittaker et al., 1993).

On the other hand, we know that most face-to-face meetings people hold do involve work-related objects. For example, Whittaker et al. (1994) found that 54% of informal office interactions involve documents. Other work (Sellen & Harper, 2002) has found that more than 90% of meetings (both formal and informal) involve paper documents. In addition to paper documents, many face-to-face meetings revolve around Powerpoint presentations and other shared workspaces such as whiteboards.

Seeing People in Relation to Objects

A second, related issue has to do with the importance not just of seeing the objects themselves, but of seeing people *in relation* to the objects they are interacting with. Recent studies of people in the same physical space have shown that even when objects in group situations are not deliberately shared or jointly viewed, people's activities in relation to their own objects are monitored by others, and are used to coordinate group interaction (e.g., people flipping through pages, looking at their laptops, reading text messages on mobile phones, etc.) Such studies have found this to be important, not only in specialized environments like control rooms (Heath & Luff, 1996), but also in more mundane situations like meetings (Sellen & Harper, 2002).

Note that conventional video systems that provide document cameras undermine the ability for remote participants to see a person in relation to an object. Most conventional video systems either show the "person" view, or the "document" view, but not both. Even if the document view is tiled on top of the person view, they are now disjoint, and the viewer must do some mental work to reconcile the two views together.

This can cause all sorts of problems such as inferring who is looking at what, who is pointing to what, whose gestures are appearing over an object, what objects are being spoken about, and so on. In addition, the inability for remote participants to share, gesture and indicate a relationship to a remote object fundamentally changes the nature of the interaction. Remote participants are rendered impotent in their ability to interact effectively with objects that other people share.

The Importance of a Shared Frame of Reference

Finally, this last point is one that is not limited to tasks involving objects or artifacts; it is an issue for *any* kind of collaborative task, and for any video system. This has to do with how the lack of a shared physical space can cause some fundamental problems for the way in which people establish shared perspectives.

For example, Paul Luff and Christian Heath have carried out extensive research (e.g., 1991) to show that when people no longer share a physical space, the rules underlying normal face-to-face interaction break down. In a physical space, the rules of “reciprocity” hold true. Generally, this means, “if I can see you, you can see me” and “if I can hear you, you can hear me”. Sharing a physical space also means all kinds of other things, such as the fact that I can tell *who* other people are looking at, I can tell *what* other people are looking at, and I can design any actions I make depending on these judgments.

Take the case of a simple videoconferencing system: Can I be sure other people can hear me? How loud am I? They appear to be looking at me, but are they really? The others are looking at some object off screen: what is it? As a viewer, I pick up what I can from what I can see of the remote participants’ local environment. From this I try and guess what other people are perceiving. I can then design my actions accordingly. The trouble is, the rules of shared physical space may no longer apply.

This point is made nicely in a study by Gaver et al. (1993). In this study, each person in a two-way video conversation had three cameras feeding into three monitors in the other person’s space. As each participant would point and gesture at objects in their own space, the remote person used the widest angle camera to try and tell what the other person was looking at in the local environment. This got worse when that person began to try and point and gesture at objects in the *other* person’s space through the monitors. Conversations broke down completely. The flipside of the problem was that in acting or pointing or talking, one participant could never be sure if they could be properly seen. This depended on knowing where the other person was looking and what camera view they were using. This resulted in a constant process of trying to figure out what monitor the other person was looking at so they could make their actions visible to the right camera. This makes the point of how important reciprocity of view is in a conversation. People have to be able to guess what the perception of the other person must be in order to feel they can participate effectively in a conversation.

An interesting point here is that this breakdown in reciprocity of perspective is actually made worse in video plus audio situations than in audio only situations. In audio-only situations, people don’t make the mistakes that they do in video systems of assuming that their actions are viewed in ways they are not, or in misinterpreting the actions of others. In audio-only situations, we may have to compensate for the lack of shared visual information, but the situation is less complex and less prone to error and uncertainty. This is one reason why some studies have shown people prefer audio conversations to video ones.

Summary

In summary, the research literature points to ways in which the videoconferencing system is both fundamentally different from the face-to-face experience, and in which aspects of their design can undermine important aspects of interaction which we need and depend on in such collaborative situations. This includes the difficulty of sharing work-related documents and objects, the problems in showing people in relation to those work-related

artifacts, and the more general difficulties created by the lack of a shared frame of reference. Given the extent of these interactional problems, it is understandable that many people prefer to use audio-conferencing technology and shared electronic document programs such as Netmeeting, for many kinds of remote communication.

The question is to what extent this research really uncovers the many practical barriers to use that exist within real organizations, the extent to which it highlights the real benefits that people report in actual use, and the degree to which there is consistency between the research findings and people's perception of the benefits and drawbacks of videoconferencing systems. This study provides an important point of contrast for these studies as well as a way of grounding these findings within use in a real organization.

METHOD

Procedure

A Web-based survey instrument was distributed to 30,000 randomly selected Hewlett-Packard employees and contractors from around the world in December 2003. Survey invitations were emailed in three batches of 10,000 names each; a reminder was sent to the entire sample during the second week of the two-week survey period. Survey responses were treated anonymously.

Instrument

Participants were invited to complete the survey to help us understand the reasons why people do or do not use videoconferencing systems. In the survey, a videoconferencing system was defined as a system using both a camera and an audio link to allow them to interact with remote participants. Since videoconferencing technology is constantly evolving, participants were asked to identify whether they had used a videoconferencing system in the last three years. Participants who had not done so were considered to be non-users. Choices in the close-ended survey questions were refined through several rounds of pilot testing and interviews; participants who marked "other" were asked to explain this selection. One optional open-ended question asked participants to share comments about their videoconferencing experiences, both positive and negative.

People who indicated use of videoconferencing systems within the last three years answered questions regarding the frequency of their use, the main benefits of and drawbacks to using videoconference systems, type of videoconference technology, and main reasons they use videoconference technology. People who indicated they had not used videoconference systems within the last three years were asked to indicate the main reasons they had not. All participants were asked to answer the demographic questions. In general, the survey took less than 5 minutes to complete, but participants may have taken more time, depending on whether they chose to answer the optional, open-ended questions.

Participants

A total of 4532 people responded to this survey, representing a 15% response rate. About half of the participants (53%) came from pre-merger HP, 38% came from pre-merger Compaq, 8% came from a different company and 1% did not answer the question. Half of the participants were from North America (51%), followed by Europe, Middle East and Africa (EMEA) (30%), Asia Pacific (13%), and Latin America (5%). A small number of people (1%) did not answer the question.

Figure 1 presents participants by HP business groups. Business groups with the largest number of people in this study were: HP Services (38%), Enterprise Services Group (ESG) (23%), and Imaging & Printing Group (IPG) (15%). Business groups with the lowest number of participants included the Executive Office (7 people), Merger Integration (8 people), Global Marketing (31 people), and Office of Strategy & Technology (OS&T) (34 people).

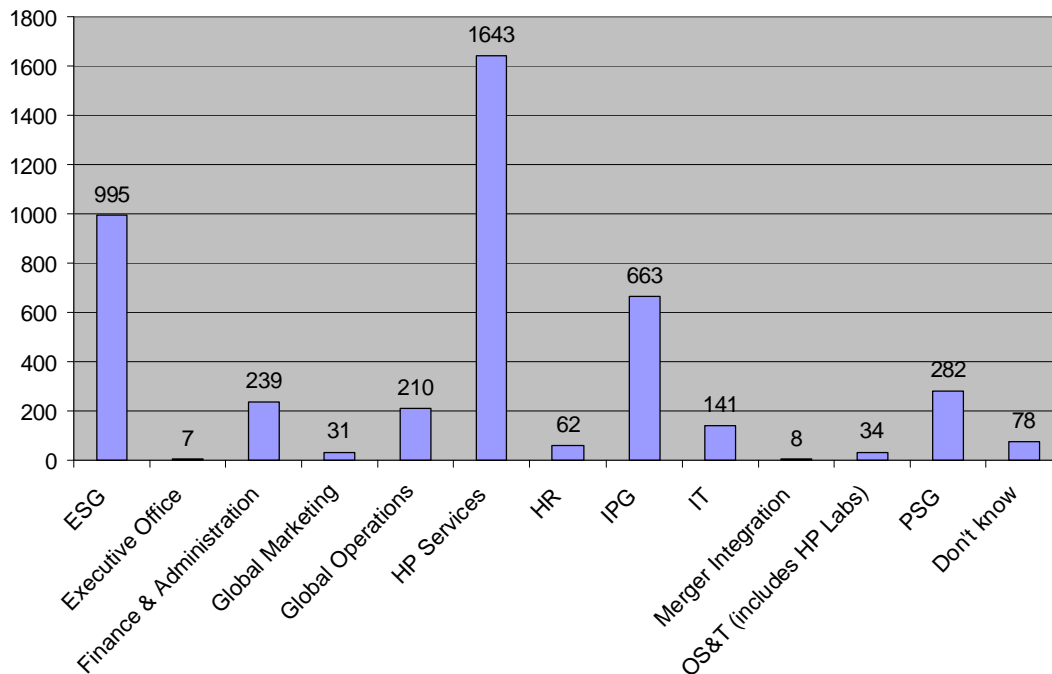


Figure 1: Participants by Business Group

The main job functions of participants in this study were: Customer Service/Support (18%); Engineering (15%); Sales (9%); and, Administration, Operations and Information Management (all at 7%), as shown in Figure 2. The lowest number was from Public Affairs/Communications, with 6 participants. Other job functions with low numbers of participants included Quality, Facilities, Research, Legal, and Marketing Support – each representing 1% of the sample.

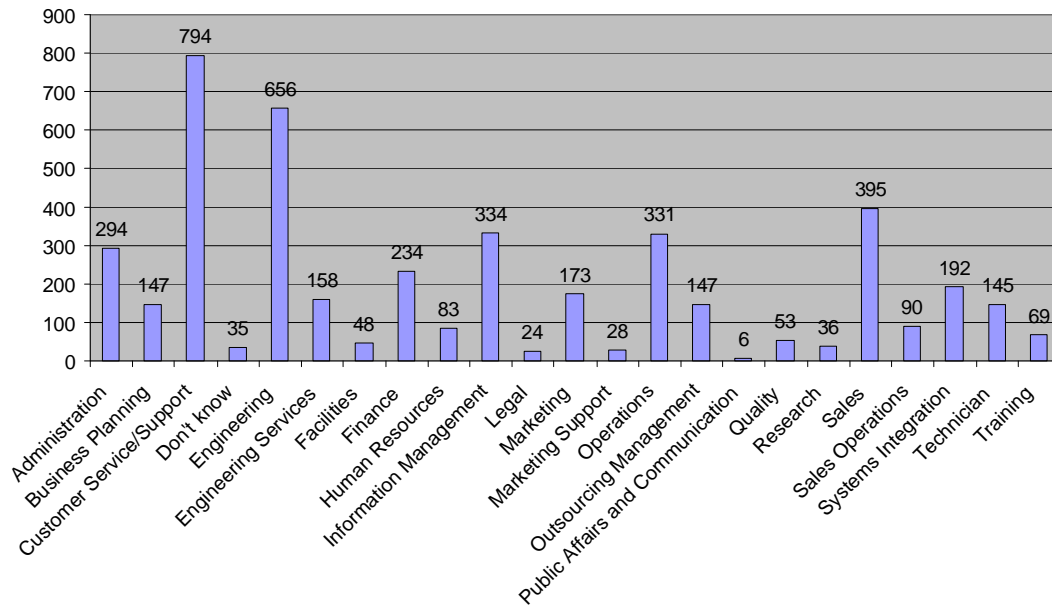


Figure 2: Participants by Job Function

RESULTS

Survey results were analyzed mainly on the basis of frequency and percentage. Cross tabulations were performed as appropriate by frequency of videoconference use and demographic variables. Open-ended responses were coded for common themes. Because of the exploratory nature of this study, and the fact we had no a priori hypotheses, no tests for statistical significance were carried out.

Overall Frequency of Use

The first major finding of interest was that the majority of people who took the survey (68%) had not taken part in a videoconference within the last 3 years. Less than one-third of the respondents (30%) indicated that they had participated in one.

Further, of the group who indicated that they *had* participated in a videoconference in the last 3 years, very few could be considered to be frequent users. The majority of videoconferencing users (73%) were infrequent users, reporting use less than 3 times a year. A total of 18% reported occasional use (between 4-12 times a year). Only 9% of the videoconferencing users (121 people) reported frequent use (more than 12 times a year). This amounts to less than 3% of the total sample.

Demographics

The following section examines some basic demographic measures in order to look for differences in percentage of users versus non-users of videoconferencing technology (as defined above) in terms of which pre-merger company employees came from, job function, geographic region and business group. In each case, we also consider the small

group of frequent users (121 people) to see whether there are any indications of different demographics for people who use videoconferencing systems at least 12 times a year.

Usage by Pre-Merger Company

Analysis according to which pre-merger company the participant worked for found that the percentage of videoconferencing users was comparable for both pre-merger companies (HP and Compaq), as shown in Figure 3. Those who came from outside these two pre-merger companies reported a slightly lower percentage of videoconferencing usage. While sample sizes for the pre-merger companies were considerably larger than the “Other” category, all samples were large enough to give a good overall picture of use (Compaq: n= 1725; HP: n=2395; Other: n = 349).

Frequent videoconferencing users were equally divided in terms of pre-merger company, with 60 people from HP and 61 from Compaq. Given that only 38% of the larger sample was from pre-merger Compaq, the findings suggest that Compaq people may be over-represented in the “Frequent” group.

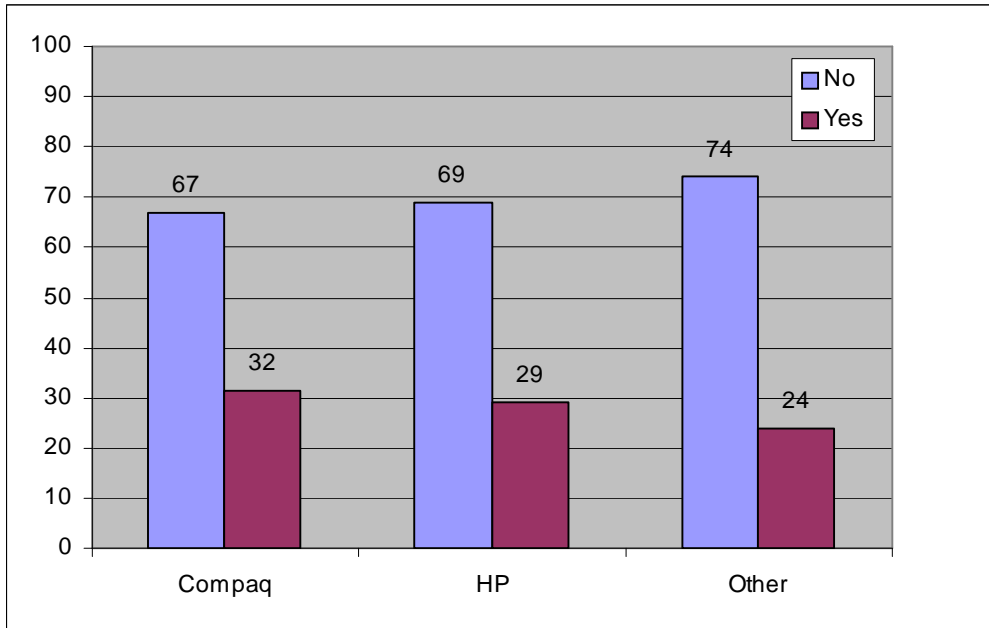


Figure 3: Percentage of Users by Pre-Merger Company

Usage by Job Function

A breakdown of videoconferencing usage by job function (see Figure 4) shows that jobs with the highest percentage of users in the last 3 years were in Research, Legal, Engineering, and Marketing. The job functions with the lowest percentage of users were: Public Affairs and Communications, Technicians, Finance and Facilities. However, sample sizes for the groups from Legal and Public Affairs and Communications were quite small ($n < 30$).

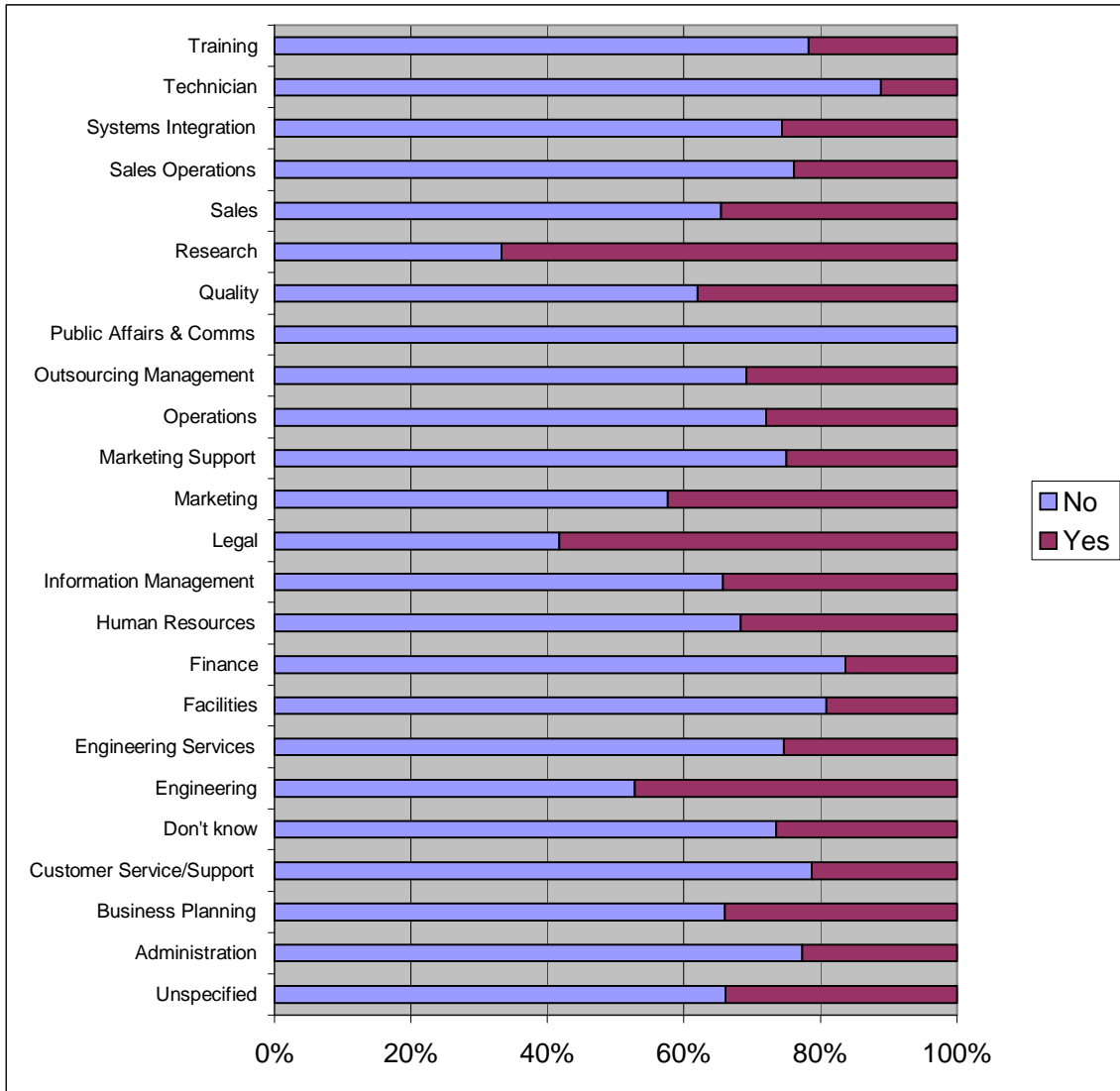


Figure 4: Videoconferencing Use by Job Function

Looking only at the frequent users, the most common job functions were Engineers (43%) followed by Customer Service and Support (12%) and Administration (8%). Relative to the total sample (of which Engineers made up 15%), Engineers were therefore over-represented in the “Frequent” group. Customer Service and Support was slightly under-represented in the “Frequent” Group at 12% relative to 18% of the total sample. There was little difference in the Administration job function (8% in the “Frequent” group and 7% in the total sample).

Usage by Geographic Region

Turning to videoconferencing usage by geographic region, respondents from both North America and Latin America reported using videoconferencing systems more frequently than those from the other geographic regions (Figure 5). Only about a quarter of HP

employees in Europe & Middle East & Africa (EMEA) and in the Asia Pacific regions reported using a videoconferencing system within the last 3 years, compared to approximately one-third of respondents from North America and Latin America.

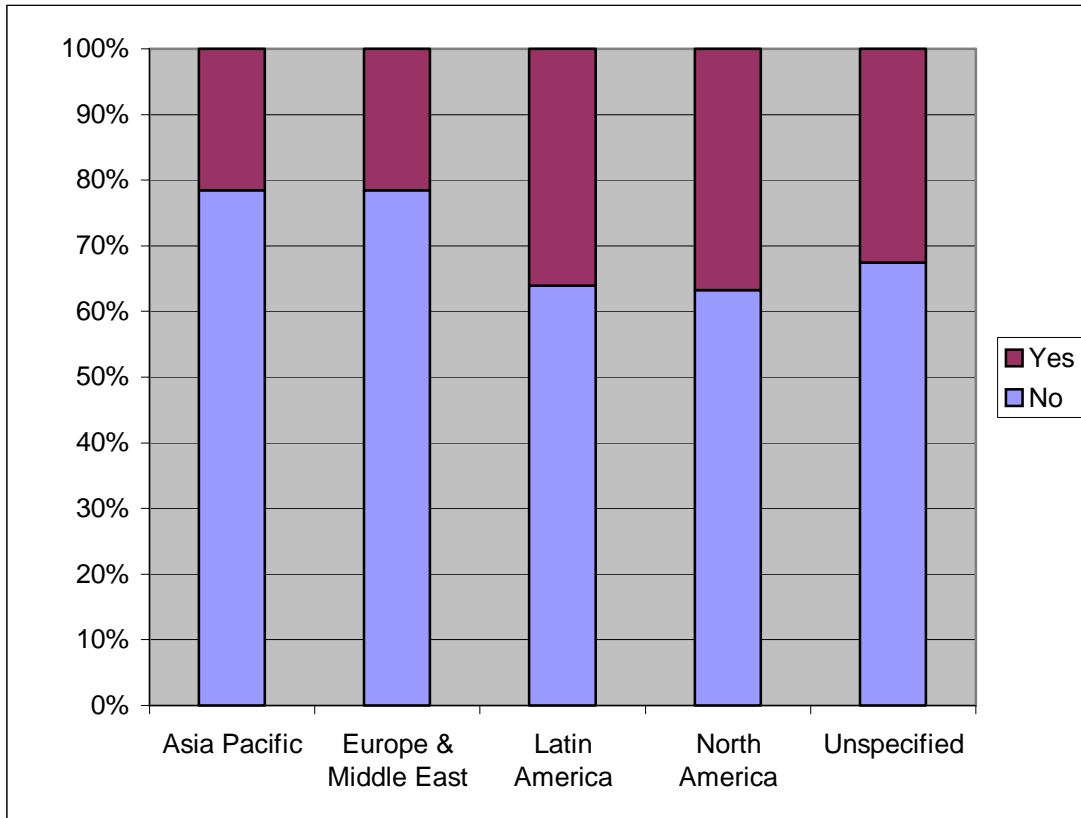


Figure 5: Videoconferencing Use by Geographic Region

People in North America were over-represented in the Frequent group at 70% relative to the total sample (51%). Frequent users were under-represented in the other geographic regions, with 2% of frequent users from Latin America, 6% from Asia Pacific, and 22% from Europe, Middle East and Africa.

Usage by Business Group

When we look at usage by business group (Figure 6), we find that the business groups with the highest percentage of videoconferencing users were Merger Integration & Organizational Effectiveness, followed by OS&T and Executive Office, however each of these groups had very small sample sizes. HP Services, the largest constituent business group in the sample, reported using videoconferencing less (26%) than the other two large constituent groups, IPG (35%) and ESG (38%).

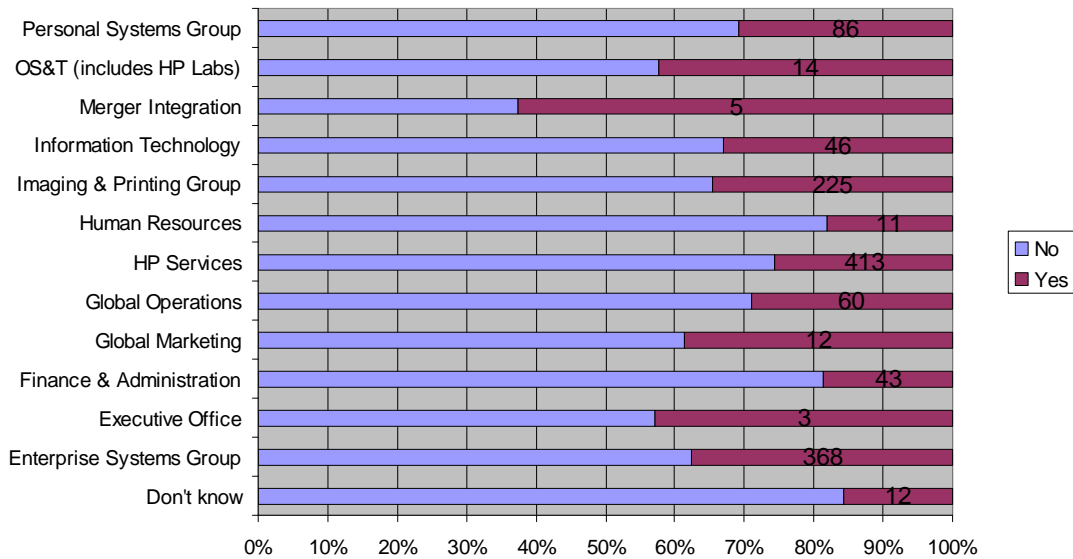


Figure 6: Videoconferencing Use by Business Group

The largest group of frequent users in terms of business groups came from ESG (36%), followed by HP Services (30%) and IPG (21%). These business groups were also the top three in terms of participation in the total sample, but the ordering was different in the total sample. HP Services, which was the largest group in the total sample at 38%, was under-represented in the frequent group. ESG and IPG were both over-represented in the Frequent group relative to their distribution in the total sample.

Patterns of Use

We now focus only on that subset of people (30%, n=1332) who reported using videoconferencing technology in the last three years (whether infrequently, occasionally or frequently). We examine the main types of technology they reported using, the main purposes for which they carried out videoconferences, and the main benefits and drawbacks that they reported in using these systems. In each case, we look to see whether there were any differences based on their reported frequency of use.

Types of Technology Used

Videoconferencing system users were asked to select the type of technology they typically used. Here the results were surprising in that most respondents (71%) used dedicated videoconferencing rooms rather than newer desktop technologies like Webcams (16%), mobile videoconference technologies for connecting site to site like Polycom Viewstations (9%), or other technologies (4%). This pattern was fairly consistent across geographic regions.

In terms of frequency of use, this pattern was also consistent (Figure 7). Infrequent, occasional and frequent users all used dedicated videoconferencing rooms most often. Furthermore, while more videoconferencing users indicated using desktop technologies

than mobile ones, there was little difference in these categories for both frequent and occasional users.

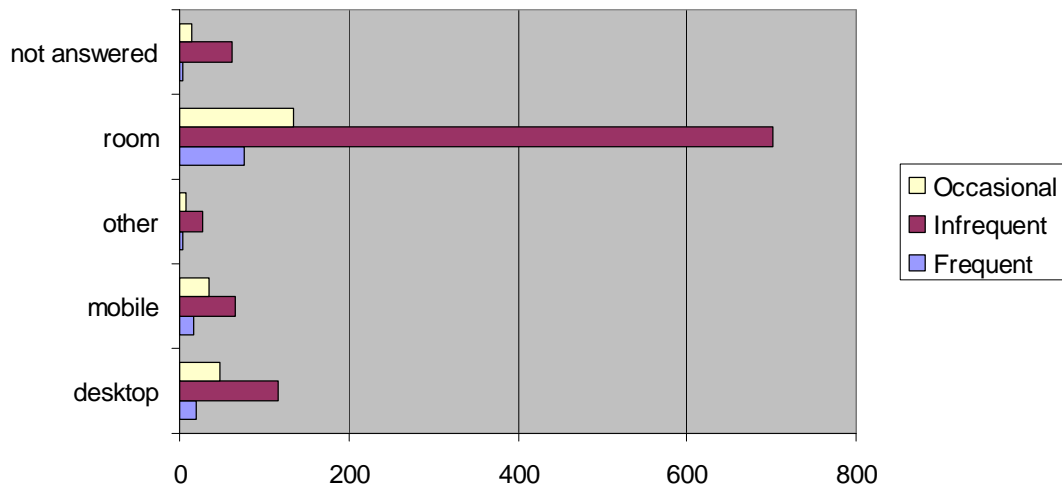


Figure 7: Videoconferencing Technology by Frequency of Use

Purpose of Videoconferencing

We also asked respondents to identify up to three main reasons that they used videoconference technology. The top five reasons, as shown in Figure 8, were as follows:

1. Project/staff meetings (21%)
2. Management meetings (18%)
3. Project reviews (15%)
4. Listen to presentations (14%)
5. Training (10%)

Only 2% of the participants selected talking to friends and family as one of the main reasons they used videoconferencing technology. In addition, 4% of respondents gave other reasons for such meetings, including meeting with partners, other companies, or suppliers and vendors, as well as special project meetings, status reviews, and project kick-offs.

This pattern of use did not depend on how frequently they reported using videoconferencing systems. However, there were differences according to people’s job functions. For example, if we consider the three main job functions in the Frequent user group (Engineers, Customer Service and Support, and Administration), Figure 9 shows that each of these three subgroups reported using videoconference systems for different purposes. Engineers used such systems primarily for project/staff meetings, followed by project reviews and management meetings. People working in Customer Service and Support reported using these systems mainly to listen to presentations and for training. People working in Administration used it primarily to attend meetings – management meetings and project/staff meetings.

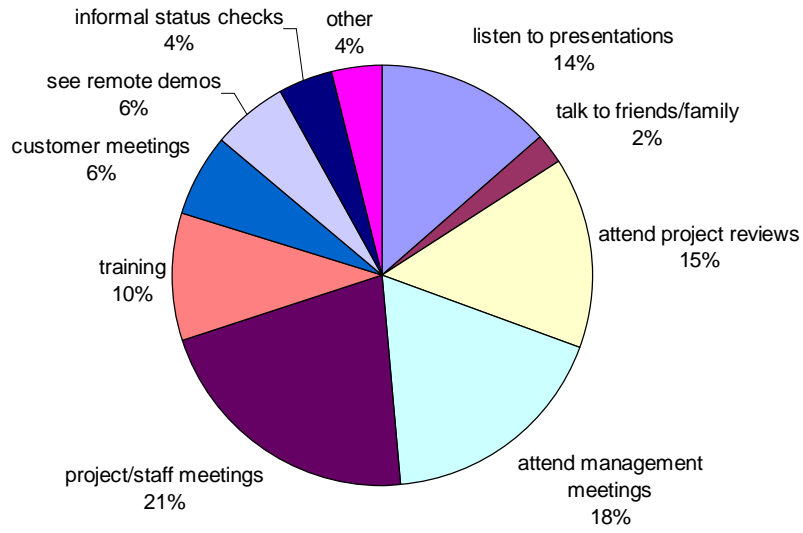


Figure 8: Main Reasons for Videoconferencing System Use

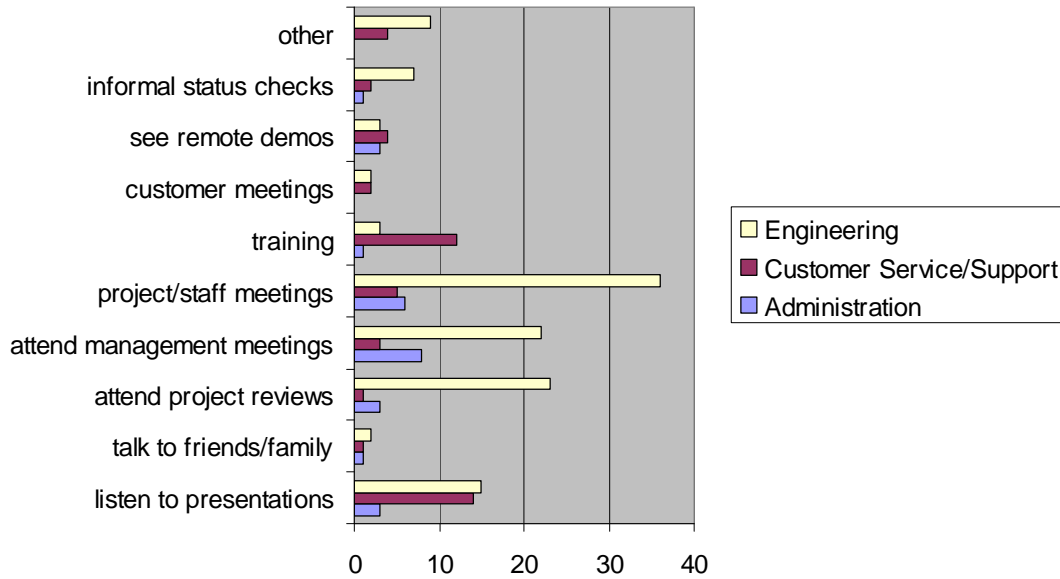


Figure 9: Why Frequent Users Used Videoconferencing Systems by Job Function

Perceived Benefits of Videoconferencing Systems

Next, videoconferencing users were asked to identify what they perceived as the main benefits of using such systems (See Figure 10). They were offered eleven choices plus the option of writing in their own response and could make up to three selections. The top benefits fell into three clusters.

The most frequent benefit videoconference users indicated was that videoconferencing systems allow you to meet and see colleagues that you may not have met before (814 people).

The next most frequently identified benefits, with nearly 600 people selecting each of them, were:

- They allow you to see the facial expressions and gestures of the remote participants.
- It is easier to follow a conversation and see who is speaking when there are multiple participants.

The third group of benefits, with over 400 people selecting each, were:

- Videoconferencing meetings are more interactive than phone conferences.
- They allow you to get a sense of the general mood or ambience of activities at the remote site.
- They allow you to see or show documents or objects and discuss them together.

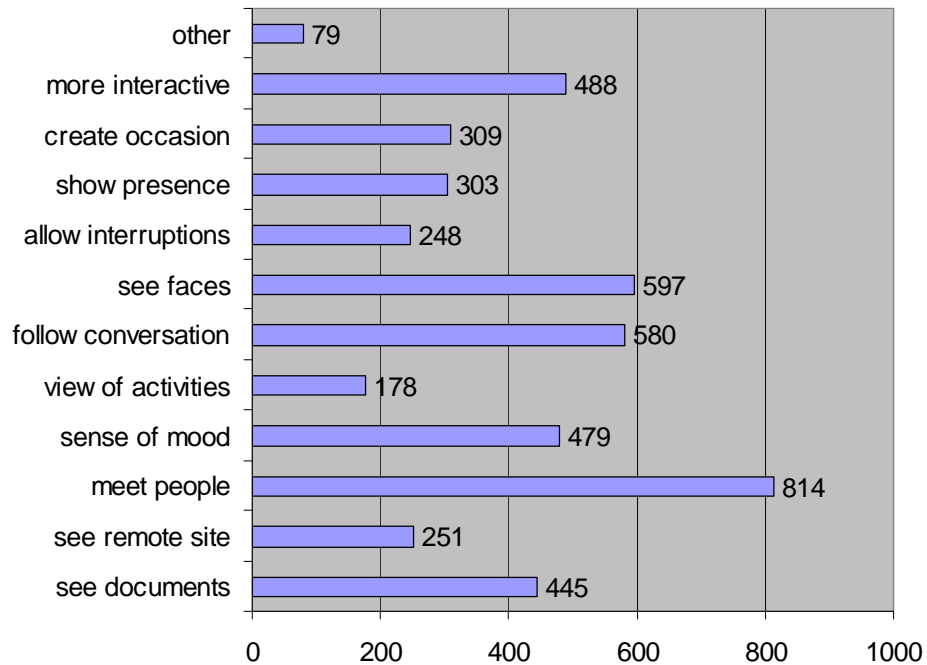


Figure 10: Perceived Benefits of Using Videoconferencing Systems

A small group of participants (79) indicated that there were “other” benefits of using videoconferencing systems and were asked to add their comments in order to clarify. The most frequently mentioned comment was saving on travel costs. An interesting cluster of reasons related to the fact that videoconferencing is a way of forcing people to be on time and pay attention in meetings. In other words, they said videoconferencing did not allow people to engage in distracting activities (like they might do in a phone conference), and the visual aspect also meant that people’s arrivals and departures could be seen by all. For example:

- “People are more focused on the subject. I think using video helps get people to arrive to meetings on time. It's much more apparent when someone is late when they are seen walking into a meeting. It's also more fun to watch (rather than just listen) when the last person to arrive to a meeting...”
- “They ensure engagement in the meeting vs. phone conferences where people can be doing email or instant messaging instead of fully participating in the meeting.”
- “People seem to follow a more disciplined discussion avoiding confusion, versus a voice-only call.”

In addition, some of the participants felt that one of the advantages of using videoconferencing technology was that it allowed them to see objects, participate in shared writing, especially with regard to looking at whiteboards and flipcharts, and draw things “on the fly”. These comments were really elaborations on one of the eleven choices already available about being able to see and discuss objects and documents (frequently selected, as previously discussed). Representative comments included:

- “Exchange of information is easier - being able to scribble on a white board or see someone doing the same is very helpful (yes, there are PC-specific ways of doing this, but they aren't the same).”
- “Videoconferencing provides visuals for engineering work/ demonstration with regard to problem issues.”
- “Demonstrating hardware or new ideas by sketching, etc. on a visible whiteboard, or pointing at hardware features.”

Others, too, used this opportunity to elaborate on other choices that they had made previously such as this frequent user who commented:

- “Body language (facial expressions & gestures) are a vital part of communicating meaning, intensity, urgency, or otherwise and may be the difference in the timely success of the meeting's purpose.”

Analysis of the main benefits of using videoconference systems by frequency of use resulted in the same top six benefits, but with some differences in their ordering (Figure 11). The ability to meet new people by using videoconferencing technology, however, was consistently selected as the top main benefit, regardless of how frequently they used this technology. However, the importance of seeing documents and objects was selected proportionally more often as a main benefit by frequent users than those who reported using videoconferencing more infrequently.

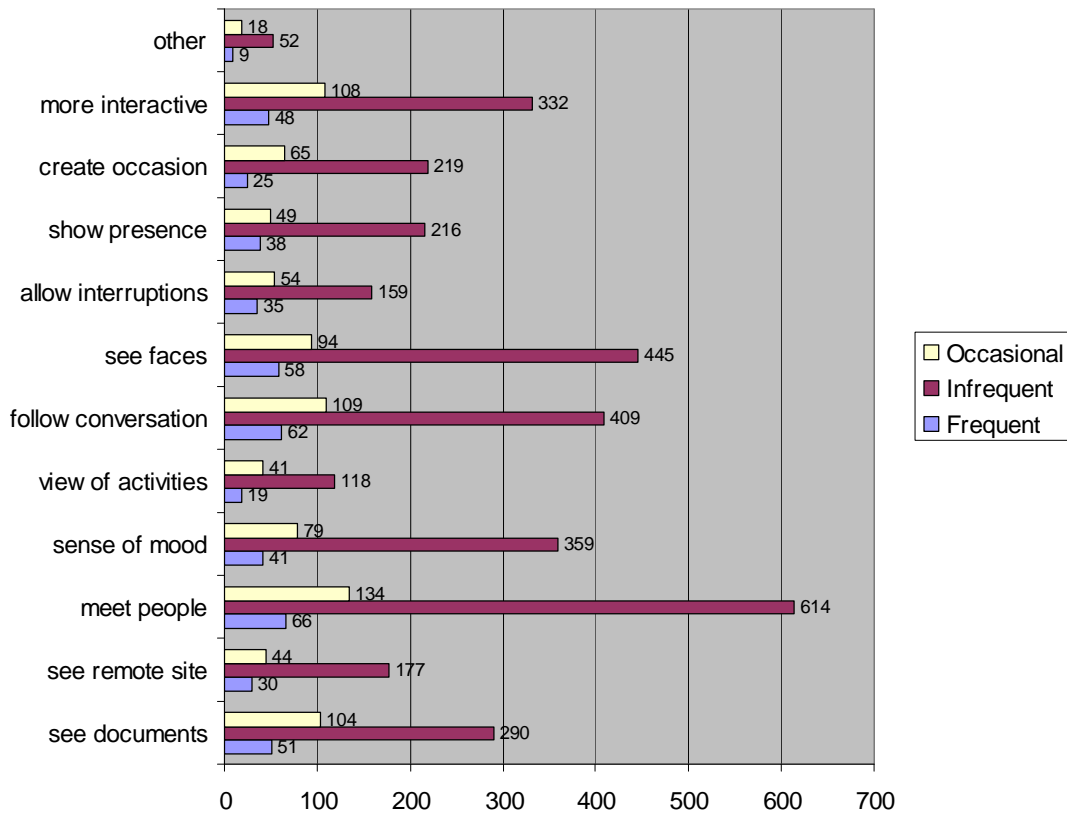


Figure 11: Perceived Benefits of Using Videoconferencing Systems by Frequency of Use

Perceived Drawbacks of Videoconferencing Systems

Videoconference users were also asked to identify what they perceived as the main drawbacks to, or problems in, using videoconferencing systems (See Figure 12). Here they were offered 22 choices in addition to the option of writing in their own response. These choices were grouped according to whether they related to set-up issues, interpersonal interaction issues, system quality/reliability issues, or other considerations such as logistical problems. Again, participants were asked to make up to three selections.

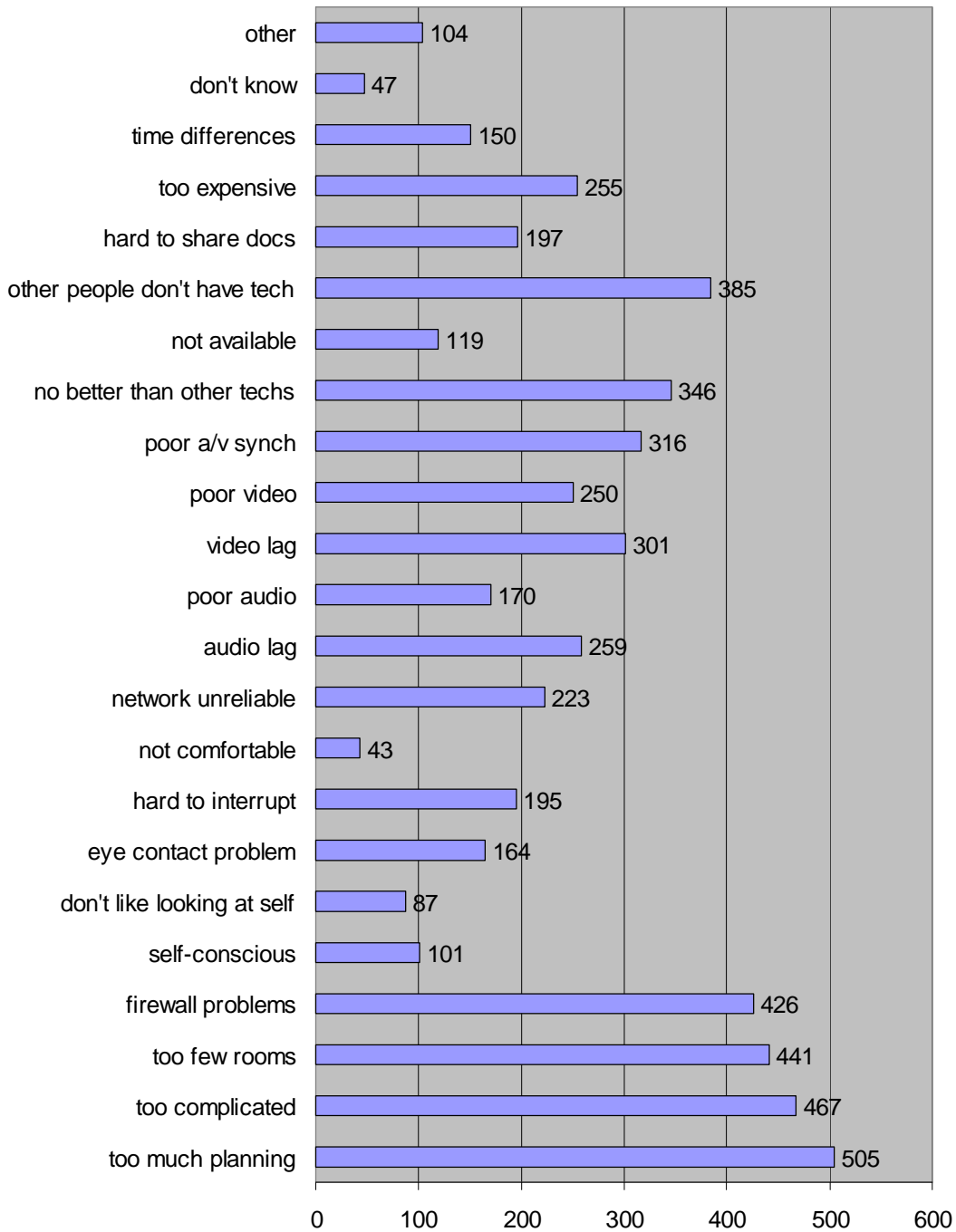


Figure 12: Perceived Drawbacks to Using Videoconferencing Systems

The main drawbacks to using videoconferencing systems as identified by its users focused primarily on the difficulties of the set up and planning involved. Set up and planning issues included difficulties in having to plan too much in advance, the technical difficulties of setting up and using the technology, and the need to book special rooms

(this relates to the earlier finding that most people were using systems that were situated in dedicated videoconferencing rooms).

Beyond set up and planning issues, the next most frequently identified problem was logistical (i.e., other people not having the technology). Following this, there was a perception that video did not provide that much more value than other alternatives (as compared to talking on the phone, emailing, sending instant messages, using NetMeeting). This coupled with a perception of its being too expensive, may go some way to explaining why alternatives were often used. Finally, there were a number of quality and reliability issues, particularly with regard to video and audio lag and synchronization.

Analysis by frequency of use resulted in similar patterns, with some differences in their ordering (Figure 13). For example, frequent users cited network unreliability and problems in sharing documents proportionally more often than the other two groups. However, even frequent users identified set up and planning issues as some of the most problematic aspects of videoconferencing use.

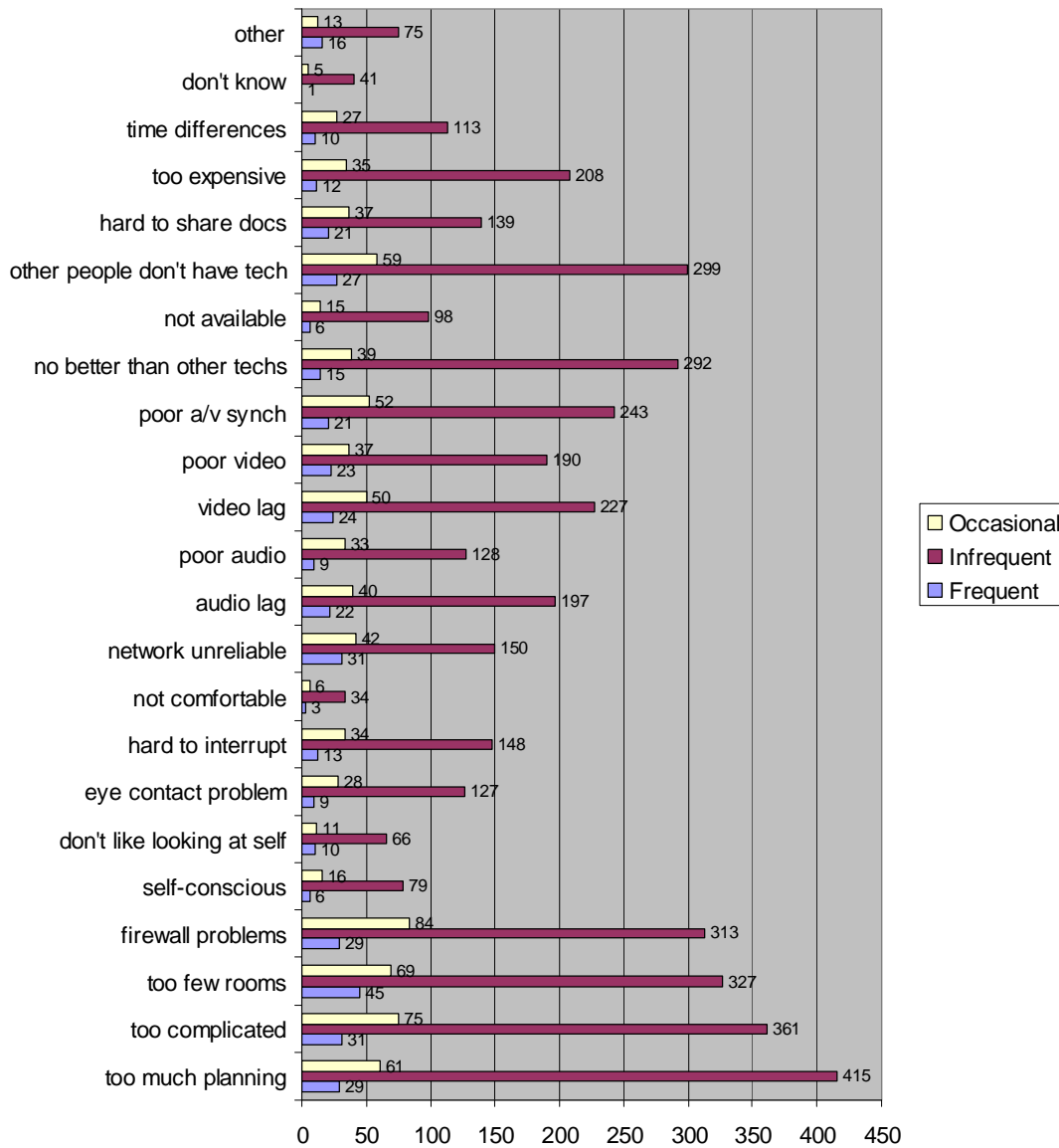


Figure 13: Perceived Drawbacks to Using Videoconferencing Systems by Frequency of Use

Relatively few people identified interpersonal factors as the main drawbacks to using videoconferencing systems. Interpersonal factors included people feeling self-conscious about being watched in a videoconference, uncomfortable about looking at themselves on the screen, frustrated by the inability to make eye contact, and frustrated by conversational flow issues. However, for those that did indicate some level of discomfort, there was an opportunity for them to enter comments which revealed users' perceptions of conversations in videoconferences being more stilted than face-to-face conversations, and less spontaneous and flexible. These problems were identified in some cases as being due to time lag problems, but were also related to the problem of

assessing gaze and gesture in such situations, and of knowing how one is perceived by others:

- “There is nothing like face to face contact. VC conversations appear stilted and don't really allow for real body language assessment. They are great in an emergency but it is not my preferred meeting mode.”
- “Everyone becomes stiff and fake when viewed by video, because they don't know who is looking at them directly.”

Yet others touched on issues relating to the fact that “being there” and physical presence allowed a range of things to happen that could not happen easily in virtual meetings. For example:

- “While a strong proponent of web based technology, I have found videoconferencing (VC) to be an impediment to successful meetings. I and others I have observed are uncomfortable without instant human feedback that the physical presence of others in a room.”
- “I think it's much better to meet in person. The best ideas/opportunities are born in the coffee corner or during lunch etc. When there's a static video meeting it's harder to get the best results.”
- “It does not allow for "out-of-channel" communications (except perhaps for some instant messaging capabilities). You lose the "hallway" conversations where so much of the "work" gets communicated.”

Finally, other comments reflected perception of general self-consciousness, such as:

- “Not me so much - but my observation was that those participants who were not used to being on a video conference were very self-conscious and aware of the technology which may have inhibited conversation and questions/comments that would have easily come otherwise.”
- “I think in general people don't want any attention focused on themselves; they can be more objective, focusing on the issue or topic if they are not "visually" observable. Perhaps video-conferencing conveys *too* much non verbal information.”

Participants also had the opportunity to write in any other comments pertaining to main drawbacks or problems with using videoconference systems, and 104 people did so. Some of these were essentially elaborations on options already selected. For example, respondents added more detail about the fact that the fuss, bother and difficulty of planning and setting up a videoconference was not worth the value that one could expect to gain in return. In particular, this worked against ad hoc meetings or meetings that needed to be convened quickly. For example:

- “The only time that I have participated in a video conference was with a customer and there were many difficulties in setting up the meeting. The meeting was delayed for approx 15 minutes while the video coordinator was troubleshooting the issue.”

- “It doesn't provide SUFFICIENT value, relative to the work of setting up and the risk of a success. Note that unreliability can tank a meeting which is a big cost.”
- “It is simply not as easy, nor as available as telephone conference which can now be ‘on demand’.”
- “I have not selected ‘needs too much planning’, but I would say that it cannot be done ‘ad hoc’ like a phone call, or an MSM messenger chat, or a NetMeeting. I think there is a space between the two for 1-on-1 and/or small ad-hoc video conferences using...”

Related to this were comments about the desire to connect to virtual meetings from the desk to minimize planning, set-up and disruption. Representative comments include:

- “Can't do it at my desk (unlike phone/NetMeeting).”
- “I would have to leave my desk and go across campus to a videoconferencing room. This takes a chunk of time out of my day.”

Another large cluster of comments related to the difficulty of effectively sharing documents, whiteboards, and other objects through videoconferencing systems.² Often mentioned was the fact that other technologies such as NetMeeting or using email and the telephone could do this better. Sample comments include:

- “Poor resolution makes true collaboration poor. We tried to show & tell a product that we were working on with R----. We tried zooming in, but this didn't work well and we had to move the product from the table and then it was tough to see well.”
- “To have a meeting in videoconference means to have the availability to share documents. If the other attendees need to use flip charts, it's impossible to see the contents.”
- “Quite often sharing plans and documents is the most important thing; video conferencing does not support this very well.”
- “Slides and documents are much more clear in NetMeeting than they are in video conferencing.”
- “NetMeeting is easier, cheaper, almost as good (if not better).”
- “What's the point? A phone conference is easier, quicker, everyone has the same familiar equipment and documents and diagrams can be shared via NetMeeting or e-mail.”

An additional drawback mentioned frequently was the inability of most videoconferencing systems to support multi-site conferences in an effective way. For example:

- “Video conferencing also has limitations for distributed teams (more than two locations). Not sure if I've ever seen a good way of handling multiple video images.”
- “Three way videoconferences don't work out well. You have to constantly switch between screens.”

² Note that the ability to share objects and documents was also one of the main benefits users reported!

- “Also, most, if not all, of our meetings involve people on 4 to 6 sites and some work at home people. VC doesn't provide for this multi-site use.”

Non-Users: Reasons Why

We have examined in some detail the “user” population within our sample of respondents, and in particular the benefits and drawbacks that they perceive as a result of that use. We now turn to the majority of people in the sample: the 68% of respondents who indicated they had not participated in a videoconference within the last three years in order to try and discover the main reasons why they had not done so (n=3100).

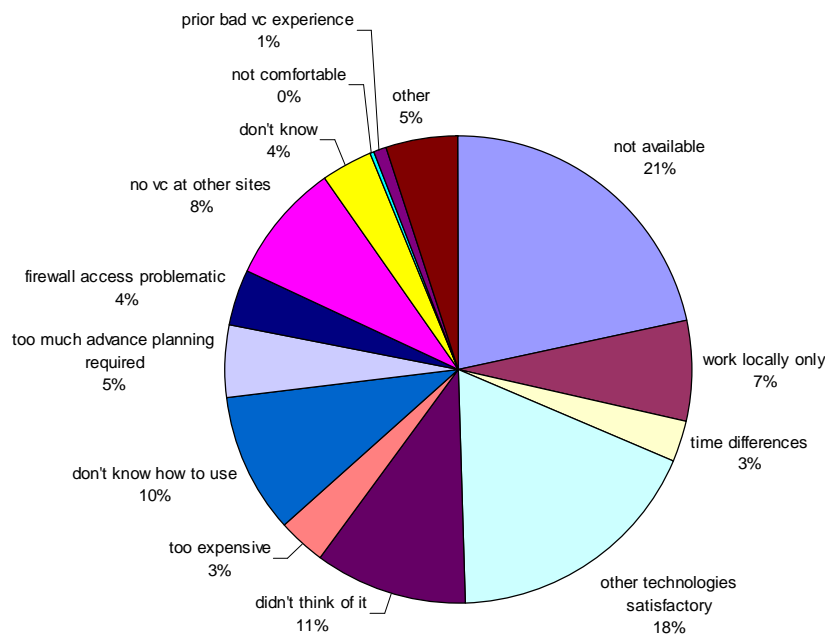


Figure 14: Main Reasons for Lack of Videoconference Use

Non-users were asked to select up to three reasons why they had not used a videoconferencing system in the past 3 years (see Figure 14). The most frequently selected reason was a logistical one, namely that the technology was not available to them (21%). However, the next two most frequently mentioned reasons were that they considered other technologies satisfactory (18%), or it never occurred to them to use it (11%). These would appear to indicate that there is no perceived or recognized strong need for this technology. Other frequently mentioned reasons were that they did not know how to use these systems/they did not have enough technical support (10%), people at

other sites did not have the same or any videoconference equipment (8%), they worked only with people locally (7%) and it required too much advance planning (5%).

Many of the comments that people entered in the “Other” option provided elaborations on these themes:

Lack or unavailability of technology. For example, many people commented on the lack of availability of videoconference technology at their site or home and/or a lack of awareness about the availability of this technology.

- “I do not know what videoconference facilities are available at HP but would like to see personal webcam PC to PC videoconference technology made available for collaborations and team meetings.”

Some participants mentioned that they work primarily or exclusively as a home or remote worker; most of these people said that they do not have access to videoconference equipment and, even if they did, their connectivity was not fast enough to support videoconference technology. Even if it was available however, they worried that their customers/colleagues would not have compatible videoconference equipment:

- “As a Telecommuter/Home Office worker, I do not know if it is even available to me. Besides most the people whom are candidates for this are for my work are customers. This makes it potentially very difficult for all parties to be able to participate.”
- “I work remotely from home and the equipment has not been made available to me or to my counterparts who work remotely also. I have used it in the past and do see where it could be of great value but currently it is not covered under our home office policy.”
- “I am a home office user and do not have the proper equipment.”

Other technologies satisfactory. While many of the participants currently not using videoconference technology expressed interest in having the technology made available to them, others commented (as many of our user group had also done) that other technologies were already meeting their needs adequately. In particular, many participants commented that the combination of NetMeeting and telephone worked well for them. Several participants felt that videoconferences, in fact, did not provide any added value over these other technologies; these participants felt that the visual element of “talking heads” was not compelling enough to overcome what were perceived to be the drawbacks of the technology.

- “There are other interactive tools to work remotely, such as NetMeeting, WebEx, and the Virtual Classroom. These work very well, are inexpensive and the work done. I like the interactive tools we have. I guess once in a while it would be nice to see the people we work with, but it is not necessary to get a job done and done well.”
- “I am not sure why seeing me over a video feed would enhance any of the communication interactions in which I engage, unless we are talking about ‘shared whiteboarding’ or other graphical tool.”

- “Videoconferencing, besides being more expensive, does not provide more value than audioconferencing or NetMeeting.”
- “As long as I’ve met the people before, a telephone conference with NetMeeting is just as effective.”
- “I don’t see the benefit of tying up network resources just to see someone’s face.”

Related to this, and echoing some of the drawbacks our user group had also commented on, there was a perception that it was more important to see shared documents than to see someone’s face:

- “Usually it is not my colleague’s faces I’m interested to see. I’d rather use the opportunity to share/show material without having any dependencies of the right application or version of application.”
- “It is a bit too much to manipulate both documents and visuals of people. It is much smoother to just use NetMeeting or Virtual Classroom. Remote meetings have become so commonplace that it really isn’t a great necessity to actually see the person.”

No perceived need. Some participants indicated that they just did not have a need to use videoconferencing systems. In particular, they did not have the interest in learning a new technology and there was no business directive to use it.

- “I don’t have the time or energy to research a new communication channel which may or may not have benefits. I have no idea whether people at all the remote locations have easy access to equipment, or how much planning is required.”
- “I’m not involved with a group or project that requires conferences where video conferencing would be an option.”
- “Nobody else I work with uses them, so there is no encouragement to do so.”

Too difficult to set-up/too much advance planning. Several participants did not use videoconferences because the technology was too difficult to set up, particularly when trying to connect more than two sites in a videoconference.

- “I have participated in videoconferences in the past and they were good for certain reasons. The effort required to set one up was immense. You need a special room, you need to reserve it before hand, you need to make sure you’ve got support, you’ve got to determine if the other party has these facilities, you may have to hand hold them to get set up... In my job, I definitely could use it. I have a global role and work with folks in different time zones. Usually I am working with people I have never met, so it would be a huge advantage.”
- “We have a videoconference system but nobody knows the phone number and it’s difficult to organize a one to many conference. We are on a remote office and the main office doesn’t use this system which may be very valuable for us.”

Other reasons. We provided participants with several opportunities to write in explanations for certain parts of this question. In these sections, respondents mentioned a number of additional reasons that explain why they had not used this technology in the recent past.

For example, several participants indicated that they did not think they would be comfortable talking to people through a videoconferencing system because they worked from home and liked the privacy that working at home provided them. For example:

- “I work from home and one of the perks is not having to dress up.”
- “Late night calls from home are very common. Prefer to dress in any attire, walk around the room, multi-task.”
- “With meetings across the time zones it can be difficult to sound awake and alert, let alone look awake! In the same time zones, it may be useful but have not had experience of it.”

Others indicated that they found videoconference technology was “not a comfortable or a natural way to communicate”. They felt that videoconferences made participants uncomfortable – that there was something “less personal” about the videoconference meeting experience in comparison with meeting in person. While one of the intended benefits of using videoconference technology is that it shows facial expressions and people’s body language, several participants felt that the visual element was inadequate for fully interpreting these expressions.

- “I find it very bad at first contact when the body language is restrained. For subsequent meetings, it can be very useful.”
- “The advantage of videoconferencing is reading the participant’s body language. This is difficult to do using the videoconferencing technology. If reading the participant’s body language is important, travel. If not, teleconference.”
- “I am not sure if the other people invited will feel comfortable in joining a video conferencing.”
- “I work from a home office and I do not always have make up on or my hair done and I would not want to have the pressure of having to get "dressed" for the video conference.”

Another group of participants commented that they had had previous bad experiences which put them off trying again. Not surprisingly, many of the comments that arose were similar to those that our user population had also raised. For example, people commented on the cumbersome and time-consuming set up and planning required for videoconferences, the problems in sharing and showing documents and objects, and the comparative ease of use of other tools such as Netmeeting. Bad experiences also focused on the quality of video in videoconferences, including the unnatural ways that people had to adjust their behavior in order for the video to look right, the jerkiness of the video, and the inability to get a complete view of the other participants. Many also reported bad videoconference experiences due to technical problems associated with the videoconference technology and network reliability. These technical problems were

distracting to videoconference participants and, when working with customers and external contacts, were perceived to be the cause of bad impressions.

DISCUSSION & IMPLICATIONS

In summary, this study has found that relatively few people in HP could be called regular videoconferencing users. Less than a third of the participants reported using any such technology at all in the last 3 years, and less than 3% of the sample reported frequent use (at least 12 times a year). These figures are fairly reliable coming as they do from a large survey sample, and spread across a range of geographic regions, business groups, and job roles. While there were more people responding from some regions, groups and job roles, our demographic analysis showed good representation of respondents across the board.

Patterns of Use

So who were the people using such systems the most and what were they doing with them? The demographic analysis showed that the small group of frequent users (121 people in all) consisted of a relatively high proportion of employees from North America. In addition, people who reported their jobs as Engineers, and as coming from the Enterprise Systems Group and Imaging & Printing Group businesses were also over-represented in this group. There was also an indication that this group consisted of proportionally more pre-merger Compaq people than pre-merger HP people. This may reflect cultural differences in organizations in terms of videoconferencing use.

The data also showed that, regardless of frequency of use, videoconferencing users reported mainly using dedicated videoconferencing rooms with built-in (or at least *in situ*) equipment. Videoconferences were used for a range of reasons. Again, regardless of frequency of use, the main reasons for having videoconferences were for project or staff meetings, management meetings, and project reviews. Some differences in use did emerge as a function of job role, however. For example, analysis of the frequent users showed that Engineers were more likely to use videoconferencing technology for project meetings, project reviews and management meetings (in other words, for more 2-way or multi-way interactions), whilst people in Customer Service and Support were more likely to use it to listen to presentations or for training (more unidirectional transmission of information).

Perceived Benefits

When we look more closely at what the users of videoconferencing technology (one-third of the sample) reported to be the perceived benefits to using such systems, we found that the most frequently selected benefit was to “see and meet people one has never met before”. Following this was the ability to see facial expressions and gestures, and to make it easier to follow a conversation when there are multiple participants. The third most frequent cluster of benefits selected included a feeling that videoconferences are more interactive than phone conferences, that videoconferences convey a sense of the mood or

general activities at the remote site, and that it allows you to see or show documents or objects. An additional benefit that users mentioned frequently was that videoconferences force participants to pay attention in a meeting, and prevent people from doing other things during a meeting (such as email or Web surfing) that they might otherwise do on a phone conference.

Some of the benefits mentioned were in line with the findings of the research literature. For example, as discussed at the beginning of this report, research has found that some of the value of videoconferencing is in allowing people to follow a conversation more easily or to help disambiguate speech, especially when multiple people are involved (e.g., Anderson et al., 1997). In addition, the fact that users recognized that video helps people gain a general sense of activities at the remote site, and also conveyed the general attentiveness of remote participants, is consistent with the research literature (Sellen & Harper, 1997).

However, other perceived benefits in some ways contradict the research findings. For example, the perception that videoconferences are more interactive than phone conferences is not backed up by any strong data in the literature. In addition, there are many problems with showing and sharing documents and artifacts that prior research has pointed to (e.g., Gaver et al., 1993; Whittaker, 2003). However, in this case, the free-form comments added by some participants may be helpful. Many commented that it was the ability to bring in and refer to objects and documents “on the fly” that made videoconferencing valuable. As we will see in the next section, respondents also recognized the inherent problems in sharing and showing artifacts via video. Finally, the ability to see facial expressions and gesture is also a complex issue. On the one hand, it was recognized as a benefit by many of the respondents in this survey. On the other hand, and consistent with the literature in this area (e.g., Heath & Luff, 1991; Hindmarsh et al., 2000), there are more subtle interactional problems with interpreting gaze and gesture, as some of the respondents themselves later pointed out when asked about drawbacks or problems in using these systems. It is to these and other issues we turn to next.

Drawbacks, Problems and Barriers to Use

When we look at the main drawbacks or problems that users of videoconferencing technology perceived, the analysis found that the difficulties and overhead involved in planning and setting up the technology were the ones most frequently selected. This included the need to book rooms, the need to get technical help with the equipment, and the fact that one could not simply participate from one’s desk. Another frequently mentioned problem was the simple fact that many people that one might want to communicate with would not have the technology available to them.

This is interesting because these issues are hardly ever touched on in the research literature. We can only surmise that primarily this is because this kind of research is hardly ever carried out with people in real work settings, asking about actual experience of use of these systems. However, we must also put this in context. For example, with regard to issues of set-up and planning, we found in this study that over 70% of

respondents reported mainly using systems in dedicated videoconferencing rooms. Thus, reserving a room would be an issue impacting the need to plan. Additionally, such systems are traditionally “higher end” technologies which may be quite complex to use, especially for infrequent users. This begs the question of whether we would see similar results if more people in the company were using lighter weight systems, such as portable systems or desktop peripheral devices.

Having said that, as many of the users’ comments attested to, the effort involved in acquiring, setting up and using videoconferencing technology must be weighed against the perceived benefits of using these systems. In fact, one of the most frequently occurring comments was that other kinds of available technologies supported remote collaboration as well or better than videoconferencing technology (such as email, telephone and packages such as Netmeeting).

In light of the findings of this research, we can now understand this cost-benefit trade-off much better. Not only is a videoconference difficult to set-up and arrange, but there are serious drawbacks in terms of the unreliability and quality that these systems offer (in terms of network reliability, audio and video lag, and the synchronization of audio and video).

Added to this, while interactional problems were not frequently selected, many people in their optional comments did discuss problems of assessing eye contact and gestures across sites, as well as the more stilted and often self-conscious nature of these conversations. These comments were consistent with many of the findings in the literature (e.g., Heath & Luff, 1991; Sellen, 1995).

Problems around the ability to share and show documents and objects also were mentioned quite frequently. The open-ended comments were again helpful here, pointing to the particular difficulties in seeing documents and objects in enough detail, and the problems of seeing people in relation to those artifacts if one had to zoom in on something, or switch between cameras in order to establish the right view. This disjointedness is again an issue which has been well researched in the literature (Gaver et al., 1993).

It is little wonder, perhaps that in view of these problems and drawbacks that the perceived value of videoconferencing is small relative to the various costs or inadequacies of the current systems in use in HP. Other technologies such as a combination of telephone and email, or audioconferencing and Netmeeting allow people quickly and easily to communicate verbally around work-related electronic documents. Often this can be done from the desktop with little effort on the part of meeting participants.

When we look at the main barriers to use that *non-users* point to, a somewhat different set of issues arises. Some were purely logistical. For example, the most frequently selected reason was the mere fact that people thought (whether rightly or wrongly) that the equipment was not available to them. A smaller percentage of people said that they

tended to only work with people locally, or that colleagues at other sites didn't have equipment available to them.

However, a common response to this question was that the respondent felt no strong need for seeking out videoconferencing technology. While it is difficult to analyze this in detail, this appears to be either because there has been no past history of use or because of a deliberate choice to rely on other technologies. The data in our study suggest both; non-users have no experience of use and thus it does not occur to them that they might use it. Additionally, with no use, there are initial barriers to learning how to use the equipment.

On the other hand, many respondents indicated that they were already comfortable and happy with the technologies available to them to collaborate with remote colleagues. Here, the comments echo those we have already discussed: that the use of an audio channel and the use of other channels such as email and Netmeeting are adequate support for much of the work that needs to get done. In this sense, these non-users appeared to be coming to the same conclusion that many of the user group did in anticipating the cost-benefit trade-off we have already discussed. This was also indicated by a group of people who reported having had a bad experience in the more distant past. In particular, people who fell into this category talked about past bad experiences where poor connections and unreliability of equipment created problems, as did problems in set-up and use of the system. While they were making judgments on the basis of older technology, it appears that the technology in place within HP in the past three years has not really provided a solution to these problems.

Implications

There are several implications that come from this research for the design of new technologies for remote communication. For example, it appears that videoconferencing may well provide potential benefits that no other technologies can, for example, in allowing people to get to know what people look like and see how they behave when they have not met them before, to help people follow conversations when there are multiple participants involved, to allow people to flexibly bring in and talk about objects and documents in an ad hoc manner, and to ensure focus and attention in a remote discussion.

However, the implications of this research are that such systems will not allow people to fully realize these benefits unless the following occurs:

- q ***The overhead in terms of planning and set-up needs to be minimized.*** On the one hand, the message here is for better usability of these systems such that they are truly "plug and play". But it also points toward fostering a culture of use of other kinds of videoconferencing technologies, such as desktop and mobile videoconference systems that are easy to set up and use. It also points toward other aspects, such as providing for simple support of multi-way/multi-site interactions, and providing interoperability across videoconference systems. Perhaps when these improvements occur, there will be a larger installed base of users to enable more widespread collaborative work to take place. Until set up and

planning processes are radically simplified, however, videoconferencing system usage will remain limited. The value of videoconferencing systems is not clear enough in people's minds to warrant the amount of effort it takes to set up and plan a videoconference event when they could easily arrange an ad hoc meeting using the telephone and NetMeeting.

q ***The quality of the experience needs to improve in terms of audio/video synchronization and lag, video quality, and system reliability.*** Once the problems of set up and planning are resolved, videoconferencing users will become more aware and troubled by technical problems that interfere with their collaborative experience. In our study, this was evidenced by frequent videoconference users citing network unreliability proportionally more often than people who used videoconference systems less frequently. Videoconference systems need to become more reliable and less intrusive in the collaborative interaction by reducing audio and video lag and improving the quality of the video image. Improving videoconferencing system quality and reliability could particularly benefit teleworkers by helping them and their co-workers to bridge distances, making teleworkers feel more a part of the organization. This group of workers in particular needs videoconference systems that can be supported on home office equipment with lower bandwidth network support.

q ***Designers of videoconferencing systems need to recognize and design for the ability to focus on work-related objects as well as people.*** The fact that many alternative technologies were used in order to collaborate remotely shows that talking is more important than seeing for many kinds of collaborative activities. However, in many of these activities, work-related objects were shared in other ways, whether by emailing documents in advance of meetings, or creating Powerpoint presentations to share via Netmeeting software. The point here is that there is a recognition that talk in addition to important work-related artifacts allows many kinds of work activities to be effectively accomplished. These could also be accomplished through videoconferencing technologies if more thought were given as to how to flexibly and effectively share a wide range of documents and objects. Here, it is crucial that videoconferencing system designers think not only about the sharing of electronic documents and Powerpoint presentations, but also the sharing of physical objects. These include: the sketches and notes on objects such as whiteboards, the sharing of paper documents (both brought into meetings as well as created on the fly), and the joint viewing and discussion of a range of physical objects relevant to different workplaces (be they automotive parts, product designs, medical equipment, technical components, and so on). Allowing such objects to be shared remotely in a way that not only allows co-participants to view them in detail, but also allows them to view other people's activities in relation to those objects presents a difficult but important challenge for designers of future videoconferencing systems.

CONCLUSION

Results from this study shed some light on what real people drawn from around the world working in a very large organization think about videoconference systems. Specifically, this study explored patterns of use of videoconferencing systems and people's perceptions regarding their reasons for use or non-use of videoconferencing systems within HP. Differing from most of the research literature addressing videoconference usage, this research study found that one of the most troubling aspects of the videoconference experience is the complexity of setting up and planning for videoconferences, particularly for more formalized dedicated videoconference rooms. Additionally, this study found that many people do not see the value of seeing people's heads and shoulders on videoconference systems over existing alternatives, such as telephone and NetMeeting, especially given the difficulties of setting up these types of meetings. We suggest that research and design efforts be concentrated in these areas, making videoconferences simpler to use, more reliable and stable, and with a greater focus on the ability to flexibly and effectively share work-related objects rather than viewing co-participants in a conversation. With improvements in these areas and a greater proliferation of easier to use, more lightweight desktop and mobile videoconferencing systems, such technology could be used in a more natural and spontaneous manner, resulting in more meaningful collaborative experiences.

REFERENCES

- Anderson, A.H., Bard, E., Sotillo, C., Doherty-Sneddon, G. & Newlands, A. (1997). The effects of face-to-face communication on the intelligibility of speech. *Perception and Psychophysics*, 59, 580-592.
- Anderson, A.H., Smallwood, L., MacDonald, R., Mullin, J., Fleming, A. & O'Malley, C. (2000). Video data and video links in mediated communication: What do users value? *International Journal of Human-Computer Studies*, 52(1), 165-187.
- Baker, H.H., Bhatti, N., Tanguay, D., Sobel, I., Gelb, D., Goss, M.E., MacCormick, J., Yuasa, K., Culbertson, W.B., & Malzbender, T. (2003). *Proceedings of the eleventh ACM international conference on Multimedia*, 470-479.
- Frohlich, D. (2001). Scanners for remote collaboration: Identifying requirements from the literature. *HP Labs Technical Report*, HP Restricted. [HPL-2001-27](#).
- Fussell, S.R., Kraut, R.E., & Siegel, J. (2000). Coordination of communication: Effects of shared visual context on collaborative work. *Proceedings of CSCW'00*, 21-30.
- Gaver, W., Sellen, A., Heath, C., & Luff, P. (1993). One is not enough: Multiple views in a media space. *INTERCHI'93*, 335-341.
- Heath, C. & Luff, P. (1991). Disembodied conduct: Communication through video in a multi-media environment. *Proceedings of CHI*, 99-103. New York: ACM Press.
- Heath, C. C. and P. K. Luff (1996). Convergent activities: collaborative work and multimedia technology in London Underground Line Control Rooms, in D. Middleton and Y. Engestrom (eds.), *Cognition and Communication at Work: Distributed Cognition in the Workplace*, Cambridge: Cambridge University Press, pp. 96-130.
- Hindmarsh, J., Fraser, M., Heath, C., Benford, S., & Greenhalgh, C. (2000). Object-focused interaction in collaborative virtual environments. *ACM Transactions on Computer-Human Interaction*, 9 (4), 285-308.
- Hindmarsh, J., Fraser, M., Heath, C., Benford, S., & Greenhalgh, C. (1998). Fragmented Interaction: establishing mutual orientation in virtual environments. *Proceedings of CSCW'98*, 217-236.
- Jouppi, N.P. (2002). First steps towards mutually-immersive mobile telepresence. *Proceedings of CSCW'02*, 354-363.
- Kraut, R.E., Gergle, D., & Fussell, S.R. (2002). The use of visual information in shared visual spaces: Informing the development of virtual co-presence. *Proceedings of CSCW'02*, 31-40.

Martin, D. & Rouncefield, M. (in press). Making the organisation come alive: Talking through and about the technology in remote banking. To appear in a special issue of the *Human-Computer Interaction* called "Talking about Things".

Matarazzo, G. and Sellen, A.J. (2000). The role of video in work at a distance: Addition or distraction? *Behaviour and Information Technology*, Vol. 19(5), 339-348.

Nardi, B.A., Kuchinsky, A., Whittaker, S., Leichner, R., & Schwarz, H. (1996). Video-as-data: Technical and social aspects of a collaborative multimedia application. *Computer Supported Cooperative Work*, 4, 73-100.

Park, K.S., Kapoor, A., & Leigh, J. (2000). Lessons learned from employing multiple perspectives in a collaborative virtual environment for visualizing scientific data. *Proceedings of CVE 2000*, 73-82.

Ruddle, R.A., Savage, J.C.D., & Jones, D.M. (2002). Symmetric and asymmetric action integration during cooperative object manipulation in virtual environments. *ACM Transactions on Computer-Human Interaction*, 9 (4), 285-308.

Sellen, A.J. and Harper, R.H.R. (2002). *The Myth of the Paperless Office*. Cambridge, MA: MIT Press.

Sellen, A.J., and Harper, R.H.R (1997). Video in support of organisational talk. In K. Finn, A. Sellen, & S. Wilbur (Eds.), *Video-mediated Communication*, NJ.: Erlbaum, 225-243.

Sellen, A.J. (1995). Remote conversations: The effects of mediating talk with technology. *Human-Computer Interaction*.

Short, J., Williams, E. & Christie, B. (1976). *The social psychology of telecommunications*. London: Wiley.

Veinott, E.S., Olson, J.S., Olson, G.M., & Fu, X. (1999). *Proceedings of CHI 1999*. New York: ACM Press, 302-309.

Watts, L., & Monk, A.F. (1996). Remote assistance: A view of the work and a view of the task? *CHI'96 Companion*, 101-102.

Whittaker, S. (2003). [Things to talk about when talking about things](#). *Human-Computer Interaction*, 18, 149-170.

Whittaker, S., Geelhoed, E., & Robinson, E. (1993). Shared workspaces: How do they work and when are they useful? *International Journal of Man-Machine Studies*, 39, 813-842.

Whittaker, S., Frohlich, D., & Daly-Jones, O. (1994). Informal workplace communication: What is it like and how might we support it? *Proceedings of CHI*, 130-137. New York: ACM Press.

