An investigation into the effectiveness of implementing video conferencing over IP

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By

Paul Meulenberg

BA Film and Television (Swinburne University of Technology)

Dip Architecture (MTS Zaanstreek)

Cert Teacher Training (Hawthorn Institute)

Faculty of Design

Swinburne University of Technology

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Abstract

Nobody really knows with certainty what education using digital video communication technology will be like in the next ten years. The only thing that seems certain is that it will not be like the present. While no one can see into the future, we can research present realities and current rates of change as bases for projecting ahead.

Video conference systems that operate over IP (Internet Protocol) are being implemented in educational organisations, businesses and homes around the globe. Video conference manufacturers inform us that the implementation of such systems and their use is relatively straightforward. This may or may not be the case. This research argues that there is significantly more to implementing video conferencing over IP than simply installing the equipment, training staff and commencing classes. This study reports on an investigation into the effectiveness of implementing digital video conferencing over IP in educational institutions. It specifically looks at this in respect of the desktop and small group user. Research in desktop videoconferencing in education exists but is not abundant, for example, Thompson (1996), Kies et al., (1997), Bogen et al., (1997), Daunt (1999), Davis and Kelly (2002), Davis et al., (2004). With the considerable progress made in IP technologies, more educational providers are moving to use desktop and small group videoconference systems to link to classes and/or students over the Internet. This is a trend that is growing rapidly world-wide. The implementation and application of IP video conferencing in education is under-researched. This study examines three separate case studies to collect the required data. It looks at the processes required to set up effective communications with students and teachers using digital media. It identifies the specific difficulties that need to be overcome, both technically as well as the human factors that are involved. It addresses these issues chiefly as related to desktop users and small groups of participants in particular. In conclusion it also focuses on the design aspects of the video conference equipment and venues used in educational environments. The aim of the research, therefore, is to understand current and future trends of implementing and using video conferencing over IP, in a technical, human and design sense. The research has practical significance for educational institutions, as it provides useful information for students, tutors, technicians and designers involved in digital video conferencing technologies now, and in the years to come.

Project program

The study initially describes the technical background of the facilities required in video conferences over IP; furthermore, it looks at the theoretical perspectives of learning via video conferencing, and then provides a current rationale for teaching and learning through a review of the literature about experiences and advantages of this environment. Practices and strategies for effective video conferencing environments are described and the issues and problems that arise from learning in this way are raised.

The main part of the project investigates:

(a) The nature and extent of research and development work on video conferencing systems that is currently taking place, through literature review, correspondence and by visiting appropriate centres;

(b) The technical and design problems encountered, through literature review, correspondence and by visiting appropriate centres;

(c) Three (key) case studies which form the basis of the data gathering:
   - Professional Doctorate in Design students - Swinburne University of Technology and students in Taiwan,
   - The CRC (Cooperative Research Centres Program) project
   - Swinburne University of Technology - Lingnan University, Hong Kong.

(d) Technological advancements relevant to video conferencing in such areas as connectivity which may impact upon video conferencing over IP;

(e) The project program concludes with reflections and evaluations. It reports on the stumbling blocks that can occur and how these can be overcome by addressing user attitudes.

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- My wife, Christine and children, Tristan, Katie and Samantha, who have had to endure my absence from time to time in my research travels, or being “unavailable” whilst being at home, for extended periods of time.

Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma, except where due reference is made in the text of the thesis. To the best of my knowledge, this thesis contains no material previously published or written by another person except where due reference is made in the text of the thesis.

Signed……………………………………………………(Paul Meulenberg)

Date…………………………………………………………

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Chapter 1 - INTRODUCTION

1.0 Introduction

This chapter addresses the following topics:

1.1 The reasons for the thesis

1.2 Some elementary questions

1.3 The limitations of the thesis

1.4 The structure of the thesis

Technology has been used for many years in education, specifically to serve distance learning. Distance learning may be characterised as a separation of place and/or time between the tutors/lecturers and students, and the interaction through one or more media technologies (Bell et al., 2004). Distance learning courses traditionally have set timetables, examination schedules and perhaps even the occasional face-to-face meeting. This allows institutions and tutors/lecturers some control over the progress and performance of students, whom otherwise are not seen. Video conferencing has claimed a large slice of the distance learning technology pie, as it is very suitable to many distance education applications. Video conferencing though, is not new. On the contrary, the concept stems back to the early 1920s when the Picture Phone, the first type of desktop video conference system, was under development at Bell Labs (Edigo, 1998). The first public video conference was held in April 1930, between AT&T Headquarters and their Bell Laboratory in New York City. Microphones and loudspeakers transmitted the audio while, under a blue light, images were captured and transmitted as participants looked into photoelectric cells (Vide Videoconferencing, 2003).

Elaborate video conferencing rooms have been used at AT&T since the 1960s, where they were mainly used as a means of linking people in corporate meetings. In 1964, AT&T introduced its Picture Phone at the New York City World's Fair. This system, marketed as an exclusive executive tool, required 1 MHz processing power (considered daunting at the time) and provided the first data-sharing feature. In 1971, the first transatlantic video conference occurred between two Ericsson systems (a product named LME).

Twenty years later, desktop video conferencing systems became available (Vide Videoconferencing, 2003). Video conferencing, however, has had a rather turbulent past. The early video conference systems available in the 1960s were both expensive and unreliable. Education had the choice to invest significant amounts of money to use a technology that often would not work well. This would lead to significant stress for early users, as well as provide major embarrassment to the main users (lecturers/tutors) and the educational institutions involved, especially when technology forced them to interrupt or even cancel a class session or meeting.

As the technology developed, educators began to harness its potential in a number of innovative ways in order to serve the distance learner. These innovations generally can be grouped under the term "Multimedia". The use of Multimedia as a tool or a learning aid was slow to begin with, but its use has been rising rapidly as the technology developed. The designs initially applied to the first primitive multimedia products have undergone vast conceptual changes. When the first embryonic World Wide Web pages were born, after earlier created bulletin boards, they were mainly text and sometimes graphics based. The introduction of gif's, animated gif's and sound represented the first unsteady steps towards a richer media. Movement was then introduced via simple animation and later, short-streamed video segments. Significantly, video conferencing and Video on Demand entered the mainstream next, with potentially dramatic consequences. The ultimate aim was towards real time connectivity, even virtual reality and perhaps combined with artificial intelligence. Franchi (1995) argues that virtual reality adds not only a third dimension, but also offers the element of movement within that dimension. It would also make 3-D face-to-face contact possible, thus imitating a real life classroom setting.

Walsh and Reece (1995) observed that universities and other educational providers worldwide were frantically building web sites and multimedia products, sometimes including video conferencing and Video on Demand systems. These offered course content for students who were geographically dispersed. Daniel (2000) reported that in 2000, 11 mega-universities enrolled about 3 million undergraduates with hundreds of thousands following other, non-degree courses. (A mega-university is defined as a distance-teaching institution with over 100,000 active students in degree-level courses.)

These universities were under considerable pressure to develop and/or use technology-based course delivery systems. An increasing awareness of globalisation emerged as students gained access to educational providers other than their locally available body. Competition became strong as the struggle for presence and global dominance took place. We are now poised on the threshold of another revolution, one involving communication and information technology and the knowledge media, which will have a profound effect on teaching and learning for all of us (Ryan et al., 2000, Inglis et al., 1999). Rich media content has arrived.

1.1 The Reasons for the Thesis

The mainstream of video conferencing technologies has focused largely on linking up via ISDN (Integrated Services Digital Network), and to some extent via ATM (Asynchronous Transfer Mode). Now, however, there is a growing trend to use IP as a main transport vehicle for such video conferences. Most schools in the USA use ISDN or, increasingly, IP over their LAN (Local Area Network), WAN (Wide Area Network), the Internet or Internet2 (Greenberg and Colbert, 2003). This move away from the traditional technologies is driven by the great flexibility that IP offers. It is a technology that brings potentially high quality video conferencing coupled to a convergence into many other communication technologies such as the World Wide Web, NetMeeting and IP telephony. Additionally, the move to use IP technology is cost-driven.

As users are only charged for the amount of information (data) sent, linking over IP offers a remarkably cheap alternative to conventional ISDN line use with its per minute charges and annual line rentals. This trend will have major consequences for the users of the new technologies, as well as the immediate environments in which the technology is being used. Traditional video conferencing required end users to travel to a specific fixed location, where sophisticated equipment was set up in order to engage in video communication. IP video conferencing is changing all that. As IP technology is available at the desktop, video conferencing has entered the mainstream because it is available wherever there is a networked PC. As conventional systems were expensive to purchase, as well as incurring high operating costs, they were mainly used for larger groups.

Systems were placed at universities and some colleges that could afford the initial outlay and cover the annual expenses which were often very high. IP video conferencing brings video communication into the mainstream because the costs of purchasing and setting up an IP video communication facility have been drastically reduced. It may be used directly from a desktop PC or a standalone system connected to a monitor, and is capable of linking person-to-person, person-to-group, or group-to-group. Travel to specific dedicated locations is therefore minimised. Furthermore, the operating costs are much more favourable. This makes video conferencing available to everyone who has access to a desktop and the Internet.

There is a significant volume of research available on the traditional application of conventional (ISDN) video conferencing and how it can be effectively used. Some research has investigated video conference systems over IP. Davis and Kelly (2002) found that many organisations employing IP video conferencing technology ultimately discover a number of common implementation and usage problems; however, there is little research on the actual implementation of IP video conferencing in educational institutions, specifically as related to the desktop and the small group user. As IP is shaping up to be the logical successor to video conferencing over ISDN and ATM, it needs to be subjected to closer scrutiny. The research presented here is not immediately concerned with the details of the technologies involved, nor is it the intention to look in great detail at the techniques for effective teaching and learning using video conferencing. The present research argues that there is more to implementing video conferencing over IP than simply installing the equipment, training staff and starting classes. Equipment providers often indicate that the implementation of the technologies is straightforward; however, the reality can be very different. Not only do the technical difficulties need to be sorted out, there are organisational and human factors to be considered. These can appear to be minor, but this study argues that the organisational and human issues are major hurdles to be overcome. This study reports on an investigation into the effectiveness of implementing video conferencing over IP. The underlying aim of the research is to understand how successful implementation of video conference classes over IP, in a technical, human and design sense can occur in educational settings. This study investigates them through an examination of three case studies and questions the usability associated with them.

In particular it:

- Investigates the implementation in respect to educational environments.
- Identifies processes required to implement and set up effective communications with students and teachers using digital video conference media.
- Identifies the hurdles that need to be overcome.
- Addresses the technical problems as related to IP video conferences.
- Focuses on the human and design aspects related to equipment and environment involved.

1.2 Some Elementary Questions

A considerable body of research exists on video conferencing related topics, ranging from the technical to the theoretical. Some early research addresses interaction in video conferencing (Schiller and Mitchell, 1993). For example, Daunt (1999) argues that high levels of student initiated interaction can be achieved, with spontaneity being a feature of the interchanges among students and lecturers in desktop video conferences. Other studies look at video conferencing technology and its standards. Schaphorst (1996) for example, goes to great lengths to describe the technologies and associated equipment. There are evaluations that look at the effectiveness of video conferencing in classes. Dekkers et al., (1986) found that students who received their lectures through 'tutored video instruction' (an embryonic form of video on demand), performed at least as well as students who attended face-to-face lectures at university. Crock et al., (1996) found this was the case even though true interactivity was not achieved in some cases. Others, such as Davis and Weinstein (2002), looked at the benefits, costs and risks of video conferencing. Additionally, there are studies that look beyond video conferencing itself. Barr (2000) researched how modern communication technology is converging with other technologies and finds that this is changing traditional media and communications. Karim and April (1997) look at best practices in video conferencing. Yet other research has concentrated on technical issues; for example, the use of firewalls, specifically as related to IP video and audio (Firewalls, 2002). Sumner and Hostetler (2000) conclude that according to most available research, desktop versus face-to-face communication produce equal learning outcomes.

This is in line with Owen and Aworuwa (2003), who present an analysis of how distributed education compares with traditional classroom teaching. Forster and Washington (2000) offer a positive, yet realistic, model of organisation for video conference courses. Davis et al., (2004) argue that many organisations involved in employing IP video conferencing technology experience a number of common implementation and usage problems. Amerian (2002) argues that educators should use video conferencing interactively, not passively like the 'six o'clock news'. Yates (2003) argues that with training for both students as participants and teachers as deliverers, video conferencing is a very good educational solution. Danthuluri (2002) looks at the technical quality of video conferencing over the Internet and Intranet. Rhodes (2001) stresses that a thorough needs-analysis should occur before selecting video conference technology as a tool for delivering distance education; whilst Barlow et al., (2002) compare video conferencing to in-person meetings.

The body of research is wide ranging with input from providers of the equipment as well as the end users and it does provide answers to a number of questions. These are briefly summarized by Greenberg (2004) who states:

- *'Video conferencing is neither more nor less effective (as a teaching aid) than traditional classroom.*
- *Video conferencing supports far greater interaction than is otherwise possible from many asynchronous technologies, and effective video conferencing-based instruction must be designed to take advantage of this capability.*
- *Other related instructional strategies have been identified to maximize the success of video conference-based learning situations.*
- *When used appropriately, video conferencing is a cost-effective way for educational institutions to deliver successful educational experiences to an expanded population'* pp.4.

Questions are raised, such as;

- Are support staff able to implement, service equipment and train staff adequately?
- Can students keep pace with technology implementation at home and can they afford it?
- Is the technology and its design sufficiently user-friendly to the user?

- Is the environment in which we apply the new technologies suitable or does it need to be re-designed to be more effective?

The study identifies these questions and provides answers to these through the data collection of the three study cases.

1.3 The Limitations of the Thesis

Whilst this study offers additional knowledge on general video conferencing, its focus is upon desktop video conferencing over IP for individuals (person-to-person) and small groups. As the research shows, developments in video conferencing over IP are a world trend and it is impossible to provide a full and accurate picture of all of the relevant technology developments that are occurring related to this. The very nature of building IP networks and their constant reshaping, fine-tuning and convergence with other new technologies, makes it an unpredictable area indeed. Broderick's "spike effect"(1997) makes it even more unpredictable, as development rates speed up incrementally. In his book "the Spike", Broderick implies that within fifty years, life as we know it will have changed completely.

> *"Imagine a graph plotting progress in technology against time. The lines start pretty flat. It begins to curve slowly upwards as machines are developed in the Middle Ages. Then as breakthroughs take place over the last few hundred years -engines, electricity, computing - it turns upwards more steeply. Now continue the curve on from the present: it becomes exponential, roaring upwards into a spike!"*
>
> *"In many fields, the pace of change is accelerating. Faster and faster the discoveries come. If things continue as they are going - and there is no evidence that they won't - within our lifetime we can expect: computers that are more intelligent than us; greatly reduced ageing of our bodies; nano-technological machines that look after all our material needs; cloning ourselves; even uploading copies of our brains into computers."* pp. 281.

Three months is a long time in IT (Information Technology). Global developments described in this thesis are therefore only a small representation of known developments and uses of the media, ascertained at the time of writing.

The three case studies described in this thesis present a sample of how the implementation and use of video conferencing over IP in an educational setting occurred. However, the very nature of video conferencing over IP is relatively new, and the technology involved is a 'living entity' that is still evolving. New developments that became available during the case studies therefore could not be included. Another limitation of this research is the development of communication technology policies by the Australian Government. For example, at the time of writing, the acceptance and implementation of standards of High Definition Television (HDTV) and Standard Definition Television (SDTV) systems are still very much in turmoil. New governments will, without doubt, also try to influence the direction of communication technologies in this country. These will eventually impact directly upon the spheres of video conferencing. For practical reasons, the case studies have opted to use end-user equipment of one particular manufacturer and brand. It was not the goal of this research to test and evaluate equipment of one manufacturer; however, for consistency only one manufacturer's equipment was used in the research. This does not mean that the data gathered from the case studies are limited to this particular brand of technology only. Some brand specific functionalities will nonetheless not be applicable to some other equipment manufacturers. While there are a number of different ways IP video conferencing systems can be used, the principles are usually the same. Consequently the author does not believe this to be of significance to the outcome of the research. Furthermore, whilst this research has concentrated on the desktop user and the small group user, this does not mean that the same principles do not apply to larger group systems. The human behavior involved in using a desktop or a large group system, may be very different. This research has limited itself to studying the desktop and small group links only; that is, person-to-person, person-to-small group or small group-to-small group. Person-to-large group has not been addressed, as this usually is a one-way delivery for practical reasons. In those videoconferences interactivity becomes problematic as many sites can not easily be seen by the main presenter.

Finally, the research presented here (literature, case studies, and key practices) only focused on the educational/training sections in respect to the effective application of digital video in the form of video conferencing. The use of digital video in the classroom is a natural progression from previous technologies applied in remote teaching. As such, the educational sectors have built up an impressive history of its application. This research was limited to the educational sectors, as most worldwide developments in this technology will usually also be applied first to this sector.

1.4 The Structure of the Thesis

The thesis initially describes the theoretical perspectives of learning via video conferencing, and then provides a current rationale for teaching and learning through a review of the literature about experiences and advantages of this environment. Practices and strategies for effective video conference environments are described and the possible problems that arise from learning in this way are raised. It is clear that IP enabled technologies are making deep inroads into the use and application of traditional communication technologies. Couple this with the trend to converge new and old technologies, it (IP technology) is shaping up to become a key player in the communication industries over the next ten to fifteen years. This will have a major impact on the way we communicate, learn and play. The Educational Sectors worldwide are playing a major part in this development, as they are usually among the first organisations to implement new technologies in innovative ways. Students and teachers will adapt and adopt these technologies to suit their individual needs. In many ways students are now demanding that educational providers give them access to these new technologies. Education over the next ten to fifteen years will almost certainly change because of the way technologies such as IP are being implemented. This research looks at only a small part of this new revolution. Nevertheless, it is an important part that can provide some direction to educational players. This research attempts to shed some light on the issues that are affected by the implementation of video conferencing over IP as applied in an educational setting. The thesis is set out in a manner that provides findings for organisations involved in using the IP technologies for video conference purposes. It identifies the difficulties that need to be overcome in order to apply the technology effectively within an educational organisation.

This can be useful for organisations embarking on implementing such technologies on a large scale, or for organisations that already have traditional video conferences integrated into their operations and who want to change over to the new IP enabled technologies. It is structured as follows:

Chapter 1 serves as an introduction to the research into video conferencing over IP. It explains how the thesis is organised.

Chapter 2 reviews currently available communication technologies. It does so to provide a background that is essential for the understanding of IP technologies. It looks at various existing video conferencing systems and streaming systems, as a natural connection exists between the two. Furthermore, it addresses connectivity and bandwidth topics as these form an integral part of video conferences over IP. The chapter concludes with an overview of IP technology itself, why it is an ideal platform, and where the technology is leading to.

Chapter 3 provides an overview of current global key practices in video conferencing by educational providers. This is no more than a snapshot of what is happening across the globe in the areas of video conferencing. It is by no means a complete account of the total video conference position, but is provided to demonstrate the huge expansion of IP enabled video conference uses across the globe. It contextualises this by references to:

- The extent and technical capabilities of currently available systems and designs at a global level; and
- The extent of research and practice regarding the educational applications of such systems and designs used in distance education.

Chapter 4 addresses technical and design problems encountered in video conferencing over IP. It looks at the limitations of bandwidth that restrict current progress. It covers current equipment design and venue design. Additionally, it investigates the appropriate use of technologies in an educational context. As this thesis is not about the detailed technical architecture of the equipment involved, it investigates the above matters only from a user point of view.

Chapter 5 describes the research methodology applied in the case studies. It offers reasons why the particular method was selected as appropriate and describes the steps in which it was applied. The chapter then presents the three case studies that form the basis of the data gathering. These were:

- video conferencing between Professional Doctorate in Design students (Swinburne University of Technology) in Taiwan to their supervisors in Prahran, Melbourne;
- implementing video conferencing over IP for the CRC (Cooperative Reseach Centres) in Innovative Wood Manufacturing to facuilitate communications between members; and
- using video conferences over IP in classrooms between students at Swinburne University of Technology, Hawthorn, Melbourne and students at Lingnan University, Hong Kong.

Chapter 6 evaluates and reports on all three case studies. It provides case study comparisons, looks at the human elements and pedagogy involved and provides the main findings of this research.

Chapter 7 describes the emerging technologies relevant to IP video conferencing that may impact upon this medium in the future. It suggests future areas of research and on the basis of the research; it lists the practical do's and don'ts when implementing video conferencing over IP.

Chapter 2 - EXTENT OF CURRENT COMMUNICATION TECHNOLOGIES

2.0 Introduction

Porter (1997) wrote:

> *'Those learners who need the motivation of a set schedule and benefit from direct interaction with other learners, as well as educators/trainers, will benefit more from these forms of interactive learning (Video conferencing) than will self starters who prefer working alone (online)' pp.157.*

Considerable information is available on the capabilities of conventional (ISDN) video conference systems and related technologies; for example, Schaphorst (1996), Karim and April (1997), Owen and Aworuwa (2003), Wainhouse (2002), Davis and Kelly (2002), Gambiroza et al., (2002), Kingham (2002), Yates (2003), and Danthuluri (2002). Nonetheless, it is useful to look closely at some of the technological developments, as these are still evolving and impact upon the effective use of video conferencing. It is also useful to provide an overview of current communication technologies and the directions in which they are moving. This enables the author to justify why the project is focusing on IP video conferencing. Additionally, it is difficult to discuss video conferencing over IP without covering at least some of the technical background involved.

2.1 Video Conference Systems

Video conferencing technologies are powerful tools for distributed education. They play a major role in the creation of new learning environments and are becoming increasingly common through the use of flexible delivery options (Bates, 1994). Today, there are many video conference systems available across the globe. They vary greatly not only in the way they look but also in the way they work.

Each system is designed to fulfill a specific purpose: some are designed for personal conferences (person-to-person) while others are suitable for conference rooms capable of seating large numbers of people. Others still are designed to suit classrooms and lecture theatres. Most of them have functionality that allows freedom of interactivity. This is very important, as interactivity is widely considered to be the key to successful video conferencing (Kunz, 2001; Twigg, 2001; Heath and Holznagel, 2002). There are two main components that make up a video conference system: *A)* Video and *B)* Audio. It is possible to be engaged in video conferencing without sound, but it is normal to have audio flowing in both directions. It is also possible to establish a video conference with audio only; however, this defeats the purpose of a video conference and one might as well have a separate (and possibly cheaper) audio conference through standard telephone lines or the web. For a video conference to be effective, a continuous flow of video as well as audio needs to be present in both directions and at both (or all) sites.

A. Video

Television viewers in most of the world are used to a good (analogue) video picture. The television picture is made up of a series of horizontal lines. Usually the better quality is in PAL (Phase Alternating Lines), the standard for television broadcasting in Europe and other countries. It consists of 625 (25 frames) horizontal lines (Austerberry, 2002). Other, less superior, formats are: NTSC (National Television Standards Committee), the standard for television broadcasting in North America, and SECAM (Systeme Electronique Couleur Avec Memoire), a colour television system used in France and some other countries. It consists of 525 (30 frames) horizontal lines. These standards are also used in digital television quality (World Television Standards, 2004). In theory, video conferencing picture quality can be as good as a broadcast picture, but this requires a huge amount of bandwidth (bandwidth is the amount of space available on the network), which might not readily be available. Analogue video signals use a bandwidth of approximately 90 Mbps (Megabits per second), but this might not always be available or could be too expensive for potential users. A common way to reduce the use of large amounts of bandwidth is to remove any redundancy that might appear in the video. The bit rate for this represented signal can then be reduced. Typically, transmission of video is in the range of 112Kbps (Kilobits per second) to 2 Mbps. It is therefore necessary to reduce (compress or decode) the use of bandwidth.

Compression

Television broadcasts usually consist of broadcasting the complete signal of video and audio at the full frame rate of 25 fps (frames per second) (PAL). The broadcaster sends all of the information for each frame. This results in a "broadcast picture" which stands out because of its high quality. Movements are fluent and realistic because a series of 25 (or 30) frames are sent each second, creating the illusion of smooth motion (World Television Standards, 2004). In video conferencing, we could also send each and every frame. However, this is commonly regarded as taking up too much bandwidth. To reduce the amount of bandwidth, a common tactic is to only send information of each frame that has changed from the previously sent frame. For example, a person walks in the video picture from left to right, but the camera remains in a fixed position. The background does not change in any of the 25 fps, so after the first frame has been sent, any further information on the background is not sent (again) to the receiver. An additional method is to anticipate the movement of an object, which essentially remains the same in the video but changes position from frame to frame. The computer sending the frame only sends instructions on how to move the information it already has (the object). This is generally known as 'motion compensation'.

Further Reduction

A digital frame is a picture made up of a number of sections called 'pixels'. Each frame usually also contains a large amount of redundant information. For example, a background wall can be evenly painted in one colour. One pixel next to another of this background, although not exactly the same, will be very similar. The computer simply calculates the difference from pixel to pixel (lighting, colour, video noise) and only sends that information. This saves on transmission 'effort'. There are many reduction methods; for example, vector quantisation, scalar quantisation, arithmetic coding, statistical coding, Huffman coding and model-based coding (Duran and Sauer, 1997).

Video Compression Standards

A codec compresses and de-compresses the video across the available bandwidth. There are many different compression standards available in the world. These standards have been determined by the ITU-T (International Telecommunications Union--Telecommunication Standardization Sector), and can be viewed at:
http://www.itu.int/ITU-T/

These standards provide technology developers with some flexibility, while at the same time ensuring that codecs using that standard can decode the bit streams. Some of the most common standards in use for video conferencing are H.261, H.263, H.320 and H.323 (ITU Standards, 2004).

***B.* Audio**

A video conference without audio generally is not useful or acceptable. Audio has to be 'captured' correctly if the user wants to hear it properly. There are many factors to take into account when capturing audio. Often a lot of ambient sound is present, which we may not be aware of; for example, the regular drone of traffic, technical equipment hum, fans and air conditioning. These are the sounds that surround us, but do not bother us. Record it or capture and transmit it on television, and we notice it immediately. The main reason is that in video conferencing most information comes across in the audio; therefore, it is something we notice immediately. Microphones need to be sensitive yet sophisticated enough not to pick up the sounds of paper shuffling, coughing and the clatter of coffee cups and saucers. They need to filter out other ambient sound whilst still obtaining the best audio of the spoken word.

Echo Cancelling

For good communication to take place, audio needs to be continuously heard at both (or all) sides (full duplex). This means that speakers, as well as microphones, need to be 'operational' at all times during a video conference. This invites 'feedback' (sound reverberating and effectively looping through microphone and speakers), an unwanted complication that can be countered by the effective use of echo cancelling equipment. This is a problem that cannot occur with simplex systems, as the sound can only travel in one direction.

Audio Compression

For audio there are also some world standards (ITU H.320) similar to the video standards as discussed (set by the ITU). The most well known is G.711 for compressing 3.3 KHz audio to 64 Kbps. G.711 is the default audio encoding for video conferencing and standard telephone technology. G.711, also called Pulse Code Modulation (PCM), will be around for a while since it is the only default audio encoder used when two video conference systems share no other common audio standard.

Its only drawback is that it compresses from 48-64 Kbps. G.711 is also the standard that uses the least computation to implement, and therefore is particularly useful when processor power is scarce or prioritised for other purposes, such as video coding (ITU Audio Standards, 2004).

Design and Application of Video Conference Systems

The design and application of video conference systems are closely related. Desktop systems are designed with the specific purpose of connecting person-to-person from geographically disparate locations, and thus compact design is important. Group systems, however, are designed to link up larger groups of people. The equipment is to be either fixed in special conference rooms, lecture theatres or classrooms or is built on 'roll-about units' so that they can easily be put in place when required, and neatly be stored when the conference has finished. Modern IP video conference systems now also come in the shape of a set top box, a unit that is reasonably portable, and plugs directly into a regular TV set or monitor. Although the systems use similar technology to link up with one another, the hardware, such as cameras, microphones and speakers, are quite different. Using these various pieces of equipment can present a challenge to many users (Shepard, 2002). A good system design will try to make all of the components that constitute video conferencing transparent; that is, the user does not need to know about them.

Desktop Systems

Desktop video conference systems are popular because they are generally much cheaper to purchase than stand-alone or group systems. This is because they are designed to operate with standard personal computers. As a consequence, coding equipment does not need to be purchased since the PC is perfectly capable of carrying out this task. This usually also means that desktop equipment design is small and/or portable enough to be carried around, so that it can be used on PC's and laptops. The camera is so small that it can be fixed on top of a monitor. Cameras are also available as built-in accessories in PC's and laptops. They usually have a fixed lens, which will capture an average 'wide shot'. This is enough to fill the screen with a close-up image of the person in front of the PC. The camera usually cannot be controlled (pan/tilt) by remote, as these features are costly to implement, although some can control cameras on larger systems. The image size will be seen on the computer screen, usually at a size of 240 x 320 pixels.

It can be enlarged to fill the computer screen and, although resulting in a larger image, the picture is merely ‘blowing up’ the 240 x 320 pixels. This is generally not an acceptable quality image. Some systems, like the Polycom ViaVideo, display the picture at 2/3 size of the screen. This is acceptable in most cases, as it provides enough detail to see facial expressions, gestures and movement. The microphone can be plugged in as an optional extra or an in-built microphone from the PC can be used (Polycom ViaVideo has a microphone built into the camera). The microphone is mostly omni-directional. This is not ideal as a lot of unwanted ambient sound is often picked up, but acceptable in most desktop environments. Standard PC speakers are used to provide the audio. The combination of speakers and microphone close together often invites audio ‘feedback’ problems, since echo-cancelling hardware usually is not part of a desktop video conference facility. It is, therefore, advisable to use a combination headset that combines speakers and microphone. This will avoid common feedback problems. Polycom ViaVideo bypasses this, at it has a built in echo-cancelling device, which stops any feedback from occurring. A popular bonus with desktop systems is the fact that some of the accompanying software allows multi-tasking. This is used for sharing documents (Word, PowerPoint, Database etc.) between the two participating sites. A drawback of these systems is that they usually cannot be involved successfully in multi-pointing (more than 2 locations) between other desktop units. Some multi-pointing data is usually not possible when sharing an MCU (Multipoint Control Unit) with other desktop or group systems using various brands of equipment. However, when using multi-tasking, such as application sharing, the transmission speed of video, audio and data, can be diminished to a point where all three media become unusable.

Group Video Conference Systems

Group systems are generally more expensive to purchase, but prices of some group systems have dropped between 50 -70 % over recent years. Video conference systems are designed to operate as stand-alone units. As a consequence, any coding and processing is carried out in the codec equipment provided. In contrast to desktop equipment, the group system design is larger and bulkier. This is due to the presence of sophisticated processing hardware, remote control systems, larger speaker units, remote control camera(s), document camera(s) and high-end microphone facilities.

The group systems normally are equipped with a remote control unit that enables the user to operate the camera, adjust volume controls, switch cameras, etc., but this can vary with different manufacturers' equipment.

Camera and Microphone Placement

Camera, microphone and monitor placement in effective group video conferencing design are very important as these will be the eyes and ears of video conference participants who are linked into the facility. Guidelines are available that address the correct placement for these (Video Conference Room Design 2004, Video Conference Cookbook, 2004; Duran and Sauer, 1997; Videoconference Facility Design, 2004; Fin et al., 1997).

A good system design tries to reflect the 'real life' situation as much as possible. At Monash University, Melbourne, the virtual Tea-room is a good example. Video projectors have been used to show the incoming pictures at life size. The ATM links are open 24 hours per day and so interaction, life size, takes place continuously. The University experimented with getting the camera as close as possible to the eye line, but this would mean placing a camera in the middle of the incoming data projection, which was not attainable. They have settled for a camera on a wall-mounted bracket directly below the video projection (CSSE Virtual Tearoom, 2000).

Point-to-Point Video Conferencing

The majority of video conferences taking place today are point-to-point (Video Conference Cookbook, 2004), meaning that only two parties are connected via video conference link. This is the simplest way of linking up. There is only one outgoing and one incoming picture. Audio only flows continuously between two locations.

Multi-point Video Conferencing

The use of multiple-site video conferencing is increasing. As users have become familiar with point-to-point links, they have realised its potential. It has become essential to the operation of businesses and the delivery of education to multiple campuses or remote areas. MCU's have been around since the late 1980s (ITU Recommendation H.140) and were further developed in the early 1990s (H.243 and H.231 approved in 1993) (ITU Standards, 2004).

The location of an MCU is important. If the MCU is part of an internal network then location generally is not an issue. Most logically it is put in a location (office or campus) that is close to the major communication infrastructure hubs and fibre optic cables. When the MCU is to be used outside the private network, location becomes an important consideration. If links are established through ISDN, then any caller ringing into the bridge will have to pay for the calls. It therefore is sensible to locate the MCU in a geographically central area, common to all links. The number of ports required is dependent on the size of the organisation and the number of locations it has, which can be linked in. It should be noted that with the introduction of multiple sites, the interactivity between these sites is becoming increasingly more complex to deal with (from an end user point of view). It is difficult to imagine a multi point video conference meeting with more than 5 to10 sites having a useful and interactive dialogue, but with proper management (for example, using a good convener) it can be done (AARNet, 2004). However, there are certainly situations where communication needs to go out to 20 to 30 or more locations simultaneously. Although interaction often is not required in such a 'broadcast type', communication can still be useful. (Technically, one would not need an MCU for a broadcast since there is no interaction between the sending and receiving sites). Switching in multi point video conferencing can be achieved manually with remote control panels, but today most switching techniques are automated with voice-activated switch control. Voice activated switching delivers the picture from the site that generates the highest, level of audio (Duran and Sauer, 1997).

Displaying Data, Images and Illustrations in General Video Conferencing

It is accepted practice in meetings, presentations, lectures and classrooms to use additional materials in the form of computer data, PowerPoint presentations, images, illustrations and even video. Usually a document camera is used to display pages of printed material, photographs and illustrations. This image can be selected as the outgoing image so all parties can view them. In the case of digital images already stored in a computer, the images can be imported and displayed on a PC. By having a PC input as well as additional camera inputs such as a document camera, the PC input can be selected and the video image sent. Problems can occur here, as picture quality often is not acceptable. Duran and Sauer (1997) argue that this is not always successful when linking up at slow speeds using ISDN (128 Kbps or less).

Video used at these speeds, does not provide the clarity required to see detail, especially when small print is being used. Transmitting the image as motion video consumes substantially more bandwidth than would be needed to transmit a single still image (even a higher resolution still image). It is more useful to transmit a single image instead. T.126 defines the protocols and primary modes of data conferencing, sharing still images, and annotations. Today T.120 is a standard often used in data collaboration; however, other methods are appearing, especially in the IP based systems. File transfers are another way of getting the information across. T.127, Multipoint Binary File Transfer (MBFT) sets out the protocols and application services for regular file transfers. This is more often done at desktop systems. Students and teachers increasingly are using additional digital media in the desktop video conferences (Yates, 2003).

2.2 Streamed Video Systems on the Internet (IP)

As opposed to standard, high end, digital video conferencing on ISDN and/or ATM networks, video conferencing is also used more frequently On-Line. Internet video conferencing has been around since 1990. Ever since low-cost video capture hardware and audio input and output became common on desktop computers, people have tried using the same network they use for other communication to carry these continuous media (Casner and Deering, 1992; Huitema, 1992). The Internet of the early ’90s was not suitable for video conference traffic. Significant functional enhancements to the original architecture was needed to make video conferencing attractive. Bandwidth availability determines the reliability and quality of On-Line video conferencing as without it video conferencing over IP can not exist. With the continuous improvement of bandwidth availability, there is a natural progression towards the convergence of traditional video conference systems with On-Line systems. Barr (2000) argues that Australia's media, information technology and telecommunications are in a state of unprecedented change. The convergence of streaming video and video conferencing represent such a change. These developments concentrated on designs that are transparent to the end user. In order to look at systems adapted and/or designed for On-Line use, we need to have a close look at the communication technology involved.

The technology is better known as “streaming video”. Streaming video is the single most cost-effective multimedia solution one can add to web pages (Shin et al., 2004). Not only does it have the potential of having the same media impact on end users that broadcast media has, it can also provide the type of visual media experience which can keep visitors at a particular web site. Streaming video has much in common with video conferencing, as much of the coding started with H.261 and H. 263, but there are differences.

Austerberry (2002) states:

> *Video conferencing demands very low latency so that natural conversations can be held; for web casting the propagation delays and processing latencies are not so important – if it takes 3 or 4 seconds for a live web cast to arrive it is of little concern. Another difference is the connection. Video conferencing is peer-to-peer between at least two participants. In contrast, web cast streaming is server-client.* pp.130.

The most commonly used form of streaming video is over the Intranet. Desktop video (and audio) is evolving in the form of streaming media and has great potential, but is still resource intensive, due to the limitations that many students still have through copper wire at home (Yates, 2003). In order for a video on the Internet/Intranet to “stream” the signal needs to be “reduced” or encoded so that it can be transported on the bandwidth available (Austerberry, 2002) and (Shin et al., 2004). Encoding existing video resources or live presentations can occur in a variety of formats; for example, Real Video, Windows Media, AVI, MPEG, QuickTime, Cisco IPTV and other systems.

Streaming Video Bandwidth Requirements

Streaming video quality and reliability is dependent on the process of encoding for transmission and the amount of bandwidth required for it to be viewed adequately. It can be custom-designed to fit end user needs and is usually encoded as streaming video for delivery over the Internet at a minimum of standard 28.8 or 56Kbps modem speed since most users are connected at these speeds. As throughput is increased, the frame rate and picture quality also increase. To digitize a video so that it will stream at high speed, a high degree of compression is applied to both the video and audio tracks.

This process degrades portions of the audio and video data, which is why most videos and video conferences On-Line don't appear or sound as clear as the original (master) video picture (Shin et al., 2004). Streaming video that is being prepared for transmission, specifically over a corporate Intranet, can actually be encoded at even higher speeds as long as the network is not suffering from internal bandwidth constraints. The higher the speed of encoding, the higher the audio and video quality is. Less compression is used and a smaller amount of audio and video data is lost. As a result, these video files are larger in size and require the faster connection speed to be seen. There are a substantial number of users worldwide who connect to the Internet using high-speed bandwidth alternatives such as cable and ISDN modems, DSL (Digital Subscriber Line), ADSL (Asymmetric Digital Subscriber Line), dedicated T-1 access or satellite dishes. The growth of these high-speed connection alternatives has eclipsed standard 28.8 and 56 modem connections (Cybertech, 2004).

Format

Trying to choose whether you should have a video encoded in Real Video, Windows Media or any number of other formats can be difficult. Real Video and Windows Media claim to have over 100 million of their viewer plug-ins already in distribution and use. Additionally, well over 10,000 people are downloading each of these streaming video plug-ins each day (Cybertech, 2004). To solve their format decision dilemma, web sites take the approach of having videos made available in multiple formats. By using this approach, a larger number of visitors to the web site will already be prepared to watch the video without having to download a plug-in first. The video streamed file itself is not stored on the local PC.

Convergence, Integration and Combining

The real power of video systems as described above is that, although they generally work best on an Intranet network, they can also connect to the Internet simultaneously. It also combines live broadcast video, archived video and video conferencing. For example, a live video conference between two sites (using high end video conference equipment and links such as Intranet, Internet2, LAN, WAN, ISDN or ATM) can be linked through an MCU. From this MCU there is a connection to a web-streaming server that in turn is connected directly into the communication network (for example, OPTUS or TELSTRA).

Anyone on the Internet (with the appropriate software/viewer installed on the local PC) can join the video conference (as a viewer only). Software allows end users to type in questions and/or comments to the broadcaster when 'live'. The broadcaster sees all typed responses appear on a computer screen and can respond for every one to see.

NetMeeting

Video conferencing on the Internet is gaining in popularity. Equipment required is inexpensive and easily installed on a standard PC. The software used to make video conferencing across the Internet accessible to all Internet users is freely available from the Internet. Microsoft NetMeeting allows users to link up audio and video simultaneously in a point-to-point meeting. Although initially used for cheap telephone calls, it quickly acquired fame by being the first readily available software. While it is not truly H.323 based, it will connect to this standard and create the illusion of true H.323 standard IP video conferencing. NetMeeting is also used for data application sharing, although often not successfully in tandem with a video conference. Some users use two separate computers, one for desktop video conferencing and another for data application sharing via NetMeeting. Today, there is other dedicated web-conference software available that does a far better job of data application sharing, e.g. WebEx, Enterprise Care, Didasko or Genesys.

Other Video Conference Software/Hardware

Although NetMeeting is a very popular software application (and freely available), it is not the only one; there are many other software/systems too. For a listing of other systems see: http://myhome.hananet.net/%7Esoonjp/vidconf.html

2.3 Connectivity through Networks

Video conference systems need to use some kind of connectivity in order to communicate. This can be as simple as hard-wiring two systems together, but in order to do this, they need to be very close. This defeats the purpose of video conferencing, as it is more effectively used over distance; for example, a different office, another building, another suburb, a far away city and even a distant country.

Although the research described in this thesis concentrates on video conferencing over IP, we need to look at other existing connectivity, especially since IP can connect to most of these or make use of various such media. Furthermore we need to look at these, as it is likely that, at some stage, video conferencing over IP will impact on these connectivity's, perhaps even eliminate the need for them.

We will look at the following communication mediums that are used to hook up video conference systems:

- ISDN (Integrated Services Digital Network);
- LAN (Local Area Network);
- WAN (Wide Area Network); and
- ATM (Asynchronous Transfer Mode).

IDSN

Analogue telephone lines, Plain Old Telephone Systems (POTS), are only capable of transmitting at speeds of up to 33.6Kbps. The slow speed of POTS makes this medium virtually useless for video conference needs. The most widely available communication medium in video conferencing at the time of writing is still ISDN. ISDN is a standardised approach to providing digital service from digital telephones. It is also available in most of the developed world. ISDN is a basic medium that can be used to send digital information from point to point. It relies on telephone or communication companies across the world having installed adequate infrastructures to distribute ISDN in their regions. In many countries ISDN is available all the way into the home, office or desktop. Basic Rate ISDN (BRI) and Primary Rate ISDN (PRI) are widely available in the western world.

For group video conference systems, the traditional way to link up is by dedicated ISDN communication lines. These lines are rented from communication companies such as Telstra or Optus (Australia). The rented lines mainly come in two sizes:

a) 56 Kbps (DS0speed) and
b) 1.544 Mbps (DS1 speed, carried on T1).

- The lowest acceptable speed is 112 Kbps (2x 56 Kbps) and since this is within the capacity of two BRI lines these lines are commonly rented out as a Micro link (2x 64Kbps=128Kbps). The remaining 16 Kbps is used for in-band or out-band dialling and signalling.
- The T1 lines are rented lines of large organisations (e.g. business, education) and they are used for voice and data traffic (1.544Mbps).

The rental of a Micro link is the cheapest, but usually also the slowest way to establish a video conference link. T1 is significantly more expensive, but will deliver a much better quality transmission. When ISDN first was deployed, it was also considered the natural vehicle for streamed media (Austerberry, 2002).

LAN

Desktop video conference systems are sweeping communications development across the globe. This trend is the result of the extensive growth of the Local Area Network. The LAN made it possible to link up a desktop video conference system with another, as long as it was hooked up on the same LAN. Usually this occurred within the same organisation. Unfortunately, all LAN communication is “packet switched”, meaning that is not an extremely reliable medium to hook-up video conference systems (packets arrival times are highly variable and sometimes packets get lost on the way). Although international standards for video conferencing on switched circuits were developed (H.221, H.230), they do not perform well, especially on LANs. By linking the Gateway of the LAN system to a Micro link, it is possible to make calls from a LAN system to another LAN system, or to a standard system connected directly to a Micro link at 128Kbps.

WAN

Wide Area Networks (WAN) are LANs linked together to make a larger type of network. Not only are educational providers now networking offices and buildings on the same block, location or campus, they are also linking to and covering services with distant campuses and locations.

The following varieties of WANs are available:

- Switched 56;
- T1;
- ISDN (narrowband up to 2 Mbps); and
- BRI.

ATM

Asynchronous Transfer Mode (ATM) networks were considered (in early 1990s) to become the basic medium for carrying telephone traffic. ATM is based on the very rapid switching of packets (53-byte). It performs so well (as opposed to LANs), that it provides reliable video and audio virtual connections. It also has the advantage over IDSN that ATM only sends information when required, rather than making a constant bit rate connection (ISDN). It is sometimes also called Broadband ISDN. ATM was developed for High-speed packet transport over optical networks (Austerberry, 2002). ATM also transparently bridges the gap between WANs and LANs. ATM operates on data rates from 25 to 155 Mbps. Although ATM is expensive, its rates are dropping fast as communication providers realize that IP communications can be more cost effective. ATM was used extensively as a backbone and many educational organisations have implemented ATM as standard across the LANs and WANs. This trend is changing nevertheless, towards total IP based solutions.

2.4 Bandwidth

The successful display and refresh rate of digital video depends on many technologies working in unison. Many factors decide the quality and sound of digital video, but generally it is the availability of bandwidth that is the deciding factor. Bandwidth is the amount of space available on our networks (for example, LAN, WAN, ISDN, Satellite, Cable, and Internet). As more bandwidth is available, the more the likelihood that traffic that can flow faster (generally in both directions). It can be likened to a highway. A two-lane highway with a lot of traffic will get congested very quickly; however, expand those two lanes to four lanes and the traffic will flow without disruption. History tells us though, that the more roads that are available, the more we are likely to use them.

Without the appropriate bandwidth, networks will get congested and transmission of data such as digital video will not work properly. The global network is in its evolution: it is constantly changing and with these changes it will invite new applications. It will also make dial-up modems a thing of the past (Clark, 1999).

Within the next 10 years, it is likely that most people in developed countries will have access to Network connections that are hundreds of times faster than the ones in common use today. This will herald an entirely new stage in the evolution of that global network. Those high-speed connections to the home, whether they take the physical form of a telephone wire, a cable television line or a satellite link, will give rise to an entirely new set of applications. Not only will users be able to jump instantaneously from page to page on the World Wide Web, they will also be able to enjoy applications that exist today but are unattainable to the mainstream users (because of cost and infrastructure limitations). New applications that now are only concepts in the minds of developers will also be accessible. Real-time, synchronous hi-fi music, telephone, video conferencing and interactive television and radio programs could all be provided by a single service provider. There will be new entertainment options, such as movies-on-demand, with features such as deciding on a particular ending of the movie, selection of language, selection of camera angles and the ability to call up information about a movie's director or its actors, similar to what is available on some DVDs today. Users will be able to play on-line games in real time against many contestants situated around the globe. Virtual-reality experiences will become more commonplace. These developments are driving industry to build the infrastructure needed to bring high bandwidth, or "broadband," communications to the home. The Internet has seen a huge growth across the globe and therefore has attracted industry’s attention as a major potential network. Most users connect to the Internet using a dial-up modem, a device that converts back and forth between streams of data and patterns of audible-frequency tones, enabling the data to be sent down ordinary telephone lines. It does this at a maximum speed of 56,000 bits per second (56 kilobits per second, or kbps). At the other end of the line, an Internet service provider acts as a kind of central point through which the subscriber can contact and exchange data with countless nodes around the globe. Unfortunately, the performance of dial up modems is limited. In addition, the need to make and pay for a telephone call to establish a connection to the service provider means that access to the Internet is not continuously available.

Broadband networks, such as those provided by Optus and Telstra, are making big inroads with the provision of cable Internet and cable television. Although called broadband networks, in many respects this is only first generation broadband. Waiting times still occur when connected to the Internet and often upload speeds are limited. A new generation broadband will eventually appear, e.g. Internet2. Once these new style broadband technologies emerge, people will receive and send text, images, audio and video over the Internet at high speeds, with little or no delays. Indeed, the Internet will always be "there" perhaps at various screens in the home, accessible at the single click of a key or voice command. The technologies will bring a host of new data, multimedia, video and television services. And they will do all this at a reasonable price.

Connectivity

There are a variety of speed possibilities when connecting to service providers. The personal computer in an office environment is typically connected to others in the company with a local-area network (LAN). The most common, Ethernet, has a speed of 10 million bits per second (10Mbps), about 200 times faster than a 56 k modem. But unless a university or educational institution has a dedicated high-speed connection to an Internet service provider (ISP), the user's Internet experience is limited by the speed of a modem. Many companies and educational providers have high-speed connections, and many cosmopolitan users have broadband access, but very few other homes or small businesses have. Home users also do not usually leave their computer connected to their ISP all the time, with the exception of broadband users. This non-continuous connection has two negative implications:

1. when users want to use the Internet, they must wait while the modem connects; and
2. it is difficult to utilise all applications, such as receiving a phone or video call over the Internet, because the recipient cannot be contacted if he or she is not on-line (unless a separate telephone line is being used and the connection is 'always on').

Ultimately, the need for broadband communications to the home will result from the ever-increasing speed of computers. This will not result in faster communications applications if users remain behind a dial-up modem, as 56 kbps is about as fast as a dial-up modem will ever go.

The assortment of older style wires and cables that run across the world between service providers, educational providers, businesses and homes, represents a barrier to high-speed operation. None of these links was intended for data transmission at any speeds, let alone extremely fast ones. There are four main streams of wires: Twisted pairs of copper wires to provide telephone services, coaxial cable to provide television signals, power lines to convey electricity and fibre-optic.

There are a number of approaches for connecting end users to high-speed data communications. Some use existing cabling, others use new technologies. The most common are: ISDN and ATM (mostly non-IP). Other technologies that are IP capable are:

1. **Digital Subscriber Line (DSL, ADSL, etc.)**
2. **Hybrid Fibre/Coax (HFX)**
3. **Fibre Optic**
4. **Local Multipoint Distribution Services (LMDS)**
5. **Satellite**

There is no single, simple approach to compare these five broadband technologies. It would be nice to rank them on comparative speed, for example, but almost all of them are capable of operating over a range of speeds, depending on how they are actually implemented. By considering the key features of each, we can make reasonable judgments about possible answers to some of the fundamental questions, such as:

- Will one technology win out over the others?
- Will several compete?
- Will broadband service be more affordable? and
- Will broadband be available to anyone?

It is certain that powerful industry forces, often economically driven, will settle these issues well within the next ten years.

Digital Subscriber Line (DSL)

Conventional copper telephone wires have been installed in more than 600 million phone lines across the world. They are being used for conventional telephone calls, but also to connect to the Internet with standard 56 kbps modems. A speed increase fifty times faster than these conventional modems can be achieved using new telephone technology called digital subscriber line (DSL) and cable modems. This is much faster than dialup modem. DSL is even usable for some video applications (Austerberry, 2002).

The capacity of a communications channel depends on its bandwidth (the range of frequencies it uses) and its signal-to-noise ratio (which depends on the quality of the connection).

The Shannon-Hartley Theorem

The capacity of a communications channel in bits per second is given by:

$$C = B \times \log_2 (s/n + 1)$$

C is the capacity

B is the frequency bandwidth of the channel in Hertz

s/n is its signal-to-noise ratio.

It is physically impossible to exceed this limit (Hawley, 1999).

DSL operates over conventional phone lines, but achieves a higher data rate using different electronics at the ends of the wire. The twisted copper pair from a home typically runs to a local building (a central point) where it connects to a switch. A switch is a complex piece of equipment that routes telephone calls to other switches or phones as required. Most of them were designed only to carry voice and have no special options to handle high-speed data. Dial-up modems work only because they implement coding schemes for data that the existing switches can carry. DSL is much faster because it does not use the existing switching equipment. New switches are installed in the central office to exploit the full data-carrying capacity of the wires, which normal phone calls simply cannot use. There are several different versions of DSL, depending on the distance from the user end point to the central point. There is DSL, ADSL and HDSL.

xDSL

xDSL refers to different variations of DSL, such as ADSL, HDSL, and RADSL that are available today. At present an end user must be within about five kilometres of the central point to make use of a DSL service and may be able to receive data at rates of up to 6.1 megabits (DSL and xDSL, 2004). The most widely developed version is asymmetric DSL, or ADSL. It is capable of delivering 3 to 6 Mbps to the home (download) and a slower rate back from the home (upload), typically a small fraction of a megabit per second. It was originally intended to send entertainment video to the end user. Because this generally is a one-way street (traffic only flows to the end user), most of the sub channels were devoted to “downstream”, at about 6 Mbps and about 0.6Mbps flowing back to the central point. Currently, ADSL is mainly used for browsing the World Wide Web. It is increasingly used in households that are in areas that cannot be covered by standard broadband cable. It is an ”always on” Internet access system, which operates at several hundreds of kbps over standard phone lines of up to 5 kilometer long. Because ADSL uses frequencies higher than the voice frequency band, that same telephone can also carry voice traffic simultaneously.

HDSL

High-bit-rate version of HDSL can transmit at nearly 800Kbps over a distance of up to 4 kilometres. Even eight million bps (mbps) has been achieved on a distance of 1.6 kilometres (DSL and xDSL, 2004). This technique divides the overall bandwidth of about 1 MHz into 256 sub channels of about 4 KHz each. Unlike the standard DSL no additional voice traffic can take place, using HDSL. A global standard has been set for DSL. This is called G.lite (DSL and xDSL, 2004). The uplink speed and the downlink speed of DSL are not equal. The reason for this is that DSL can deliver content fast. Downlink speeds are higher, designed to bring content to you quickly. Uplink speeds are designed more for email and small file transfers.

SDSL

SDSL (Synchronous Digital Subscriber Line) is a type of DSL circuit that provides the identical up and download rates. This speed increases the overall consistency and speed of the Internet connection. SDSL will be available in some areas where ASL or ADSL cannot because the distance required from the location to the provider is longer.

It is usually more expensive, as the overall performance is better than ADSL. Because of this, SDSL is more suited to businesses that can afford it.

A DSL Summary Table:

DSL Type	Description	Data Rate Downstream; Upstream	Distance Limit	Application
IDSL	ISDN Digital Subscriber Line	128 Kbps	18,000 feet on 24 gauge wire	Similar to the ISDN BRI service but data only (no voice on the same line)
CDSL	Consumer DSL from Rockwell	1 Mbps downstream; less upstream	18,000 feet on 24 gauge wire	Splitterless home and small business service; similar to DSL Lite
DSL Lite (same as G.Lite)	"Splitterless" DSL without the "truck roll"	From 1.544 Mbps to 6 Mbps downstream, depending on the subscribed service	18,000 feet on 24 gauge wire	The standard ADSL; sacrifices speed for not having to install a splitter at the user's home or business
G.Lite (same as DSL Lite)	"Splitterless" DSL without the "truck roll"	From 1.544 Mbps to 6 Mbps , depending on the subscribed service	18,000 feet on 24 gauge wire	The standard ADSL; sacrifices speed for not having to install a splitter at the user's home or business
HDSL	High bit-rate Digital Subscriber Line	1.544 Mbps duplex on two twisted-pair lines; 2.048 Mbps duplex on three twisted-pair lines	12,000 feet on 24 gauge wire	T1/E1 service between server and phone company or within a company; WAN, LAN, server
SDSL	Symmetric DSL	1.544 Mbps duplex (U.S. and Canada); 2.048 Mbps (Europe) on a single duplex line downstream and upstream	12,000 feet on 24 gauge wire	Same as for HDSL but requiring only one line of twisted-pair
ADSL	Asymmetric Digital Subscriber Line	1.544 to 6.1 Mbps downstream; 16 to 640 Kbps upstream	1.544 Mbps at 18,000 feet; 2.048 Mbps at 16,000 feet; 6.312 Mpbs at 12,000 feet; 8.448 Mbps at 9,000 feet	Used for Internet and Web access, motion video, video on demand, remote LAN access
RADSL	Rate-Adaptive DSL from Westell	Adapted to the line, 640 Kbps to 2.2 Mbps downstream; 272 Kbps to 1.088 Mbps upstream	Not provided	Similar to ADSL
UDSL	Unidirectional DSL proposed by a company in Europe	Not known	Not known	Similar to HDSL
VDSL	Very high Digital Subscriber Line	12.9 to 52.8 Mbps downstream; 1.5 to 2.3 Mbps upstream; 1.6 Mbps to 2.3 Mbps downstream	4,500 feet at 12.96 Mbps; 3,000 feet at 25.82 Mbps; 1,000 feet at 51.84 Mbps	ATM networks; Fibre to the Neighbourhood

Table 2.1 Speed scale (DSL and xDSL, 2004).

DSL Technology	Uplink	Downlink
DSL	90-680 Kbps - 1.5 Mbps	640 Kbps - 1.6 Mbps
Residential ADSL	90-680 Kbps	1.5 Mbps
Commercial ADSL	1.1 Mbps	7.1 Mbps

Table 2.2 Simplified table speed comparison, main DSL forms

	Cable	ADSL	SDSL
Target user group	**Domestic** General Internet.	**Domestic** General Internet	**Businesses** Sharing information between PC's. Hosting Web servers.
Advantages	Fast download speeds. Affordable.	Fast download speeds. Relatively inexpensive.	Very reliable. Fast upload/download speeds. Good bandwidth.
Disadvantages	Slightly unreliable Shared connection in local area provides a slow connection.	Relatively unreliable (interrupted services) Slow upload speed.	Expensive compared to domestic services.

Table 2.3 Simplified Internet access comparison

<u>DSL Evaluation</u>

Positives

The technology uses existing copper telephone wires, which will make it available anywhere in the developed world at approximately 70% of phone lines. ADSL uses minimal power and thus is cheaper to run. The system, being on cable modem, is designed to be "always on", a feature very much in demand. Additionally, the line signal is dedicated to the user, not shared with other users. ADSL (backbone) can carry composite signals for a few hundred users at 155 Mbps. This, combined with all above positive reasons makes DSL a cheap option compared to other services.

Negatives

The technology only works well within a short distance of 5.5 kilometres. As central points of telephone companies often are much further apart than 5.5 kilometres, this is very limiting to most users. The line quality affects the quality of the signal greatly. This can be a problem in the case of lines with very old wiring.

As even telephone wires do not reach all country areas, these cannot be covered adequately. The operating speed of 1 - 6 Mbps is considered slow for video conferencing purposes and as such the application for video can be poor. An acceptable bandwidth for H.323 video conferencing is 128 Kbps - 384 Kbps at 30 fps. The problem is that DSL can accept the download within its specifications, but cannot upload at this required speed. Additionally, many other local users are constantly sampling and readjusting bandwidth and frame rates based on the locally applicable congestion. This usually results in very poor quality including serious audio and video frame loss. A common solution is to choose a lower call speed of 128 Kbps at 8-15 fps.

HYBRID FIBRE/COAX (HFX)

The cable TV industry developed a coaxial cable network in order to offer television services, usually referred to as cable television. This industry soon discovered that its technology could also be used to support other services. It also realised that it had to upgrade additional equipment in order to meet the delivery standards of these added services. These services included Internet and telephone, but later also other data such as video services. The introduction of fibre-optic cables presented another upgrade to the industry. Fibre-optic lines were laid from key signal distribution points to main residential areas (as backbone). From there the conventional coaxial cable was used to distribute the signal to the homes in a serviced area. By using fibre-optics as backbones only, the cable companies spent far less than would have been necessary to replace the entire network with optical lines (Medin and Rolls, 1999) Nevertheless, even this partial use of optical fibre improved the television signal while making it possible for the network to carry two-way Internet and telephone traffic. End user must have a cable modem. The capacity of an HFC system is considerable. Just one of the many television channels offered to subscribers can carry almost 30 Mbps to the end user. It is also possible to allocate multiple channels for broadband Internet. Cable TV operators in Australia are mostly using HFC to deliver their content to subscribers. In an HFC system the data channel is shared among other neighborhood homes linked by coax to the end of the local fibre-optic line with a stream flowing at 40 Mbps. Thus, the actual data rate achieved in any individual home depends on the number of users sharing the channel at a given time. On a good day, the system can download data from the Internet at speeds of around 10 Mbps.

There is also a lower-speed channel to upload data from the home back to the Internet. Cable modems are designed as an “always on” connection of the service provided. Communicating using a TV cable allows users to view information on a PC screen as well as on the regular television. Eventually this will allow users to move seamlessly from television viewing to data access.

HFX EVALUATION

Positives

Fast access at 10 Mbps is good for viewing most desktop video conference systems: it is also very good for receiving streamed video and audio. The “always on” availability makes use of existing technology and will eventually allow seamless switching between television and data. Cable television providers already have lots of connections at user locations. HFX will allow seamless switching between TV and data, which will attract customers.

Negatives

Country areas are hard to service as HFX is not available there. The limited access in country areas will limit the market. Cable modems can cost around $600 - $1000, a costly option for users. Higher cost of both access and cable modem could drive customers elsewhere. Many users in the same neighbourhood will reduce the speed of service. This is more noticeable in the upload part, as this often is restricted to 256 Kbps (shared). This is a big problem, especially for video conference applications, as it can never be guaranteed that only one user is using the uplink capacity.

FIBRE OPTIC

Fibre-optic cables are now commonly replacing the old style copper backbones on networks across the world. The capacity of fibre-optic cables is so huge that it can handle all types of communication signals at the same time; for example, Internet, television, telephone, video conferencing and video-on-demand. The signals are sent as a beam of laser light, through a fibre. Because of the optical qualities of the fibre, the light can follow the twists and turns of the strand, coming out the other end (nearly unaffected) where it can be detected and converted to an electrical signal.

The laser is turned on and off at a rate of billions of times a second, generating a pattern of light pulses that correspond to bits. The bits in data, audio or video traffic are sent through fibre-optic cables as brief pulses of light. A pulse is a value of one and the absence of a pulse equals zero. Between splitting the wavelengths of light into a hundred or more channels, and making each pulse millionths of a second or less, standard fibre-optic lines now typically run 2.5 billion to 10 billion bits (2.5 gigabits to 10 gigabits) per second. Faster ones -- 40 gigabits to 3.2 terabits per second -- are now in the pipeline (Wired News, 2003). Fibre-optics are used as backbones with cable television companies (cable-to-the-kerb). A logical step would be to extend the fibre all the way into the user location (fibre-to-the-home). This would eliminate the problems encountered when a lot of users in the same area slow down the performance of that area (bandwidth sharing). Unfortunately, the cost of installing fibre-optics "all the way" is currently expensive. The cost to bring optic-fibre to a user location is approximately $2400 per location (including equipment at user location). This is too expensive for Australian suburban conditions. Fiber to the home is being rolled out in densely populated areas only, in Europe and the USA. As distance is not a limiting factor in fibre-optic technology, it is suitable to cover large distances in country areas (Shumate, 1999).

FIBRE-OPTIC EVALUATION

Positives

Fibre-optic cables can transmit more data than any other service. It is by far the best communication channel available today. Far-away areas, as well as Metropolitan areas, can be reached without affecting the quality of the signal. Fibre-optics can bring many services to the home, office or educational institution. Video conferencing across IP would be ideal using this medium.

Negatives

Currently the costs for setting up the infrastructure and services of fibre to-the-kerb or to-the-home are prohibitive in Australia. The large outlay for service providers will result in high running costs for most end users.

LOCAL MULTIPOINT DISTRIBUTION SERVICES (LMDS)

LMDS is a broadband system that is wireless. It uses a radio signal of very high frequency (28 Ghz on the 1.3 Ghz bandwidth). The wave band that can be used varies greatly in different countries, as it is regulated by licensing regulations (it can range from 2 to 42 Ghz). Like a cellular telephone network, LMDS uses radio connections from a base antenna to receivers at user locations. This allows for data transfers of up to 155 Mbps. This makes it suitable for all kinds of data transfers, such as telephone, Internet, television, video on demand and video conferencing. Recent upgrades in the improvement of performance from technologies such as advanced modulation systems, gallium arsenide integrated circuits and digital signal processing mean that sending digital signals at a complexity of 28 Ghz is therefore now possible. It is also more practical as the costs of manufacturing these components have come down considerably (Skoro, 1999). LMDS is a technology that does not require the conventional infrastructures of cables and wires. It is a technology that any new communication company can deploy quickly and relatively inexpensively by utilising existing cellular communication towers. The wireless cells cover geographic areas ranging from two to five kilometres in radius. LMDS radio signals only travel in straight lines, so it is important that antennas at user ends are within line of sight. Unlike cellular phones therefore, it is not an ideal medium for “mobile” users. It is envisaged that antennas on the roofs of user locations will receive the signals and process them within that fixed location. LMDS systems generally send data using ATM. This allows various high quality services (for example, voice, television, Internet, video on demand, video conferencing and data) to run simultaneously.

LMDS EVALUATION

Positives

LMDS can be deployed quickly and relatively cheaply compared to other broadband services. This will make it a cost-effective system for end users as well as broadband service providers.LMDS can easily be used to complement other services; for example, it could be used in DSL services to provide links to country areas. It can also reach other areas not covered by cable television companies or fibre-optic networks.

Negatives

The radio signal of LMDS has some limitation in that its waves can only travel in straight lines. Large objects, such as hills, buildings and bridges will therefore block the signals. Another limitation is that the radio waves cannot easily penetrate dense moisture; for example, rain will affect performance, as will trees with a lot of foliage. High-density metropolitan areas with many "obstacles" will pose a serious problem.

SATELLITE

Satellite services are the most technically advanced today. They are not necessarily the fastest and could also turn out to be the most expensive. With satellites having an unobstructed view of the entire globe, satellite services are in the position to deliver broadband data communications in the most dense and remote areas. The data rate, however, is only a mere 300 Mbps. That is slow compared with other vehicles of data transfer.

Current Satellites

Current communication satellites orbit the world at very high levels of about 36,000 kilometres. They are geo-synchronous satellites, meaning, they orbit the world at such speed and height that they appear to be stationary over one geographical spot. The result is that they appear to be fixed in the sky with respect to receivers on earth. At user locations a dish needs to be aimed accurately at the satellite position for communication to be established. Geo-synchronous satellites are not really suitable for heavy broadband interactive traffic. Because they are very high up in the sky, there is about a quarter-second delay in sending a signal up and back. This affects the performance of any interactive services. The long distance that needs to be covered by the signal also means that the transmitters have to be extremely powerful, making it expensive to operate.

New Generation Satellites

In the year 2002, the first of a new generation of satellites was launched into space. They are called LEO (Low-Earth-Orbit) satellites. As the name implies, these satellites orbit the world at much lower altitudes of below 1600 kilometres. LEO satellites pass by overhead instead of appearing fixed in the sky (approximately two hours per orbit).

The plan is to launch many such satellites (approximately 400) into orbits and enable them to communicate with one another. This means that there is always one within reach of the user location (Norcross, 1999). A user can communicate with a LEO satellite close by which, in turn, relays its data to another satellite. End users need to install a small antenna so that signals can be received and sent. It is also possible to have mobile users in remote areas or even in cars. LEO similar systems are already in place; for example, the Iridium system by Motorola. Very small aperture satellite antennas (VSAT) offer one-way and two-way links to the Internet. In North America the DirecTV satellites offer a data service called DirecWay. A similar service is offered in Europe and Asia (Austerberry, 2002).

SATELLITE EVALUATION

Positives

The most positive reason for using satellites is that they can reach locations all over the world. Third world counties could select satellite systems for their communications as no infrastructure (such as cable networks) needs to be built on the ground. This could be a cheaper alternative to cable networks. Because of low orbits there is no significant delay in signals traveling back and forth, so communication is fairly instant without delays. It also means that small transmitters can be used, resulting in the need for smaller antennas. The satellite can process 300 Mbps, which is good for video conferencing.

Negatives

The high cost of putting the LEO satellites services into place could result in high end user costs. End users may have to pay approximately $1500-$2000 for a satellite receiver and transmitter. The uplink to such satellite systems may not always be possible, depending on available equipment, and in some cases will be extremely slow.

Speed comparison broadband systems

System	Description)	Data rate
Digital Subscriber Line (DSL)	High frequency on copper phone lines	**3 - 6 Mbps**
Hybrid Fiber/Coax (HFX)	Part copper part fibre-optic cables	**10 - 30 Mbps**
Satellite	LEO satellites orbiters	**300 Mbps**
Local Multipoint Distribution Services (LMDS)	Radio transmitting from towers	**155 Mbps**
Fibre-Optic	Cables	**2500Mbps**

Table 2.4 Speed comparisons various broadband systems

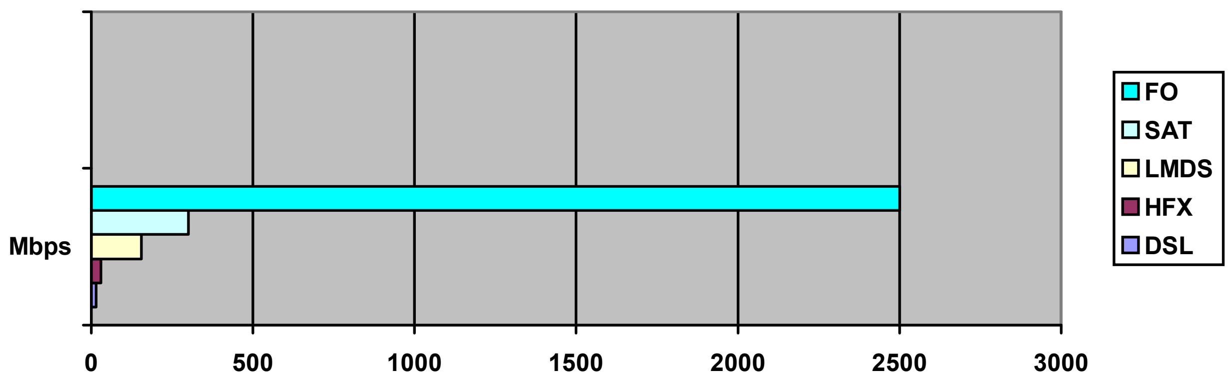

Figure 2.1 speed comparison broadband systems

2.5 IP

IP is the network level protocol used in the Internet and other computer networks. There is a growing tendency to run data, voice and video over IP. Initially, this occurred with LANs and WANs, but increasingly this is occurring outside these 'private' networks. Running data over IP is not new, but effective voice and video communications using IP is. This thesis will look at video over IP and make references to Voice over IP (VoIp) only where the technologies are converging.

During the research described in this thesis it became clear very quickly that the backbone of many of the new technologies is considered to be broadband IP. The rapid change to broadband IP networks is a fundamental challenge for most telecommunication providers. This is partly because of the various other options telecommunication providers have to consider; for example, wireless, DSL, satellite and fibre-optic cable. Although ISDN for now still remains the mainstream for video conferencing in business and education, standard Internet is being challenged to send large files, applications, streaming audio and video. Without access to broadband communication technologies, the Internet is a poor medium and the result is often poor performance, bottlenecks, lost data, inefficiency and low quality. Broadband IP is a significant improvement on this performance. Most of the Internet uses IP version 4, which has been around since 1981; however, it is showing its age and IP 6 is now offering better solutions (Austerberry, 2002).

Video over IP

Video over IP has been around since approximately 1996. Its use has been somewhat hesitant. A lot of organisations were lured into adopting the early (LAN) video conference systems, but often were disappointed with the results. This was for a number of different reasons, such as network restrictions, not enough bandwidth availability and the use of various standards such as H.320, which was not entirely supported throughout the different networks. However, the adoption of the H.323 standard for video conferencing has made a large impact on the technology. The H.32x family of standards (ITU) handles multimedia communications. This family includes H.320 (communication over ISDN) and H.324 (communication over switched circuit network - SCN). The H.323 standard came about in late 1996, aimed at the emerging multimedia communications over LANs. The standard has since been revised to include voice-over IP (VoIP) and IP telephony, as well as gatekeeper-to-gatekeeper communications. Other data communications that involve packet-based networks (these networks include IP-based networks like the Internet, Internet Packet Exchange (IPX) LANs, and WANs) are also included (VideNet, 2003). Video over IP is driven by the need for Internet providers to develop new sources of revenues. The creation of affordable broadband networks is also stimulating and encouraging the use of more demanding technologies such as video. Video streaming, video conferencing and voice over IP are set to become the three major players for ISPs and ASPs.

As the above-mentioned applications are all using networks that require broadband technologies, there are a number of companies that now concentrate on delivering video conference networks or video-on-demand networks, as this seems to be profitable. Connectivity and speed are of importance to all applications. Broadband networks therefore will remain in demand, specifically since more bandwidth is still not enough, as applications are further developed and thus become more bandwidth hungry. For example, Wire One, a new ASP, is researching and developing its own video over IP network called Glowpoint. It is, at the time of writing, the largest video application service provider in the world. It provides a full range of video, voice and network communication solutions to clients in the USA. VTEL is another company that recognized this trend and is now also moving toward delivering APS. There are many other companies moving in this direction. Additionally, companies like Polycom and Tandberg are delivering good IP Video technology systems that work on standard IP networks. These are video conference systems designed for the professional desktop user and they retail for approximately AU$800 (Polycom) or $1500 (Tandberg). It is more expensive than the home user web-cam which costs between AU$70 and AU$200.

Why IP?

IP brings together voice, image and data in a synchronized manner. Although IP was initially designed to handle only data packets, the industry has seized the opportunity to make it handle voice and image, mostly in a proprietary form. Although voice, image and data have been used in networks, they have mainly existed as separate entities. IP technology makes it possible to converge all of these media in a new technology, without losing some of the advantages of packets. There are other advantages to IP.

ISDN	IP
Errors can cause calls to fail	Packet loss usually does not effect the connection
Approximately 30 seconds to connect	Approximately 3 seconds to connect
High usage cost	Low usage cost
Modem required for support	Internet browser will suffice
International calls high in cost	International calls low in cost
IMUX codes used for connection	IP address used for connection

Table 2.5 Comparison ISDN versus IP

Where is IP going?

IP will enable users to access application/service based networks rapidly and individually. Access to content will be almost instantaneous, given that broadband is used, and it will change the way we live, work and play. Barlow et al., (2002) state that eventually video conferencing (over IP) will be seen as adding value to other communication media rather than simply taking the place of in-person meetings. They also argue that video conferencing (over IP) will become as common as fax machines.

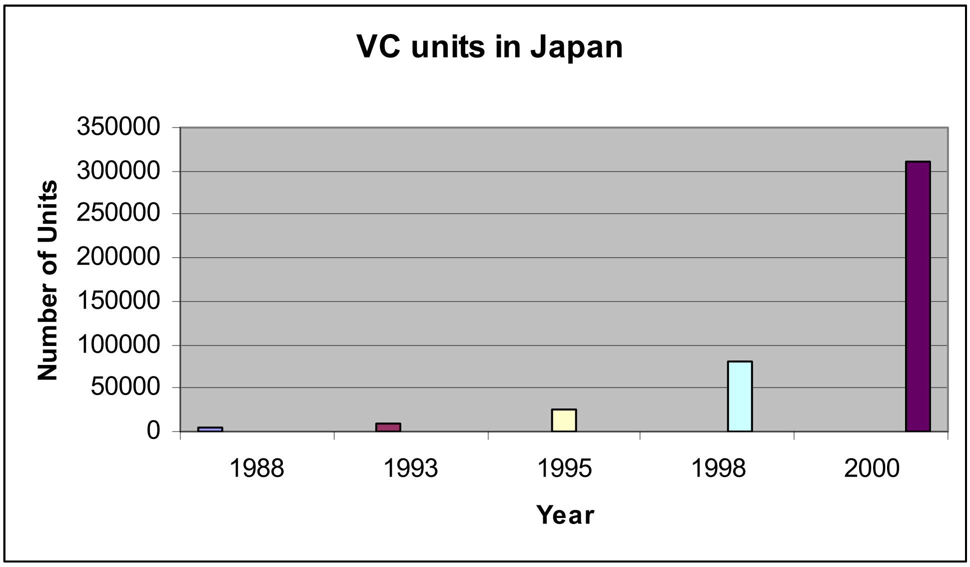

Figure 2.2 Growth of video conference units in Japan

The above figure represents the number of video conference units installed in Japan (Barlow et al., 2002).

IP technology will be available nearly everywhere we go. At work, home, in restaurants, cars, mobile phones, etc. Home security and home application control systems also will make extensive use of IP. Another application of IP technologies is the increase of tele-working. IP technology will increase the possibilities of working at home, linking to the main office for voice, video and data. There will be a significant increase in the number of workers who will elect to stay home to do work. Tele-working brings the office into the home. The following tables demonstrate the growth in the number of tele-workers in the UK and other countries.

Year	1997	1998	1999	2000
Home Tele-workers	225	256	255	312
Mobile Tele-workers	504	589	693	805
Occasional	285	301	357	477
Total (k)	1014	1146	1325	1593

Table 2.6 UK Tele-working statistics (Denbigh, 2000)

	Workforce %	Increase 98/99 %
Denmark	11.6	+20
Finland	10.0	+59
Sweden	9.0	+67
UK	5.5	+13
Germany	5.1	+53
France	1.8	+67
Italy	1.7	+40
Greece	1.3	+160
Spain	0.0	+50

Table 2.7 European Tele-working statistics (Denbigh, 2000)

Broadband is already in use around the world, but is not widespread everywhere (Denbigh A, 2000). Global bandwidth availability will increase over the next few years, but the change over to broadband IP will be gradual.

Convergence of Data, Video and Voice

Today we still do most of our communication through voice. Immediate voice-to-voice translation is now possible using digital technology.

If we look at the development of digital communication technologies, we can stage them in three waves:

- The visual Internet - first wave. Visual (digital) information on a PC
- The visual Internet - over the phone - the second wave
- The visual Internet combined PC/Phone

Following the Internet first wave, the second wave of e-business has begun. It combines the power of the visual Internet with the explosion of mobile communications. Broad based initiatives like WAP (Wireless Internet Protocol) herald an age of mobile Internet information. Handheld Internet devices download special WAP, optimised WML pages (Wireless Markup Language) for display on very small screens.

The visual Internet combined PC/Phone - using speech recognition - third wave

The spoken word, over the phone, can be used to search or retrieve Internet information - or connect us to individuals. Today the capabilities of modern speech recognition technology deliver promise. A new class of service provider, speech portals, is using speech recognition and text-to-speech technologies to deliver Internet services and messaging over the phone. The third wave of technology also delivers a combination of wave 2 and 3, where people speak into their phones to request information but the information is delivered back to them visually. This 'speech-in, visual out' holds great promise for many consumer applications that rely on visual presentations, like maps, graphic images, etc. The era where speech-activated services abound are connected into one global speech network and is captured by the phrase Open Speech Web (OSW). Like the WWW, the OSW will rely on browsers - in this case 'speech browsers' and speech links (instead of text-hyperlinks). With speech browsers, speech links and a vast corpus of speech activated content, users will 'speech surf' the OSW in the same way we now surf the web (Patterson, 2000). Voice XML is the markup language that describes the interactions between a caller and a server over the phone. Speech browser ™ and Speech links™ are VoiceXML based for cross-platform functionality and has speech recognition interfaces.

OSW allows the user to retrieve web-based information, send and receive email, purchase products and services, or simply just surf the web, all by speaking naturally into any telephone. The browser will track the sites previously visited by the caller and provides support for ‘hot word’ navigation. This is made possible by its three components: the Voice XML interpreter (provides http link setup and control), the SNAPS (Speech Navigation And Presentation Script provides URL history), and the speech recognition interface (also supports Text-To-Speech). The browser is available under Open Source, so requires minimal investment while it opens up a whole new world of Internet navigation, enabling a personalised caller experience, flexible integration, and porting to a variety of telephony platforms (Holthouse, 2000).

2.6 Summary

We can see that the technologies related to current communication technologies are very wide. There are many systems available, and lots of choices to make. There are many ways in which we can use all of these communication technologies. Some are effective and others are not. Some are useful and others are a passing trend. What makes all communication technologies bind together is the availability of bandwidth. This is the most important to the end user. It does not matter to them what occurs in a technical sense when communications are made. What matters to the end user is: does it work, and does it work fast? Technology should be transparent. The strong rise of communicating using IP technologies for data, voice and video is rapid and overpowering. The specific use of IP as a medium (educationally) is also dramatically on the increase. In 2002-2003, most Australian universities were informally trying to adopt video conferencing over IP as the new standard. This move to use video conferencing over IP occurred virtually overnight and was helped along by the involvement of AARNet (Australian Academic and Research Network) which plays a key role in providing the high-speed infrastructure amongst the universities. As IP is shaping up to be the delivery platform of broadband high-speed communication, it is an area that is identified as in further need of examination. As the technology is racing ahead, educational providers are finding it hard to keep up with new developments. Students are now demanding access to these technologies, as they see these technologies readily become available on the Internet. Educational institutions are rapidly implementing the use of these technologies.

Rather than re-invent the wheel, these institutions would benefit from cross-referencing experiences. This research is a step in that direction in that it provides an insight via case studies of how these technologies were implemented in an educational environment. It shows the processes, the success and the failures. Ultimately, it provides future users with some basis for a starting point.

Chapter 3. GLOBAL KEY PRACTICES OF VIDEO CONFERENCING

3.0 Introduction

An investigation into the effectiveness of implementing digital video conferencing over IP in geographically separate locations would need to look at past and present occurrences in the use of such technologies. Furthermore, it would need to include some future directions. It is essential, however, that this occurs with knowledge of the existing technologies as they have been applied up to this point.

Although video conferencing has been around for a number of years, IP video conferencing using the H.323 standards is relatively new. Little research has been conducted mainly because the standard of H.323 was not formally accepted until the late 1990s. As desktop video conferencing today relies heavily on this standard (but not entirely so, as other less robust standards are also used) it is useful to concentrate on the use of desktop video conferences in an educational context. The known research literature in this area will be considered where appropriate.

This chapter addresses questions pertaining to the following:

3.1 Educational use of video conferencing and video on demand
3.2 Australian key practices
3.3 European key practices
3.4 USA key practices
3.5 A brief description of other key practices
3.6 Summary

3.1 Educational use of Digital Video

The use of digital video in the form of video conferencing or Video-on-Demand initially took off in the business world, which first realised its huge market potential. The first, embryonic video conferencing systems were used in LAN accessible offices, but already businesses discovered WAN and ISDN and took video conferencing to the world.

Soon there were regular meetings between Head Office and regional counterparts, interviews, product roll-outs and customer briefings on the digital video conference networks (Pidsley, 1994). The use of digital video was not confined to the office. In 1994, a 384 Kbps digital video link was used in a series of auctions to sell deer in New Zealand. Bidders in the Telecom Bureau in Christchurch and other bidders in the Grand Hotel in Invercargill (both in the South Island) linked with Windermere Deer Stud, Hamilton, and Stanfield Oaks Deer Stud, in Cambridge, both in the North Island (Newby-Fraser, 1994). Education could no longer afford to stay behind; universities and other educational institutions also realised a potential use for using digital video: -Training. This was (and is) not always easy to implement. All tertiary institutions, whether they see themselves as being open and distance institutions or not, are grappling with the challenge of information technology in relation to the very core of the academic enterprise -teaching and learning, research and scholarship (Holt, 1995). Digital video can be used in a variety of ways. The terminology differs from each application; for example, video conferencing, tele-training, tele-education, tele-work, tele-meetings, tele-interviews and tele-medicine to name a view. Video conferencing today is used in all of these categories (Barlow et al., 2002). Desktop video conferences and small group video conferences provide real-time distance learning possibilities in many schools and universities (Yates, 2003). According to Shepard (2002), video conferencing is enjoying a significant uptake, and web conferencing is becoming a reality. To Lundin (1993) a clear way of thinking about useful applications is to see them in five clusters:

- **Education/training:** that is, active teaching and learning. With interactive technologies it is possible to import education and training to the learning setting (for example, classroom), as well as to export it (distance teaching). Furthermore, interactive technologies can empower learners to send as well as to receive and to initiate their own peer-to-peer self-help links.
- **Administration/management:** this includes meetings, interviews, briefings, project management, curriculum planning and development and courseware production.
- **Services:** support services from specialists for such things as guidance, health, legal, social, counselling, advisory assistance and emergency services.

- **Research:** data collection, cooperative action research, exploratory analysis, assessing and processing outcomes, many with a view to educational improvement.
- **Social/entertainment:** sports coordination, social interchange, games, family meetings, especially for special occasions and general entertainment.

The research in key practices presented here only focuses upon the educational/training aspects. The use of digital video in the classroom is a natural progression from previous technologies applied in remote teaching. The previous communication means that were used to link classrooms were mainly as follows:

1. Audio conferencing (POTS).
2. Audio-graphics (POTS).
3. MAC-FAX-DUCT (POTS).
4. Slow scan television, to deliver the instructor's image and voice via a separate audio network for use by students asking questions (POTS).
5. Video conferencing with separate audio lines for questions (POTS and ISDN).
6. Video conferencing/streaming (point-to-point and multi-point) (ISDN, IP).

This thesis mainly concentrates on innovative current applications of video conferencing and streaming over the Internet and IP. Key practices discussed in this research are so because they represent leading examples within their respective fields at the time of the research. Some data were collected via literacy review and correspondence. Other data were gathered by visiting on site the various locations discussed. The research is grouped as follows:

- Australian key practices.
- European key practices.
- USA key practices.
- Other key practices in other parts of the globe.

3.2 Australian Key Practices

An evaluation of the use of digital video (video conferencing) in Australian Higher Education (DEET, 1993) showed that in 1993, half of Australia's public universities (18 at the time) were using video conference facilities. Another 13 universities were in the planning process to purchase video conference facilities. The report estimated that in 1996 there were between 80 and 100 sites. Traditionally, it was the multi-campus educational institutions that had a high demand for such technology. It was seen to serve both education as well as administrative purposes. The pedagogical advantages usually attributed to video conferencing are its capacity for real-time interaction and the transfer of visual images (DEET, 1993). South Australian TAFE is a good example. It offers students at dispersed campuses all over South Australia a wider range of subjects than was previously possible. Lecturers spend less time travelling, although they rotate campuses in order to make a real-life appearance regularly on each site. The use of digital video conferencing in education is global, meaning, that it is open to international competition. Australians can enrol in courses delivered from overseas. For example, the National Technological University, Colorado, comprised of 46 contributing US universities and with over 100,000 enrolments, broadcasts regularly to the Pacific Rim, including Australia (James and Beattie, 1996). Synchronous interaction with this sort of digital video is very difficult because of the large number of participants involved.

Higher Education institutions in Victoria have been using various forms of telematic technology for several years. Implementation of telematic technologies has generally focused on its application for specific studies within courses and as a tool for delivery of curriculum (Hill et al. 1991). The reasons for implementation were a typical refection of what was happening across the entire Australian continent. Most Australian universities and many other educational institutions have used video conference facilities in some form. The initial users of video conference facilities tended to be institutions that had multiple campuses. With a large number of amalgamations and fusions of several educational providers, numerous multi-campus institutions were created. They all experienced similar problems such as isolation, distance, cost-effectiveness of travelling, and a spread of resources, (both human and equipment).

As a result, video conferencing today is used for a number of reasons; for example, administration, business applications, distance education, staff development, cross-sectored links, linking to overseas students and/or lecturers, research, seminars and conferences, student support, regional community education, interviews and staff seminars.

Victorian Education Department

The Victorian Education Department has a significant number of video conference units operational throughout country Victoria. They are being used to link up students from high schools and/or primary schools to give students access to subjects such as LOTE, Maths and English. Often class sizes in the country for some subjects are too small to justify allocating a teacher. By introducing the schools network to video conferencing these students can now join other small groups to make-up a larger class. Eighty-four schools in rural Victoria form a total of twenty clusters, which share teachers' expertise to expand curriculum options available to students. The Telematics clusters have for years used computers linked by modems, facsimiles and audio conferencing to create "virtual classrooms" enabling teachers from one school to conduct classes with students in other cluster schools (Arms, 2000). In 1999, video conferencing (H.320) was used in 54 of these schools. Some schools installed H.320 video conferencing for VET provision. Extension education institutes, such as the Melbourne Zoo, the Royal Children's Hospital and Taralye Early Intervention Centre (hearing impaired), use video conferencing to connect with remote students. Regional offices in Loddon Campaspe Mallee and Northern Metropolitan have also installed H.320 video conferencing. There are 56 subjects at VCE level via video conferencing (Arms, 2000). At the time of writing 38 Victorian government schools are using video conference technology (Sofweb, 2004).

The Telematics Project and the IP video conferencing project manager have been working together to plan professional development for teachers in the use of IP video conferencing (H.323) as a tool in the classroom. PLDC/ ITD/ Learning Technologies Project - there are now 10 activities on the Video conferencing Discussion Group available for use in training sessions, accessible via the Internet. PLDC has been involved with ITD/LT in creating these activities. CASES labs across the Victoria are being set up as training labs for video conferencing to train teachers (Arms, 2000).

South Australia TAFE

Video conferencing in South Australia TAFE has been in use since the beginning of 1990. It developed as a tool for connecting learners with other learners and their teachers. Class sizes are about 15-25 students on average. Frequently, three to four rooms are connected together to combine enough students for a class. Most of the rooms are very busy - the busiest rooms are in use for 1,500 hours per year (up to 45 hours for their busiest weeks). These rooms are connected to about 1,000 different sessions during the year. Overall, the utilisation adds up to about 16,000 hours of different sessions, most of which are provided to several sites simultaneously. Connection is through ISDN services, at 128 Kbps using OnRamp 2s. South Australia TAFE uses their systems for a wide variety of teaching purposes; for example, business studies, accountancy, languages, law, tourism, automotive studies, hospitality, horticulture and sign language for the hearing impaired. Currently, 30 sites are operational. In 2002, approx 20,000 hours were logged on video conference systems in their network. The TAFE institute is testing video conferencing over IP, but IT is experiencing network congestion problems. This is because their current network is not robust enough to handle the increased data traffic. The institute is hoping to revamp their IT infrastructure within the next three years at which time they will also move towards implementing video conferencing over IP (TLC, 2004).

Cental Queensland University

Central Queeensland University (CQU) utilises IP video conferencing to deliver over 120 hours per week of lectures to around 10 national and international campuses. An additional 10 hours per week video conferencing is used for administrative purposes. The university replaced their ISDN-based video conference infrastructure with a full IP-based infrastructure. The installation included a 100-port IP multipoint conference server, a 30-port IP to ISDN gateway, a gatekeeper, and 16 IP-capable room based endpoints. CQU now runs on average three concurrent daily multipoint IP video conferences at 768kbps, five days a week. Conferences are managed centrally and are scheduled to commence automatically at every hour. The lecturers control all of the video and audio sources. Every student sits in front of a microphone and the cameras automatically single them out when they speak. Future directions are to expand to desktop systems, self-scheduling and enabling call tracking and charging (QUESTnet, 2003).

AARNet (Australian Academic and Research Network)

The Australian Academic and Research Network interconnects Australian Universities and other Australian research organisations with each other, with the global internet, and with other national advanced networks as part of the global research and education network community. AARNet Pty, Ltd. (APL) is a non-profit proprietary company in which 37 universities and the Commonwealth Scientific Industrial Research Organisation (CSIRO) have an equal beneficiary interest. By far the greatest impact on video conferencing in education in Australia has been the involvement of AARNet. The ISP carrier, VRN (Victorian Regional Network) offers connectivity to many educational providers in Victoria and arranges access to AARNet. The clients consist of more than 800,000 staff and students of universities and research organizations. AARNet enables clients to interact in more effective ways (AARNet 2004 VoIP and Video over IP connectivity across Australian universities is making a huge impact and is changing the way Australian universities are communicating with each other. In July 2002, CSIRO and AARNet set up the "video over IP (VIDEOoIP) working group", with the aim of planning the deployment of video services over IP, and for the future development of video services. The VIDEOoIP steering group decided that one of the activities should be regular trial video conferences (monthly). All interested parties were welcome to the trial. In October 2002, a multipoint link took place between 16 locations via the AARNet MCU. The session had participants from Perth, Adelaide, Darwin, Brisbane, Newcastle, Melbourne, Sydney, and Canberra. The meeting lasted for over two hours with no significant technical difficulties. Most participants were University staff from around Australia. The meeting tested visual links across the MCU as well as audio channels (open all simultaneously). Subsequent meetings were to test multi-pointing even further by introducing application sharing.

A CSIRO case study, Facilitating Collaboration using Video over IP Conferencing, Questnet 2002, (Kingham, 2002) made the following observations:

- IP is easier to use than ISDN
- Improves collaboration for the masses
- Easier to fault find
- Is cheaper than ISDN

- Has complications with security
- Local user support is critical
- Central support goes to local co-coordinators, not users

Several multipoint connections were initiated, one conference per month. It was interesting to see how fast IP awareness grew in Australian universities during this time (the latter half of 2002). The first meeting linked 16 locations for two hours. The second video conference connected 22 locations and experimented with data collaboration (T.120), but this was not successful as the T.120 links failed to work adequately. The third meeting linked 26 locations and provided limited T.120 data collaboration. As most universities had participated in the AARNet MCU multipoint video conferences, a Mega conference was seen as an interesting development. The first global Mega-conference was held in late 2002. This linked up 200 sites from all over the world. Although some minor dropouts occurred, and some participants had to dial in again at times, the Mega-conference was a success. AARNet, at the time of writing, is deploying a plan to offer video-over IP through its two MCU's. MCU's capable of carrying 10 to 50 connections are becoming more affordable and are entering the tertiary sectors. These MCU's also allow voice conferences. This converging of video and audio is well on the way. It is no longer necessary to talk about video conferencing *per-se*. Users will simply meet on a conference either with a video unit, or if there is no access to this technology, with a phone. Connectivity is made across IP as well as ISDN. The connectivity is transparent. The provision of high-speed access to ISPs (for the educational sectors) through organisations such as AARNet is becoming more common across the world. Most countries do have similar or partner organisations that can offer better access at competitive rates. These organisations are also networking amongst one another, thus providing world connectivity and sharing each other's networks. AARNet's involvement can be largely credited with the phenomenal growth of IP video conferences in the educational sectors in Australia during 2002 to 2004, where it grew from two or three Universities to practically all universities in Australia being involved.

GrangeNet

GrangeNet is installing and developing a multi-gigabit network supporting grid and advanced communications services. The GrangeNet network links Melbourne, Canberra and Sydney via a 10-gigabit backbone.

It also provides a 5 gigabits link into Brisbane. GrangeNet is an experimental network providing advanced services with a high level of performance commensurate with the experimental nature of the network. Some areas it provides are:

- Next Generation Internet Protocol service (eg IPv6).
- Traffic Engineering Service (for example, MPLS, to allow fast switching and traffic tunnelling technology for a variety of protocols).
- Multicast service (to deliver traffic from one/many-to-many).

Most universities in Australia are now becoming involved. It is not entirely clear what the future holds for GrangeNet; however, what is clear is that it is providing an excellent base for investigating and developing new high speed communication technologies. It also is increasing the creation of access grid nodes that are being developed at various universities across Australia. Access grids are available at various universities.

3.3 European Key Practices

University of Art & Design (UIAH), Helsinki, Finland

The University of Art & Design is unique, as it is the only university in Europe that restricts itself to the disciplines of art & design. Thus, there is graphics, fine art, ceramics, textiles, etc. The University also houses Finland's only Film School (Lumière). The University is making extensive use of wired technologies, especially since most telephone lines are directly connected to the ISDN network.

Video Conferencing

The University uses video conferencing on a regular basis in education, as well as in administrative areas. There are two systems currently being used: desktop via ISDN and Group systems using ISDN.

1. **Desktop systems using ISDN**. Most staff have ISDN connected to the PC workstations. This allows them to and to link at 128Kbps to any location in the world that has access to ISDN. This is mostly used for administrative purposes. Desktop IP was being trialled in 2002 and successful links were established between UIAH and Swinburne University of Technology.

2. **Group systems using ISDN/IP.** The University uses PictureTel as well as Polyspan (also known as Polycom in Australia) products. PictureTel is in use mainly in classrooms, specifically available for video conferencing. The rooms use roll-about systems without any special adaptations.

All video conference units at UIAH are capable of linking up together. The bridge capability of the Polyspan makes it fairly painless to set up multi-point conferences. Because of the cheap ISDN rates in Finland, it is widely used for broadband applications such as video conferencing. The room design, although simple, is effective. An interesting feature of these rooms is the use of black or darkened walls, which have the effect of focusing the attention of the viewers toward people and/or artwork displayed. This is an option worth looking into further, especially since it is a bold move away from conventional video conference rooms where there is an expectation of bright walls or at least light backgrounds.

Rotterdam School of Management (Erasmus University, Netherlands)

The faculty at the School makes extensive use of group-based case studies in courses. Using video conferencing, students are enabled to work on a case study with students at other locations and universities. The School found that the use of this technology became important to them as distance learning over video means that time differences and distances become irrelevant. It also enables them to invite guest lecturers from around the globe. The school has exchange students that look for an internship with a company. The first meeting between a student and a company usually takes place over a video conference. This gives companies an extra advantage as they can obtain more of an overview from the student than they would normally get from a written CV (VC Insight, 2004).

Datafleet and Television Education Network (T.E.N.) (UK)

These organisations are offering VideoCAST ™ delivery to the desktop of T.E.N.'s professional development/training video programs with Datafleet's VideoCast Corporate Intranet solution. The technology is unique in its ability to deliver high quality video direct to users desktops over existing local area and Intranet infrastructure (Video Conference Insight, May 2000). T.E.N. in partnership with Sheffield Hallam University (SHU), aims to deliver the most effective training in the most flexible way possible.

SHU and T.E.N. work together to create content analysis and learning materials in a variety of formats, including video, print, CD-ROM, Web, and DVD. These are delivered directly to the PC or company Intranet using the latest broadcasting and Internet technologies. The system allows direct connection and interaction with the distance learning facilities at SHU, providing tutorial feedback, additional learning materials and support (Television Education Network, 2003).

Kingston Vision, Hull, UK

Kingston Vision, a subsidiary of UK-based Kingston Communications (Hull) plc, uses PixStream video networking solutions to provide bundled services to customers over the existing telephone network. Over 800 paying customers have signed up for the service package called Kingston Interactive Television, which includes multi-channel digital television, high speed Internet access, e-mail, local information services and video-on-demand. It takes uncompressed and compressed video feeds and adapts them to the Kingston platform, allowing video signals to be redistributed over copper telephone lines to customer homes (Videoconference Insight, March 2002). Kingston Communications is able to deliver interactive television services to its customers in and around Hull, built upon software developed by iMagicTV. It does this through its broadband network and ground-breaking interactive television platform, KIT. The latter is an ADSL-based service that delivers 60 digital television channels, Video-On-Demand, TV Internet & Email, BBCi, Home Shopping and the KIT Channel – providing news/community information, including a weekday, award-winning news service from Yorkshire Television. KIT is available in Hull and parts of East Yorkshire (Kingston Vision Case Study, 2002).

Duke University, USA and Kings College Hospital, UK

VTEL TC 2000 systems transmit live, lectures and panel discussions worldwide, to over 60,000 cardiac surgeons and technical cardiographers. Over 200 video conferencing systems were linked up to the 4.5 hour conference. Originating simultaneously from Kings College, London, and Duke University, Durham, USA, the video conference was broadcast live to Europe, the Middle East and the Americas. The lectures were then rebroadcast to the Asia-Pacific region with a live faculty for discussions. This was a good example of a 'broadcast type' that provided limited interactivity (Videoconference Insight, March 2000).

3.4 USA key practices

YAHOO surveyed the ranking of 'most wired' Universities in the USA (http://www.wiredcolleges.com). The site provides timely information about wired services that exist on college and university campuses in any given year. It is clear from the statistics that the trend to improve technology infrastructure is accelerating. The improvement of infrastructures increases the likelihood of using the communication technologies for educational purposes. In 2000, the most highly ranked university was Carnegie Mellon University, followed by the University of Delaware, followed by New Jersey Institute of Technology and Indiana University Bloomington (Most wired Universities, 2004). In 2001, Indiana University Bloomington came first. Their motto is that in the future, the leading universities will be those who are leaders in information technology. "The computer isn't just a study tool. It has become totally integrated in the lives of the students" (IUB, 2002). This does not necessarily mean digital video is used on a great scale in these organisations. In fact these three universities use video conferencing, but not necessarily only over IP; however, the use of IP related technologies is increasing dramatically. Rensselaer Polytechnic, USA, professional and distance education ranks position 7, and regularly uses streaming video. The University of California ranks position 10 and offers many course subjects.

Rensselaer Polytechnic Institute, Troy, NY, USA

Rensselaer Polytechnic Professional and Distance Education section has been providing distance education via satellite since 1988, using CLI encoders. This provided one-way video to participants. Interactivity was achieved through standard telephone lines. Participants usually phoned the classroom directly to raise questions. The classrooms were rooms purpose-designed to house in-built cameras, microphones and large television screens. Operation was carried out from the bio-box, which was attached to the back of the classrooms. Lecture theatres were also used and fitted out with these facilities. IBM supported this project. In 1993, Rensselaer Polytechnic commenced video conferencing using PictureTel systems. This provided two-way interaction in video as well as audio. The facilities used where the same as those used for satellite delivery.

Lectures took place from classrooms, as well as lecture theatres. Since 1996, the institute has invested time and capital in developing and applying digital video on the web. Initially, LearnLink was used (also called ILINK). This allows for map sharing on the web using Microsoft Media Player. Today Rensselaer Professional and Distance Education section is offering courses by way of video streaming on the web. Students may view classes on their own computers, at their home or office or at the time of their own choosing. The technology allows remote students to

- Participate synchronously with other students on the Troy Campus while the class is happening live, or
- Asynchronously, in a delayed mode, at a convenient time.

There are basically three modes of delivery:

1. Live: The stream is web cast as the course is actively taking place. In this synchronous mode remote students are able to interact with the class.
2. Raw: These are video files of a course that has been stored for delivery on demand. These files are available very soon after a class session has been completed. Raw files are encoded when the class is actively meeting, and can be viewed asynchronously at a time and location of the students' choice.
3. Completed: After the raw files are posted, PDE producers and developers work quickly to add index points and script commands to the video files. This creates synchronization with a web browser and provides descriptive markers for Windows Media Player. In the completed mode, slides, overheads, and objects are displayed in a web browser to enhance legibility of the course materials.

Three access mode options are available for students who often have access to various kinds of bandwidths:

- 56 Kbps: This is low bandwidth, good enough for accessing streams from home over a 56 K modem. It is also relatively fast to buffer.
- 100Kbps: Medium bandwidth provides better video quality than the low bandwidth option. It is good for students accessing the video streams over an ISDN link.

- 260 Kbps: This high bandwidth option provides excellent video and audio quality. It is provided for students who have access to LAN or Cable modems.

How does it work?

The institute uses software developed in-house that converges all the media used: video, graphics and web pages. The cycle works as follows:

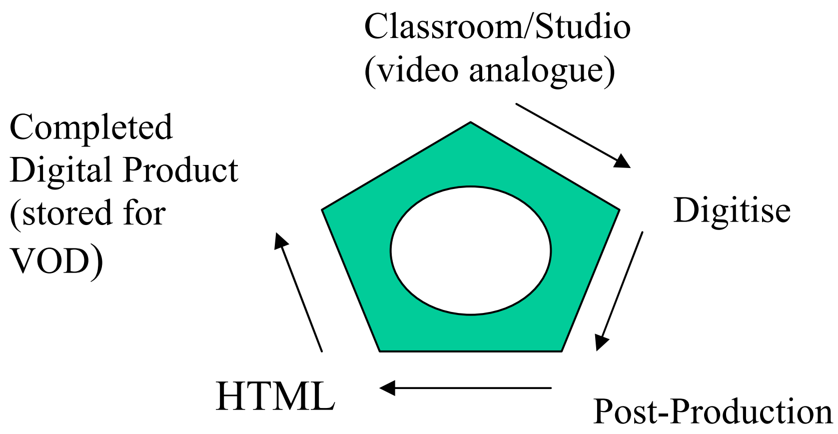

Figure 3.1 Processing cycle of video recording to digital media on demand

1. Sessions to be made available on satellite and On-Demand are delivered in lecture theatres equipped with built-in cameras, document cameras and well placed microphones. A student operates the equipment from the bio-box. In the bio-box, the operator can select the best picture from any video camera source and manipulate iris, focus, zoom, tilt and pan. A computer program (UniBrowser) also stores any digital presentation material that is being used (for example, PowerPoint, Web pages).
2. Once completed, the video is digitized in a postproduction facility. The output files are MPEG.
3. In the postproduction facility, using UniBrowser, staff are keying in key points in the presentation, in which the digital (presentation) media can be slotted in the HTML page. This is called bonding.
4. Further editing, if necessary, can enhance HTML pages.
5. The completed product is stored on a server for video on demand access.

During the live presentation, a number of participants join in from various locations, using various kinds of media. These are:

- Satellite: participants receive the pictures and sound, usually in a community venue. Interaction can be gained by ringing into the classroom by phone. In such a way, questions can be raised and answered. Usually during interaction, audio at the receiving end has to be turned down, or preferably off to prevent “feedback”.
- Video conference: participants join in from one of the many available sites. Interaction is commonly available using the video conference systems (two-way).
- Web access: participants join the session live from home using the Internet and their PC. Interaction usually is not possible here.
- Classroom: mostly these are local students in the classroom where the presenter is situated. They can view the video pictures, which are being web-cast, and broadcast via satellite. They can also see students who have joined in a video conference link and can hear incoming telephone calls from students from the satellite locations.

New York and the University of Pennsylvania

College students are involved in ‘Remote Learning Solutions’ (RLS) in an innovative program created by Bell Atlantic and Educational Video Conferencing, Inc. It enables students to see, and communicate to teachers and fellow students through their PC at home or at work. RLS uses Bell Atlantic’s high speed data services (DSL) and video enabled PCs to deliver fully accredited college courses and corporate training programs that go far beyond typical text-based classrooms offered on the web. DSL gives users real-time interaction at speeds of up to 126 times faster than a normal 56k modem (Videoconferencing Insight, March 2000).

The University of Pennsylvania is a good example of how digital video is being used in day-to-day education. The University has 15 campuses and has video conferencing facilities in each of them.

Topics covered by video conferencing are ageing/human services, articulation disorders, basic principles of computing, business law 2, business writing, change in education, child psychology, clinical decision making, community health nursing, developing library collections, drug education, various languages, general psychology, german film, humana and physiology, human genetics, criminal justice, sociology, language disorders, message design, multimedia technology, oral communication, pharmalogic applications, pittsburgh history, principles of management, public relations applications, quantitive methods, real estate fundamentals, russian civilisation, speech pathology, social problems, teaching and learning in the information age, world geography, world religions, writing for media (University of Pennsylvania, 2001).

California State University, Chico Campus

California State University (CSU), Chico has been in the business of delivering distance education throughout California for over 25 years, with the average age of the typical student being 38. CSU, Chico's dynamic distance learning initiatives address the educational needs of all types of students. Such distance education programs have served over 16,000 students, with an average of 1,200 students each year.

Satellite

Their extensive ITFS/Microwave system (Instructional Television Fixed Service) was started in 1975, C-band uplink was installed (satellite) in 1984 and a Ku-band uplink went ahead to deliver computer science courses across the United States. This campus delivers a variety of courses and programs not only to the northern California service region, but also across north America. Interactivity was achieved using a standard telephone link up (using the plain old telephone system: POTS). The Chico Campus designed and built two "origination" rooms from which such broadcasts were transmitted.

Video Conferencing

In 1986, the University also commenced using video conference facilities (CLI) using microwave links at 384 Kbps. These facilities were also installed and connected into both the "originating" rooms, so a presentation could be a video conference and/or broadcast via satellite simultaneously, thus providing very good flexibility.

In 1999 up to 100 hours of educational sessions per week were delivered using the satellite and video conference technology. Participants had to go to community venues and other centralised points to be able to join the sessions. Throughout the 1990s, CSU, Chico transitioned all of its ITFS programs to satellite/video conference.

Internet

In 1998, Chico selected HorizonLive to be its synchronous course provider (via the web) for various reasons, but primarily because of its low bandwidth requirements and ability to run on both PC's and Macs. The satellite-based video conferences were replaced by a combination of live and on-demand Web-based systems, with the winning technology mix being the integration of WebCT and HorizonLive. The combination of these two technologies resulted in the combination of the best of live and self-study tools rolled into one web-based solution. Live, interactive classes that ultimately simulate a real classroom are accessible from a student's computer, whether he or she is in a dorm room, campus computer lab, off-campus residence, or even a coffee shop.

How it works

The same "originating" rooms are used. The rooms are equipped with fixed cameras, one at the back, one at the front and one ceiling-mounted document camera above the presenter's desk. These are all controlled from the bio box in the back of the room (white balance, focus, pan, zoom). The presenter's desk has two PC's permanently set up; one for the use of digital media and another for viewing Web CT and Horizon-Live. The rooms are set up to seat approximately 25 students. The students are seated behind long curved benches that allow them to write notes. Microphones (Crown) are placed on the benches (one for each two students). The presenter stands on a slightly raised platform. In a Web CT/Horizon-Live web cast it will display the digital media used by the presenter. The presenter has access to two permanently set-up PCs:

1. A PC used to display digital media used such as PowerPoint, etc.
2. A PC displaying the web cast (the web site of the presentation).

The presenter delivers a presentation from the front of the class, but is being video taped. Simultaneously, all of the digital media that are being used by the presenter are also stored digitally. Horizon-Live then automatically converges all of the media onto the live web page (in this case using Web CT). The presenter can immediately see if the session is going live. He/she can also see who has joined the session.

The presenter instantly observes any questions that are raised through the chat function and can reply immediately. A Media Studies student usually operates the bio-box. The student gets paid as well as earning points towards a media subject in his/her studies. At the end of the session, the following has been achieved:

- The session has been web cast live using Web CT/ HorizonLive (synchronously).
- The session has been stored digitally for immediate use on-demand using Web CT/HorizonLive (asynchronously).
- The session has been video taped for back-up purposes.

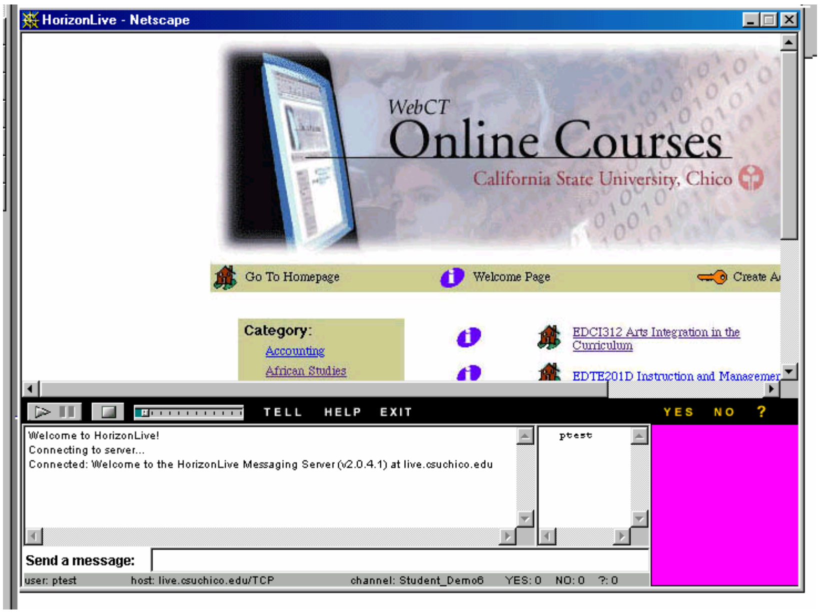

Figure 3.2 Screen grab of Horizon Live

(Note the square bottom right is the area in which the video is usually displayed)

<u>University of North Carolina</u>

School of Social Work: Teaching and Training over the Internet.

This project is a continuation of previous work by the faculty at the UNC School of Social Work to make college courses and professional training available to students and practitioners across the state of North Carolina and other Southern states. In the past, this has been done through the use of the NCREN video network and/or extensive travel by the faculty of the School. Users all employ desktop facilities, Intel ProShares and VCON Escort 25s.

Trainers are located at five sites around the state of North Carolina, all of which are model demonstration sites for development of systems of care to serve children with serious emotional disturbances and their families. Agency personnel from North Carolina human service agencies are invited to participate in training provided via H.323 video conferencing. This interactive video conferencing class allows interested practitioners in public and voluntary agencies around the State to participate in all or selected portions of this course. This application is being supported by the ViDe LSVNP project (ViDe, 2001).

H.323 Video Conferencing for Medical School Planning (University of Alabama)

The University of Alabama introduced use of H.323 where regular communications was required among three or more sites that are distant from each other.

This project supports three activities:

1. *South-East Regional Medical Education Conference:* The University of Alabama School of Medicine's Office of Curriculum Development and Management is pursuing a quarterly medical education conference series with the University of North Carolina School of Medicine's Office of Educational Development. These offices are supporting the educational activities at the Schools of Medicine. Both offices are involved with a variety of projects focused on effective medical teaching, learning and curricular reform.
2. *Administration and Planning of the Medical School on the Three UA System Campuses:* The four Deans from the three clinical campuses (two in Birmingham, one in Tuscaloosa, and one in Huntsville) hold meetings among themselves and other campus administrators. Video conferencing systems are located in School of Medicine conference rooms, where they are accessible for use by all the faculties and *ad hoc* curriculum planning committees.
3. *Video Multicast:* The systems were purchased with multicast software, UAB and the Gulf Central GigaPoP (GCG) have committed to deploying multicast, at least on a pilot basis, to each of the three sites in Alabama. Multicast traffic is already supported between GCG and SoX.

In addition to these uses, H.323 is being used for distance training of standardised patients used in our end of third year Objective Structured Clinical Exam, a performance examination of students' skills using specially trained lay patients. This application is being supported by the ViDe LSVNP project (ViDe LSVNP, 2003).

3.5 Key Practices in other Parts of the Globe

The following examples are brief descriptions of other global key practices of video conference use. They are summarised to indicate that the deployment of video conference systems in educational sectors is taking place at a rapid pace.

Texas Education Center, Region XIII

The Texas Education Center has built a network of 35 Polycom ViewStation systems in high schools in 15 counties in Texas. Half of the sites in the network are fully equipped as originating points of instruction. Polycom was chosen because of its design features, such as smooth, full motion images at 30 fps, as well as voice quality with microphones covering a 15 foot area (Videoconference Insight, 2003).

Nottinghamshire County Council

Nottinghamshire County Council has 16 video conference systems in 16 libraries. All of these systems are available to the public for general use. The linking-up of these units occurs through traditional ISDN lines, but IP is being considered at some point in the future (Videoconference Insight, 2003).

Fulton-Montgomery Community College (FMCC), State University of New York (SUNY)

FMCC has deployed 36 VBricks MPEG systems in its network to provide educational and informational programming across its campus. They have replaced traditional equipment in distance education rooms and have provided video security monitoring. Linking up occurs with low cost T1 placed in eight distance learning rooms, giving it worldwide connectivity.

FMCC connected Vbricks to its 100BaseT switched Ethernet network, and then centrally located its VCR's, DVD players and satellite television feeds in the campus library. Educators call the library to request programs, and then use a remote control to select programs.

China People Bank (CPB)

The Tianjin branches of China People's Bank have created one of the world's largest room-based IP video conferencing solutions for their banking network, which are being used for training purposes. It is the first video conferencing application to be deployed over the China National Finance Network (CNFN) in China's history. The CNFN operated by China Financial Data Network Company Limited (CHINA FINET), is a dedicated network providing financial information and value added services to bank branches across China's 29 provinces. A total of 100 end points are available. The video conferencing network enables real-time, interactive multipoint conferencing at 384 Kbps. China has one of the most advanced networking infrastructures in the world. Although several video over IP solutions are already operational there, FINET has the most widely distributed topology in China (Videoconference Insight, 2003).

Global Leap 2000

Global Leap 2000 was an event organised by PictureTel Enterprise Services Division. The event took place over one day. Lots of Schools, Colleges, Universities, Government and private organisations were involved in the link-up from 6.30 am to 11.00 pm. Locations were London, UK; Great Barrier Reef, Australia; Melbourne Zoo, Australia; Bishop Stortford School, UK; Belfast Institute, UK; Science Museum London, UK; Cambridge University, UK; NASA, USA; UK Prime Minister, Game Reserve, South Africa; Shepens Eye Centre, USA; Ocean Institute, Kosovo; and other schools from all continents. This case showed that real-time leaning could take place at a global level with a variety of cross-sectored students with different cultural backgrounds.
A total of 10,000 children enjoyed the first video conference event. The event lasted for one day, totaling 16 hours. It linked up with schools across five continents. Various topics were covered.

VRVS Virtual Room Video conferencing System

VRVS is a web-oriented system for video conferencing and collaborative work over IP networks. The Virtual Room Video conferencing System provides a low cost, bandwidth-efficient, extensible means of video conferencing and remote collaboration over networks within the High Energy and Nuclear Physics communities. VRVS also extends the service to various academic/research areas. Since it went into service in early 1997, deployment of the Web-based system has expanded to include 12150 registered hosts running the VRVS software in 63 countries. A set of 48 "reflectors" interconnected using Uni-cast tunnels and multicast manage the traffic flow at HENP labs and Universities in the USA, Europe, Asia, and South America. VRVS provides the versatile collaboration tools - MBone (vic/rat), H.323 (Polycom, NetMeeting), QuickTime, Desktop/Application sharing and Chat on various platforms. Ongoing developments include support for MPEG2 video conferencing, shared collaborative environments, QoS over networks. The goal is to support a set of new requirements for rapid data exchange, and a high level of interactivity in large-scale scientific collaborations (VRVS, 2002)

VideNet

ViDe was founded by representatives from universities and education networks in the USA. The Video Development Initiative (ViDe) promotes the deployment of digital video in research and higher education. ViDeNet is providing numerous, autonomous managed H.323 gatekeepers around the world. A Global Dialling Scheme provides a structure for peering between the various gatekeepers in a way that members can contact anyone in any ViDeNet zone (ViDeNet, 2004).There are companies around the world that are now offering similar services that duplicate this concept. Integrated Vision (Australia) for example, offers VisionNet, a dedicated secure IP-based network, designed and built for real-time, live videoconferencing. This allows users to take advantage of IP videoconferencing without affecting their existing IP network. It is likely that similar services will be offered elsewhere. The deployment of H.350 Directory Services integrates with some of these services. H.350 provides a uniform way to store and locate information related to video and voice-over-IP in directories that are linked seamlessly to enterprise directories (ViDeNet, 2004).

The ViDeNet consists of over 80 H.323 zones and is the largest network of its kind in the world. The ViDeNet architecture has been adopted for use by Internet2, and the integration of video conferencing with directory services is being explored through ViDe's participation in the Internet2 VidMid program.

Internet2 is the next generation Internet, which has huge bandwidth capabilities to enable transmission of CD quality sound and DVD quality images, at as much as 250 Mbps. Like the Internet at its inception, it is the province of universities and technology centres. All you need to join the system is academic accreditation and nearly $12,000 (US) a year to pay an affiliate membership (Midgette, 2004). Although ViDe is mostly USA and Canada orientated, the Australian National University is also a member and Global Root at Canberra Australia is also involved (VideNet 2003). Through AARNet.CSIRO, most Australian Universities are now also learning about ViDe.

3.6 Summary

The global key practices are a very brief reflection of what is happening across the world in the offerings of video conferencing within educational sectors. This will impact on Australian educators and learners. Communication developments are no longer locally contained. As innovative projects are set up and evaluated, cross-referencing applies rapidly and other institutions adopt similar models. Thus the development and deployment of IP video conferencing is accelerating at high rate. The increasing availability of broadband access, especially in educational institutions, now virtually guarantees good IP connectivity between universities at a global level. The relatively new IP collaborations between organisations, such as AARNet, CSIRO and international IP ‘contractors’, are opening up huge communication pipelines to educational providers at attractive user rates.

The trend of using IP as a communication medium is very strong. This further justifies the current project of investigating video conferencing over IP in an educational context. What is emerging is that learning can no longer be strictly contained at a local level.

It is clear that the availability of the technology, combined with the information sharing that occurs across many educational providers, is changing the way that we look at offering education to learners of the future. The use of IP as a communication medium is also having an effect on educational providers who not only have to deliver the technical infrastructure to make learning across IP video conferencing possible, but also need to look seriously at changing the ways of how subjects can be taught across the vastly different mediums that are now available.

The use of video conferencing, utilised with added facilities such as web-conferencing for digital information, chat and feedback mechanisms across the Internet, will mean that interactivity between learners and educators across vastly different cultures is improving dramatically. Teachers and academics will need to alter their teaching strategies to take account of these new delivery platforms.

Chapter 4 TECHNICAL AND DESIGN PROBLEMS ENCOUNTERED

4.0 Introduction

Video conferencing has faced many changes since its introduction. Some changes were technical while others were directly due to the design of the hardware and software involved. For example, people who were used to operating typewriters could adapt easily to the keyboard of the PC, as in principal the functionalities were the same. Learning to work with a video display, however, was new. Operating controls of video conference systems were changed as the early models displayed too much information and had too many controls for the general user.

Norman (1988) argues;

> *'the user needs help. Just the right things have to be visible to indicate what parts to operate and how to indicate how the user is to interact with the device'.* pp. 8

He also says;

> *'It is lack of visibility that makes so many computer-controlled devices so difficult to operate. And it is an excess of visibility that makes the gadget-ridden, feature-laden modern audio set or video cassette recorder (VCR) so intimidating'.* pp.8

DOS operators will remember the introduction of the Microsoft Windows platform. This was a newly designed tool that they needed to become familiar with. Pull-down menus, file structures and a roving cursor operated by a mouse were all relatively new concepts that were available in the early Windows versions. Some of the operating controls in the video conference systems have not been user-friendly. Often systems offered too many buttons, with too many choices, which presented a complication to educational users. Yermish (2000) remarks that students learned very quickly that it was not easy to walk up to the podium, press the buttons and make a quality presentation. The interaction of technology and content became obvious to them. Some hurdles have been overcome.

Bandwidth availability has improved, compression techniques have been enhanced, camera/video technologies have advanced, and room designs have been altered. At the turn of the century we have reached a point at which more people are comfortable with using digital video. We have entered the maturity stage of video conferencing. Systems are more user-friendly and reliable than before. Skilled help or staff development is usually close at hand, or at least within reach. However, there are still problems to be resolved. Traditional video conferencing system designs have been tested during initial trials by TAFE South Australia (Mitchell, 1991), the University of New England (Hansford, 1990), and by Western Australia's Live-Net (Atkinson et al., 1991). Trials by TAFE South Australia and by the University of New England were based upon Megalinks, 2Mbps, point-to-point digital circuits leased from Telstra. After these trials, it became evident that there was considerable scope for alternative and improved approaches to system design, due to the technological developments in ISDN and video conferencing equipment (Mitchell, 1993). This is a consistent with more recent studies that have worked with desktop and small group systems (Daunt, 1999; Yermish, 2000; Rhodes, 2001; Yates, 2003). According to Shepard (2002), many organisations talk about using desktop video conference facilities, but in reality, few have actually implemented them because they tend to share bandwidth on the corporate LAN that can have deleterious effects on the delivery of other network traffic. Problems that are at play in both group video conference systems and streamed (IP) video on the Internet can be grouped as follows:

- Image quality.
- Equipment design.
- Venue design.
- Appropriate educational use of the technology.

As this thesis is not about the detailed technical architecture of the equipment involved, it investigates the above from a user point of view. However, it is necessary to consider them in some detail because of their importance to the user experience.

4.1 Image Quality in Video Conference Systems

A good quality moving image is dependent on the amount of bandwidth available. The more bandwidth that can be utilised, the more data can be sent at a faster refresh rate. This delivers a better quality picture. The current bandwidth that is available to video conference systems is discussed in detail in Chapter 2.4 *Bandwidth Issues.*

This reported that fibre-optic and satellite bandwidth capacities are a vast improvement on the older technologies. However, the majority of educational video conferences taking place today still use ISDN as the main means of transportation. According to TANDBERG, 80% of global video conferences in 2003 used ISDN as the communication link. The remaining 20% used predominantly IP. As IP networks have become more robust throughout the world, many organizations are looking to determine if IP would be a higher quality and/or more cost-effective alternative to ISDN for their video conferencing network (V-University, 2004). Today, an increasing number of educational providers are offering IP as an alternative way to link video conferences and there are strong indications (in the educational sectors at least) that video conferencing over ISDN is now rapidly being replaced by video over IP. ISDN, however, will still be required for a while. According to Rhodes (2001), there are still many technical, social, financial and regulatory hurdles to be cleared before ISDN no longer is required. Although linking through IDSN was very popular up to the turn of the century, there are strong signs that greater bandwidth is desirable and lower running and call costs are becoming driving factors. Video-over-IP offers competitive solutions to combat some, if not most, of these conventional stumbling blocks. Computer processing power is doubling every eighteen months or so, and the technical capacity to transmit information over networks is currently growing by about twenty per cent per year (Barr, 2000). Most connections are made through 128 Kbps and 256 Kbps, and although these data rates are sufficient to introduce some improvement, it is not always the best solution for showing quality motion activity or even the replaying of videos. The connection rate of 384 Kbps is such a small improvement on 256 Kbps that the additional costs are often prohibitive to many organisations, especially less well funded bodies like State schools (costs are related to line rental for example, 128 Kbps-2 lines, 256 Kbps-4 lines, 384 Kbps-6 lines).

Low bandwidth itself technically is not an issue; however, users may see it as a problem. This is the case where participants are used to watching high quality broadcast television pictures, and increasingly DVD, SDTV and HDTV. Users may want a quality image, and thus improved data rate, that allows the use of digital video to behave and 'look' more like watching a normal television broadcast (Austerberry, 2002). The report 'Expanding Options: Delivery Technologies and Postgraduate Coursework' by James and Beattie (1996) states:

> "This technology has had its major impact on lecturers, rather than students. Low bandwidth technology leads to imperfect transmission of moving images; when the subject moves, the image blurs and jumps, and fast action is not transmitted well at all. There are also time delays in the sound, akin to an international telephone call. As well, the audio system may not function well at low levels or with background noise such as chatter from students. Lecturer's movements are limited to some extent, if wireless microphones are not used - this is a problem for staff who prefers to walk as they talk. And with material written on the board, smaller monitors are thought to be inadequate: 'everyone squints at the little monitor…. You can get by, but you do a lot of zooming in and out with the camera'. These factors mean that the simulation of face-to-face contact is less than perfect and lecturing strategies and style is affected considerably" pp. 35.

Availability of broadband technologies will make many of these problems disappear. Others can be addressed by equipment and venue design, and by the improved use of appropriate educational delivery techniques. Bandwidth availability, and restrictions, with digital video on Intranet/Internet over IP can be more or less severe, depending on local infrastructures. This is less of a problem for (LAN/WAN) Intranet users, but it is more problematic for Internet users. In most modern educational institutions, LAN and WAN allow the take-up of wider bandwidth of up to 10 Mbps. Although LAN/WAN IP technologies are not ideal for the use of full-blown digital video, they are excellent for video-on-demand and video conferencing purposes. The enclosed environment allows network operators to set a quality priority for certain applications such as digital video.

The problems experienced on the Internet are similar to those as discussed in group video conference systems but there are additional issues which are similar to Internet users. The Internet is NOT an enclosed environment and as such cannot be controlled. Additionally, modem users are severely restricted by the slow nature of the transfer process 28 and 56 Kbps on standard POTS modems. Users on Cable networks are a little better off (up to 10 Mbps maximum on a good day) but usually only when linking to another site that is connected also on a cable network or better. Picture quality can also suffer because of the slow transmission combined with the small picture size of 120 x 180 pixels. The picture size available varies greatly with each brand of equipment that is used. Although the image can be enlarged, it generally means that all the pixels are also enlarged, thus offering no real improvement in quality.

4.2. Equipment Design

The design of video conference equipment is a major factor in the operability of each system. In the early days, systems needed to be set up and operated by skilled technicians. The technology used was not very transparent to the users and users wanting to avail themselves of the facilities often left the switching and use of cameras to the technical experts. Users usually did not need or want to be bothered with pushing "buttons". This is changing, as system designs are increasingly becoming more user-friendly. Some of the technology has become "hidden and automated", thus making operation easier. However, complications still exist with multi-camera designs, often used in large lecture theatres. 'Creeping featurism' is the tendency to add to the number of features that a device can deliver, often extending the number beyond all reason (Norman, 1988). Some of the large group systems suffer from this 'creeping featurism'. This only adds to confusion for most users, but does turn them away from using the technologies, (Yermish, 2000).

Multi-pointing also tends to confuse many users, especially when voice switching occurs, appearing to switch incorrectly, or too slowly, or in some cases not at all.
The conventional designs were aimed at two groups:

- large group systems, such as students and a lecturer, in a large venue.
- small group systems, for meetings and or small classes, often in standard rooms.

They each have different designs. The smaller rooms often use roll-about systems. That consist of a cabinet, which houses one camera, codec and microphone(s). Operation is from an infrared remote control. Roll-about units are suitable for meetings when the chairperson sits among the group (Figure 4.1). The whole group faces the camera. Roll about units are conceived not to be suitable for traditional teaching/learning situations. A lecturer often wants to stand facing the group at the near end, as well as facing the group on the far end (Figure 4.2), (Mitchell 1993).

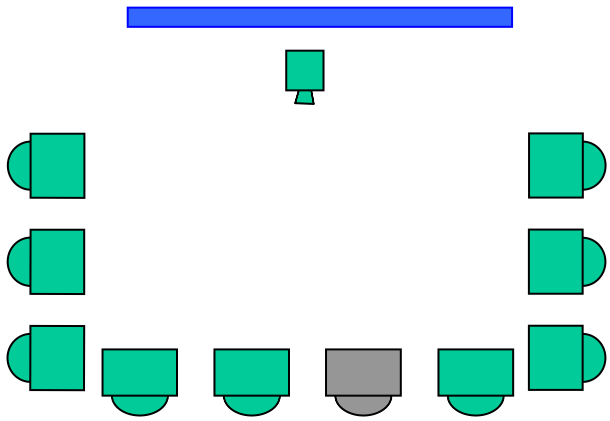

Figure 4.1 A typical roll-about setup; one camera faces the whole group.

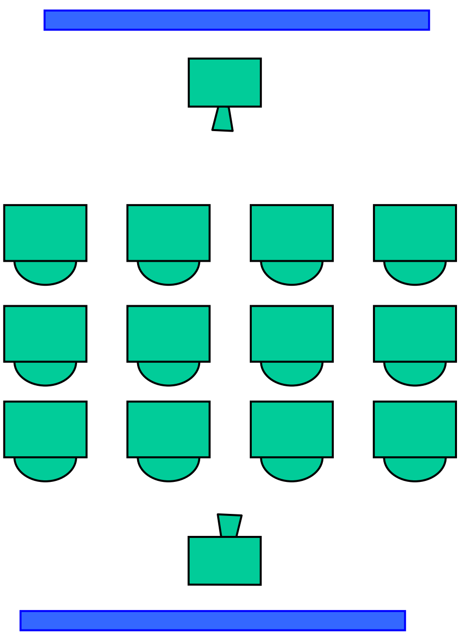

Figure 4.2 A typical classroom setup (One camera for teacher, one for students)

Video conference system designs revolve around the proper placement of equipment such as cameras, monitors and microphones. Although each individual item may work perfectly, when not placed strategically in the appropriate location, problems can occur. This is where venue design comes into play. Desktop video conference systems are often limited to the deployment of one camera only. This camera often has only a fixed lens of relatively narrow angle, which is placed on top of or near to a computer monitor. As users are placed very close to this camera they appear not to look to the far-end; rather one notices that they are looking at the computer monitor. Direct eye contact is therefore very difficult, if not impossible, to establish. This is a major problem in desktop system designs. Microphones are sometimes built in the desktop equipment (for example, Polycom ViaVideo), but often they are set up separately. These are often placed too close to PC speakers, resulting in 'feedback'. Polycom ViaVideo has a very effective echo-cancelling function that does a good job of eliminating such errors.

4.3. Venue Design

Research into room decoration revealed that choices in background colour, lighting, and even the clothes we wear impact upon the video quality of a video conference (WVN, 2003). Books are available on good venue design for larger systems, for example Rhodes, (2001). Venue design is closely related to video conference system design. As the above figures show, smaller rooms often have roll about units, larger venues often have multiple cameras. Problems may arise if the design of the venue and system is not well thought out. For instance, in a large room or lecture theatre, multiple viewing monitors are sometimes used. This will give viewers the opportunity to select the closest monitor, but users often still have to strain in order to see detail. Eye lines in these cases may also be incorrect. Data/video projectors offer a better solution as the image can be projected large enough so that groups can adequately see detail.

Lighting

General venue design must address appropriate available lighting, natural or artificial. A sufficient amount of light has to be available to expose all of the participants in a video conference. The topic of lighting has also been covered by many books such as Rhodes, (2001) and Barlow et al., (2002).

Care has to be taken that natural light, from windows is not entering directly opposite active cameras. This will cause the camera auto-iris to close, resulting in under-exposed images. Today's cameras have in-built technology and filters that compensate for various lighting conditions and automatically produce reasonably balanced colour pictures.

Audio

Although a video conference relies heavily on the combination of audio and video images, a video conference can still be maintained even if the picture drops out. This cannot be said if it was the other way around. If we have pictures, but no audio, it is very difficult to maintain the flow of the video conference. Audio problems arise often. Today, audio is taken for granted, therefore it can frequently cause problems. Occasionally this is because of inappropriate behaviour of users, but more often than not, the problems are technical and or design-related. With roll-about units, the microphone has to be positioned manually by the users. If the microphone is set up too close to the loudspeakers, feedback may occur. If it is too close to computers, there can be ambient noise. If too far from the main speaker, the levels may be too low. These problems can easily be overcome with appropriate staff development. Occasionally, audio problems arise because of acoustics. The venue may have noisy air-conditioning systems or it may be next to a busy road. The location of a venue, therefore, needs to be chosen with care. Microphones need to be selected carefully, especially as some lecturers/teachers like to walk when they talk. Radio microphones are suitable in that situation.

Monitor/screens

The size of the venue often dictates the location and size of the monitor or screen used. Generally, a video data projector is used in lecture theatres and large monitors are used in smaller venues. A complaint often heard is that participants cannot see enough detail. Screens are often too small. The placement of cameras and screens at eye level, with screens adjoining tables for instance, creates the effect that one room is being used. This creates the illusion that if two similar looking rooms were connected in the same video conference, it would look like one room.

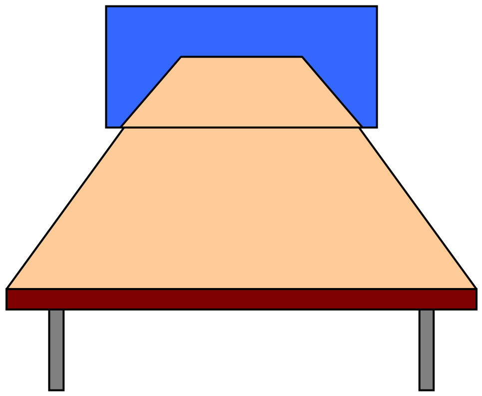

Figure 4.3 The illusion of one single meeting room

The virtual tearoom at Monash University, Melbourne, uses this idea well. Although not a formal meeting room, the designers have tried to set up both rooms in a similar way, to replicate a real virtual meeting place. Of course, this situation would not work well when a lecturer wants to face all participants simultaneously. The configuration in figure 4.4 would be more appropriate. The lecturer would need a large screen in front, so he/she could see the back of the class, as well as the front. This screen can be a large screen at the back of the class, or a smaller screen directly in front of the lecturer.

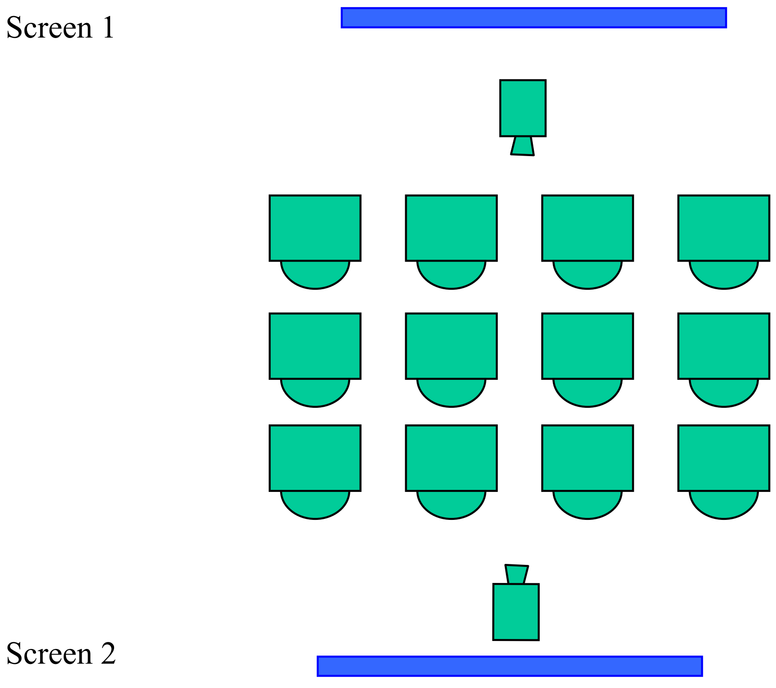

Figure 4.4 Display of the far end class

An alternative to screen 2 would be to have a monitor immediately in front of the lecturer. This can be built into a desk with other electronic display equipment.

4.4 Appropriate Educational Use of the Technology

Using video conference systems today is easy: using it appropriately and effectively in an educational sense is not so straightforward. Research by many educational institutions show that a rigorous staff development program is needed to support the implementation of video conferencing. Specific training must be offered for lecturers who are presenting on-camera (James and Beattie, 1996; Arms, 2000; Rhodes, 2001).

James and Beattie (1996) reported that:

> *"Teaching in new ways is not always a rewarding experience for academic staff. On the one hand, this may simply be because personal preferences or assumptions about the role of the teacher are being thrown into question. On the other, it may represent an understandable frustration on the part of staff that have become skilled in using face-to-face interaction to guide their teaching. In this case, reduction in feedback from students, for instance, is not only dissatisfying, it can also be disconcerting, to the extent that it undermines teaching performance".* pp.71

Some cases, video conferences are initiated because it seems the modern thing to do: in others it is because the equipment is there (Barlow et al., 2002). Frequently, the technology is selected because it is available. Also, there are cases where the institute is encouraging the use of the video conference facilities because they represent a significant investment and were under-utilised. This is using technology for technology's sake, Barlow et al., (2002). This is inappropriate, as a real educational need to use the facilities has not been identified. Selective video conferencing needs to occur at all times and should be based on sound educational grounds. Educators need to ask themselves beforehand: is this the appropriate medium to use for my course content? Can I convey my content in a more effective manner? Sometimes a simple audio conference will suffice. These can usually be scheduled across a standard telephone line.

At other times a chat program or Internet presentation, combined with a telephone link, can more than adequately convey information. There are many forms of communication systems available that can be utilized in an educational environment.

4.5 Summary

The difficulties encountered in video conference systems are not all technical. Although technical issues play a large part in the success of a good program (for example, image quality and equipment design), a significant problem lies within venue design and appropriate educational use of the technology. The image quality is increasingly more critical to the complete experience. Improvements are generally made possible by equipment manufacturers and network IT companies who have control over such matters. Equipment design is being altered, often as a result of feedback from customers or the availability of recent research. The above are beyond most users' control; however, significant pressure can be put on manufacturers of systems that are not delivering what today's users demand - picture quality and technology transparency. Venue design can be rectified at a local level once a thorough examination of each participating location has been completed. Only then can a design be prepared that will suit the location and its users. The choice of decorative colours and materials combined with appropriate lighting can improve the experience in a significant way. An appropriate approach to educational use of the media is also something that can only be addressed at a local level. Educators need to access the material that needs to be conveyed to their students. If technology is to play a part in this, then careful thought needs to be given to which technology is the most appropriate for the occasion. This is often very clear in how certain software for computer programs have been written. Most programmers are not users, certainly not teachers or students using the software. Software programmers fluently write programs that do wonderful things, but some programs are that complicated that they are unusable by the non-pc professional (Norman 1988). At all times the designer should have the end users in mind and take their needs into consideration.

Chapter 5 CASE STUDIES

5.0 Introduction

Video conferencing research has mainly focused upon large group systems. There are many examples of this (Schiller and Mitchell, 1993; Treagust et al., 1993; Biner et al., 1996; Aworuwa, 2003). Some research has studied smaller group and desktop video systems; for example Thompson (1997), Daunt (2000), Tasmanian School of Distance Education (1995*)* and Amerian (2002). Video conferencing has been studied, probed and dissected in a variety of ways. Topics have covered the technologies as well as the interactive educational uses (Daunt, 2000). Video conferencing (over ISDN) has been a part of the delivery of mainstream education for a number of years. Group video conference systems are well integrated in a large number of educational institutions. Some educational providers use these video conference facilities extensively for the delivery of course content: others have the facilities but rarely use them educationally. Today, an increasing number of people are using desktop video conference system from home, the office, the computer laboratory and now also the classroom. They use IP as the main communication technology. Research into its application, design and implementation is limited; for example, how can it be used to link a supervisor in a university to a student in a remote home? How can it be used in a broadcast sense, teacher to-one or many students? How can it be applied in a classroom environment, perhaps linking to a world-renowned expert in a particular topic? Video conferencing over IP has brought video conferencing into the mainstream. It has come within the reach of home users, and therefore also students and subject experts alike. Many users are new to this technology. As desktop video conferences are different from the average group systems, there are many questions that still have not been answered. In the case studies described in this thesis, answers to some of these questions are sought.

5.1 Research Methodology

This research in this thesis is based on case studies. Three independent case studies are examined. The first case study investigates the effectiveness (educationally and technically) of implementing video conferencing over IP from Swinburne University of Technology, Prahran Campus (Melbourne), to various sites throughout Taiwan. The study examined the use of video conferences over IP for the research supervision of students living in Taiwan undertaking the Professional Doctorate in Design. This program was specifically designed with the intention of using video conferencing for distance supervision. All links were to be with a single student, enrolled at Swinburne University of Technology but living and working in Taiwan, to one or two supervisors at the Prahran Campus. Desktop video conference systems were to be used linking across IP. Fifteen students were involved in this project.

The second case study investigated the implementation of IP video conferencing in a number of different organisations involved in the CRC for Innovative Wood Manufacturing project (a Cooperative Research Centre, funded by the Australian Commonwealth Government, which receives substantial financial backing from the timber and furniture industries). The case study examined desktop video conferencing to improve communication between all stakeholders in the CRC. The CRC partners were drawn from industry, the Government and educational sectors. Links were to be person-to-person, small group to small group, and multi-point between small groups and/or individuals. All participants were in Australia, but in places as distant as Perth (Western Australia), Melbourne (Victoria), and Brisbane (Queensland). Desktop systems linking over IP were selected as the preferred tools.

The third case study investigated the linking of small groups of students in two Universities: Lingnan University in Hong Kong and Swinburne University of Technology, Melbourne. Students and lecturers were to interact across the two Universities as part of an innovative program originating from Lingnan University. This study used a combination of desktop systems and small group systems, all linked across IP. It was the largest of the three selected, as it involved more students and lecturers at each end. It was also to be the most innovative case study of the three, as the boundaries were pushed further by students as well as lecturers.

The Lingnan group comprised approximately 30 third year business students in a management class and the Swinburne group comprised 12 second year marketing and international business students. Tutorials were conducted in September and October 2003. The first tutorial was run by Lingnan and had six groups of three to four students present findings for an ethics case study on scaffolding. The follow-up tutorial was conducted by Swinburne two weeks later with two students presenting a case by Trimarchi (2003) on designing relationships approaches for participating in the Hong Kong business market. The environment was a classroom, where one class of students at Swinburne University, Melbourne, was linked to another class of students at Lingnan University.

The case studies selected represent a cross-section of typical IP video conference users in three different educational settings. Multiple case studies were selected as the researcher believed that data gathered from multiple case studies can be more complete and consistent. This is in line with Herriot and Firestone (1983) who argue that multiple case study designs have a distinct advantage because the evidence from them is more compelling than from a single case study. Some disciplines (e.g. anthropology and political sciences) have developed double sets of rationales, one for single and one for multiple case studies (Eckstein, 1975, Lijphart, 1975, George, 1979). Yin (1993) argues that, with the multiple replications of certain findings that can be obtained from multiple case studies, the findings can be more robust as opposed to single case studies. Yin (2002) also argues that, when it is uncertain if external conditions will produce different case study results, conditions must be explicit at the outset of the study. The objective of the case studies in this thesis was to follow similar procedures in each case study so that conditions would be similar in order to increase the likelihood of replicating any results of the data to be gathered. Research using case studies is common and there are many ways in which these can be undertaken. According to Stake (1995:8):

> "The real business of case study is particularisation, not generalisation. We take a particular case and come to know it well, not primarily as to how it is different from others but what it is, what it does. There is emphasis on uniqueness, and that implies knowledge of others that the case is different from, but first emphasis is on understanding the case itself".

Jensen (2002) argues that three types of sampling all generate and document a set of meaningful events, instances, or cases for further study and Gomm et al.2000;Yin 1994 state that one type of qualitative case study explores delimited entities. Babbie (1990) states that a single case study sometimes cannot confirm a hypothesis and that additional further (case) studies are required for that purpose. The researcher has chosen multiple case studies that replicate each other with the expectation of finding results that are similar across all case studies to further support his hypothesis.

The research methodology applied in this thesis is a comparative case method. It chose three separate case studies that were very different from one another in order to gather data that could be cross-compared. Some fields, for example, political science and public administration, have tried to delineate sharply between single and multiple-case studies (Lijphart, 1975; George, 1979; Agranoff and Radin, 1991). However, single and multiple-case studies are really just two variants of case study designs.

This research examines three separate case studies in line with the comparative method and gathers data from each. The data gathering is based on a model used by Yin et al., (1984). It commences with a theory or subject topic worthy of research. A process is devised for selecting three individual case studies, and a model is applied on how to collect data (see model Fig. 5.1). Each case study was then conducted, independently. On completion of the data collection an individual report was produced, describing the case study from beginning to end, and describing all relevant processes, data and information. At the conclusion of all three of these reports, cross-case conclusions were to be drawn. Furthermore, the original theory and subject matter were to be modified if required. A policy reflecting the findings could then be developed and an incremental plan created for implementation in an appropriate educational setting. At the conclusion of the research, a complete cross-case report would be formed and presented.

The model in Fig. 5.1 depicts the process that was applied in this research. Based on Yin, et al., (1984), it was adapted to suit the current research. The model was also extended to include the following:

- Running on-line surveys and printed surveys that were accessible to all participants, regardless of their locality.
- Observing all video conferences and recording the findings in written form. student comments were also noted and recorded.
- Video taping conferences with classes (in case study three) for later scrutiny.
- Discussing observations with the lecturers involved in follow-up interviews.
- Extensive email exchanges that were carried out with the students as follow-up to see if extra data could be obtained.

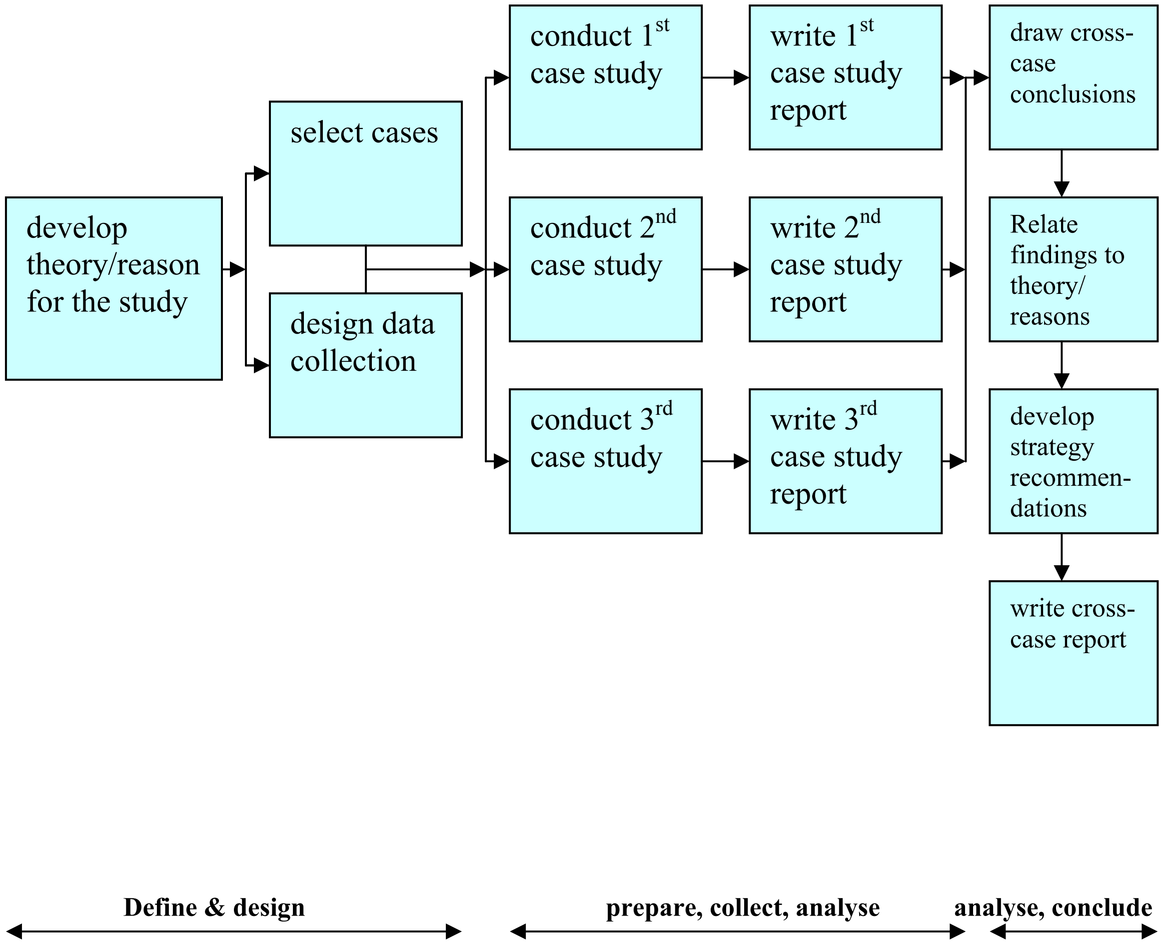

Figure 5.1 Case Study Method (from Yin, et al., 1984)

5.2 Rationale

The reason for using the multiple case-studies is that it enables the examination of a cross-section of different types of video conference that take place in today's educational environments. It would be inappropriate to generalise data obtained from one isolated case study of desktop video conferencing (from one location to another). Such a case study would almost certainly be narrowly focused and deliver results of limited application.

With this research, two data collection approaches were used to provide a combination of qualitative and quantitative information, regarded as a worthy approach to improving understanding. According to Coll and Chapman (2000, p28) "some research questions will be readily answered using qualitative means, others quantitative, and some will be best addressed using a combination of the two. What is necessary is appropriate research design". To facilitate the collection of complementary data, a survey to collect students' viewpoints and observers' comments was used in order to understand the effectiveness in operation of the videoconferencing.

The research followed a structure set by similar projects, in particular the 'Information Technology Enhancement Program, Desktop Video Conferencing' (Thompson, 1997). This project's objective was:

> *To establish a range of educational applications of video conferencing by testing PC-based desktop video conferencing in the context of cross-campus and workplace-based training.*

Parallels can be drawn between the present research and the Thompson project, which was carried out at Deakin University. Thompson worked with the School of Visual, Performing and Media Arts. This School was a very active user of video conferencing, and visual communication was of paramount importance. Two of the case studies in the present research also worked within 'the Arts section', namely the National Institute of Design, it provided a common ground on to which the methodology could be based.

Furthermore, Arts lecturers involved in the Thompson project were concerned to work with desktop video conference technology to explore possibilities for individual and small group teaching. This also was a strong concern in the three case studies presented in this research. However, the Thompson project did not cover desktop video conferencing over IP, nor did it adequately distinguish between group and desktop systems. This was an additional encouragement to concentrate on desktop linking (IP).

5.3 Data Collection

Each case study was designed around existing projects that were about to commence and where an opportunity existed to implement and test the IP technology.
Data were gathered in a number of different ways:

- Interviews with students were conducted.
- Interviews with lecturers were conducted.
- Questionnaires were administered in printed form as well as On-line.
- Transcripts of video recording were taken during video conferences.
- Email correspondence took place with participants overseas.

The purpose-designed questionnaires were available in print and On-Line. Two questionnaires were to be completed for each case study, one at the start of the project and another after participation in a number of sessions; however questionnaires were applied in two case studies only as the second case study questionnaires failed to come to fruition:

1. Case study 1: Taiwan students – Swinburne University (see appendix 2 and 3)
2. Case study 3: Lingnan University – Swinburne University of Technology (see appendix 7 (pilot) and appendix 8 (main)).

The questionnaire that was to be devised for the CRC project was curtailed for reasons that will become clear in the description of the case study. All the questions in the questionnaires were formulated in consultation with lecturers, administrators and technicians from both universities as well as the researcher. They were devised with the view to obtain as much information as possible about educational, organisational, human and technical elements that were part of the video conferences.

5.4 Case Study 1

IP VIDEO CONFERENCING WITH PROFESSIONAL DOCTORATE IN DESIGN STUDENTS, TAIWAN

Abstract

This case study reports on an investigation of the effectiveness (educationally and technically) of digital video conferencing over IP across two geographically separate locations, Melbourne and various sites in Taiwan. The study looks at the processes required to set up effective video communications with students using desktop technology. It identifies the hurdles that need to be overcome, and looks at the educational value of such link-ups. It also addresses specific problems related to IP video conferences that most users would encounter when involved in such links.

Background:Professional Doctorate in Design (DDes)

The Professional Doctorate in Design is a program of advanced study designed to meet the professional needs of experienced designers in industry and education. Its focus is upon the new emergent electronics media and their creative application within the fields of design. These have wide application across the entire range of design professions, and are equally relevant to professionals working in, for example, Industrial Design, and Interior Design. Its project-based structure allows the designer to pursue a research goal appropriate to his/her discipline, while using technology to better achieve that goal. The DDes was designed with the intention of using desktop video conferencing for supervision, as students were to be mostly located overseas for the duration of their studies. As there was a strong visual aspect to their studies, video conferencing as a communication medium seemed a logical choice.

Initially, fifteen students from Taiwan were involved in the project which commenced at the start of 2001. All of these students were employed as university or college lecturers in Taiwan. Their motivation for undertaking a doctorate was that without one their prospects for promotion were very limited. The Professional Doctorate in Design commenced with eight weeks of intensive study at the Prahran Campus, Melbourne. Part-time students then returned to their respective homes to continue study.

The strong visual aspect of their research required visual sighting of their design work. Upon return to Taiwan, students were required to establish contact with their supervisors on a monthly basis to discuss their progress. Visual sighting of students' work could not always be achieved through communication via the WWW. Nor could it be achieved through telephone calls or the use of chat facilities. The visual elements that played such a large part in the required monthly communications were seen as essential by the program leader of the Professional Doctorate in Design program. He realised the potential of desktop IP video conferencing for long distance research application. Video conferencing offered not only an immediate person-to-person contact, it also enabled students to show designer work in real-time. Of the fifteen students that initially arrived to study part-time, three decided to change their study to full-time. As a result we could expect to study twelve individual cases of separate video conference links per month.

Case 1 methodology

Following Thompson (1997), the data required for the case study report was to be gathered from interviews with students and supervisors. Additionally, two questionnaires were devised to obtain further data. Questionnaire 2A was to be completed by students immediately after their first video conference. It was designed to obtain data on possible past experience of setting up, establishing and using video conference links. Questionnaire 2B was to be completed after a number of video conferences had been undertaken. This questionnaire was designed to gauge students' impressions of the effectiveness of the video conference sessions.

<u>Video over ISDN or IP?</u>

The Taiwanese project used IP communication technology. To justify why this project used IP as a communication media, it needs to be considered how and why it was selected. This is important as in today's communication environment, IP has become an alternative to conventional communication technologies. Standard video conferencing over ISDN was considered, as this was available on the Prahran Campus at which the National Institute of Design is located, but since the nature of the link-ups required was person-to-person, this seemed an overindulgent and expensive media to use.

Nevertheless, the possibility of using it needed to be considered. On the other hand, IP video conferencing was also available and this seemed to be more suitable for person-to-person contact. The possibilities of linking via ISDN as well as over IP were compared.

The Case for Video Conferencing over ISDN

ISDN based video calls utilise a combination of data channels (called B channels), each offering 64 kbps of bandwidth. A standard business or classroom quality video call requires the use of six ISDN - B channels to provide the necessary 384 kbps bandwidth. This is a suitable data rate to enable a reasonable quality of viewing. As specific cabling is required, the high cost of purchasing and installing ISDN-based video systems generally limits the installation of such facilities to specific conference rooms and other shared meeting spaces. As these facilities are shared with non-video conference classes, access to the room is often difficult. As the facilities were already installed at the campus, these costs were not seen as important; however, regular access to the rooms was difficult and was identified as a real issue. The dynamic bandwidth allocation, described previously for ISDN-based video conferencing, requires the use of dedicated data lines. Once connected to the video conferencing system, these lines cannot be shared between more than one video conference systems, or by other applications/users within the organisation. Also general video conference demands existed in the University, the lines could already be in use by other users when planning these additional video conferences.

Positives & Negatives

On the positive side, the School could expect good quality video and audio, and trust it was applying a reasonably reliable medium using well-established conventional technology. The available room layout and design also made video conferencing over ISDN attractive, as the facility concerned was light and spacious making it comfortable for users. Additionally, the availability of a document camera and connectivity to a PC was also attractive.

On the negative side, there would be significant call costs incurred. The average duration of each meeting was estimated to take one hour, a total of 12 hours per month for all students. The costs were estimated to be approx $390.00 p/h @ 128Kbps (at the lowest quality). The monthly cost would amount to $4680.00. The total costs for these regular video calls were considered to be prohibitive. A further problem was the logistics of booking video conference facilities at the Prahran Campus. The facility was heavily booked, because it was also used for normal classes. This made regular meetings and *ad-hoc* meetings difficult to organise. Additionally, it was seen as unlikely that all of the students in Taiwan had immediate access to ISDN video conference facilities. The PC connectivity in the video conference room was available; however, it worked though a VGA converter, which results in a quality that is less than desirable, especially if small fonts or fine detailed artwork were to be produced. Additionally, the reliability of the ISDN connections through the Swinburne University infrastructure at the time was low. This is a common problem in many organisations. Other research projects in other organizations had experienced reliability difficulties as well. (For example, the 64 % average reliability factor of ISDN connections was also unacceptable to Henkel (2002)).

The Case for Video Conferencing over IP

The majority of new and larger types of video conferencing systems available today support operation on both ISDN (H.320 protocol) and IP (H.323 protocol) networks; however, this is not always the case with smaller desktop systems, which usually run across IP only. This is changing with the implementation of MCU’s that can connect ISDN as well as IP calls. The benefits of IP-based video conferencing are given below.

Minimum purchase Cost

IP video conferencing systems are usually less expensive than ISDN-only based systems. In desktop video conferencing, participants use their PCs as the basic processing engine for IP conferencing. The incremental cost is typically only the cost of a quality camera. This can be as cheap as $80 - $100.

Minimum User Cost

Users of IP networks do not incur per-minute usage fees (internally). The Swinburne University existing IP data network has the necessary bandwidth and quality of service to support video traffic. Video calls originating and terminating on that network are free. In addition, many IP network providers offer flat rate plans for network services for data rates used externally to the organisation. With these plans, the network usage is often viewed as a fixed cost which allows either a certain number of usage hours or, in some cases, an unlimited amount of network usage. Swinburne University, like most Australian Universities, has an arrangement with AARNet, which provides network services at reduced costs. Data rates used for video conferences are added to the normal cost of normal data rates used. These rates were not charged back to individual departments. This made video conferencing over IP extremely cost-effective to the School involved. The real data usage cost, however, even if a charge were applicable, is not a barrier (see Table 5.4.1).

Better Audio and Video Quality

The quality of a video conference meeting depends heavily upon the available bandwidth of the connection. IP networks typically offer at least 10 Mbps bandwidth to each video system. Therefore, a standard IP video call can be placed at speeds of 512 kbps or even higher, resulting in an enhanced level of audio and video quality. Although theoretically this is true, the desktop systems used in the project were capable of 384 Kbps only. This is at least equal in quality to a 6-channel ISDN link.

Improved Convenience

IP network lines are easier and cheaper to deploy. Video system installations in offices and student homes have become more affordable. Since these spaces are not typically shared with others, these users now have virtually unlimited access to these video systems, without having to reserve any shared facilities. As the students and lecturers involved in the project were planning to link from their respective work places, it was assumed that a reasonable standard college or university network was already available in each location. As IP video conference systems can be deployed at each of the available network points, it was assumed a suitable and available location could be found with relative ease, thus improving convenience significantly.

Gatekeeper Control

As a gatekeeper can be used to control and track the use of video conferencing systems, Swinburne University could, in principle, determine which calls to allow, at what speeds, from which users-system, to which users-system, and across which networks. For example, Swinburne University (through AARNet) could decide that calls from public conference rooms should never exceed a speed of 384 kbps. This is useful at times of heavy data traffic. It would allow video conference calls to be accepted at lower rates which, in cases of lower data rates of 128 Kbps and 256 Kbps, are still quite acceptable.

Management Benefits

IP based video-systems are always connected to a packet-switched network, which allows these systems to be remotely controlled and managed. Management tools are available that allow support staff to effectively manage a large number of locally and remotely deployed video systems. Support staff no longer need to be physically present in the video conferencing rooms.

On-Line Availability

The widespread availability of IP lines for Internet access and the low cost of IP-only video systems have made video conferencing economically attractive. As the availability of broadband increases in homes, the use of video conferencing by students, teachers, and other overseas campuses will increase (Davis and Weinstein, 2002).

Positives & Negatives

On the positive side, the National Institute of Design would have no direct call costs to deal with. This was assumed to be the case for the students in Taiwan. (See 'Call cost comparison IP versus ISDN' below). Calls could be made from various locations, provided that high-speed Internet facilities were available; for example, at the university, the office or from home. These were significant factors, and were reflected in other research (Aber, 1997) and (Taylor, 1997). Additionally, video conference facilities did not need to be booked, either at the Prahran campus or in Taiwan, as it was accepted that the technology could be deployed anywhere near an IP network point. Another positive factor was that desktop video conferencing can be used in a similar fashion to a telephone, thus making spontaneous link-ups a possibility.

There are providers on the market that will allow IP calls to be connected to ISDN calls at reasonable cost. If users needed to use an ISDN facility, they could still link up with the other IP users. Additionally, IP-enabled group systems can connect to personal systems and vice versa.

On the negative side, students needed access to individual desktop video conference facilities either at work or at home. Such access availability was an unknown factor. It was also well known that video and audio quality was likely to suffer in low bandwidth situations, and thus the reliability factor of using IP video conferencing across various unknown ISPs in Taiwan could be questionable. It was not possible to test this before the project commenced.

Call Cost Comparison IP versus ISDN

As the initial research indicated that call costs could be a problem, the National Institute of Design needed to know the realistic facts of these costs. Both conference systems were compared, ISDN as well as IP. Cost comparisons were made for call costs only as the infrastructure costs, that are normally included, were not applicable as it was already present.

Calls over ISDN

ISDN is a metered service. A typical video conference call involves multiple ISDN connections. For example, a single ISDN video conferencing call at 384 kbps requires the use of six data (or B) channels simultaneously, each of which are charged on a per-minute basis. This means that ISDN video conferencing users incur fees for approximately six phone calls, (timed if STD or International), which can make ISDN video conferencing expensive. User costs can be lowered significantly by making video conference calls at lower data rates, such as 128 kbps or 256 Kbps. This means fewer data lines are used, and therefore the total charges are lower. This can sometimes be considered in cases where the picture quality can be compromised. ISDN call charges are based on time and distance. On average ISDN call charges are approximately $32 per hour (128K) from anywhere in Australia to the capital city where the video conference is being held. Infrastructure cost, required to enable ISDN calls, are also high.

Generally, the hire of one Microlink (2 lines) is approximately $950 P/A, regardless if calls are made or not. Swinburne University usually uses 6 lines for 384Kbps calls (line rental equivalent to $2,850 pa). This is infrastructure that needs to be there for no other purpose, other than video conferencing.

Calls over IP

When making video conference calls over IP, the costing structure is different. Since the university network needs to be there for normal data traffic anyway, it is not an extra infrastructure such as ISDN. The network is 'always on'; it does not matter if data flows internally or not. It will have no bearing on its operating cost. Consequently, internal calls can be made cost-free. External cost will lift the annual data download and upload rate though the ISP. This is usually charged at a cost per Mb. Swinburne University uses AARNet at considerably cheaper rates than commercial rates. The following is a call cost comparison of a one hour video call at 128 Kbps (Kilobits per second).

Translations:

1 Kilobyte (KB) = 8 Kilobits (Kb)

1 Megabyte (MB) = 1024 Kilobytes

Call destination	ISDN TELSTRA Government rates	IP standard commercial rate @ $0.08 p/Mb	IP AARNet member rate @ $0.035 p/Mb
SUT campus	**(ATM) no charge**	**No charge**	**No charge**
Melbourne	**$1.98**	**$4.50**	**$1.97**
Sydney	**$28.87**	**$4.50**	**$1.97**
Taiwan	**$389.90**	**$4.50**	**$1.97**

Table 5.4.1 Cost comparison ISDN versus IP (provided by IT Communications)

Note 1: Some minor extra charges may apply for overseas connections as additional ISPs may be involved.

Note 2: ISDN calls are being charged to the originator only.

IP calls are traditionally being charged to both parties, as data flows in and out at both locations. AARNet splits these costs between member organizations.

Note 3: Dynamic Bandwidth Usage

The pricing model in this section is based on the number of bits transferred on the providers IP network. In this situation, it is important to understand that during an IP, the number of bits transferred across the service providers network usually is less than the connection rate (only information that has changed is sent). In other words, during a 384 kbps IP, the number of bits transferred may actually average 280 kbps (or less) per second. The number of actual bits transferred per second is dependent upon the motion content in the actual video (i.e. changes in the video image, see Chapter 2).

According to Masergy (2002), one of the service providers in the US, the bits transferred during a typical IP video conference is actually 30-40 % lower than the connection rate. This factor is valid only for those service provider plans that charge a fee based on the number of bits transferred across the network. Further comparisons between ISDN and IP were made as follows:

ISDN	**IP**
Errors can cause calls to drop	Packet loss usually does not drop the call
Requires NT1s and possibly IMUX	Requires router only (edge device)
Approximately 30 seconds to connect	Approximately 3 seconds to connect
Modems are needed for support	SNMP and Internet browser remote
IMUX codes used before numbers	IP address used for connection

Table 5.4.2 ISDN versus IP facts

The decision to adopt video conferencing over IP was made by the researcher and supervisors involved in the Professional Doctorate in Design project. It was made by weighing up all the positive factors and negative factors of both systems. The main deciding factors turned out to be accessibility of the systems by each individual, as well as the relatively low operating cost of IP video conferencing as compared to ISDN.

Equipment

Once it was decided that video conferencing over IP was to be adopted, research was conducted to determine the most appropriate video conference equipment. The selection criteria factors that needed to be taken into consideration were;

- Low purchasing cost to individual.
- Ease of operation.
- Platform compatibility.
- Quality of service.
- Quality of the visual and audio capabilities.
- Access to application sharing facilities.

Systems such as Tandberg, PictureTel, RadVision, Sony, Polycom and Aethra-Vega2 were all considered. Some were tested or demonstrated, others were eliminated that did not meet all the selection criteria. The final choice was based on ease of use, quality and reliability of the product, bearing in mind that the project's main aim was not to test particular equipment of one brand name, but rather to look at the implementation, educational and technical outcomes of using the media over IP. The research accepted the video conference systems of Polycom, specifically the ViaVideo products, as this were offering QOS compatibility, were easy to use and it were affordable as desktop units. The ViaVideo unit consists of a small camera that can be mounted on a PC monitor. It connects to the PC via a cable and a USB connector. A separate cable connects the audio to the soundcard. The camera has an inbuilt microphone and a manual focus control on the top. Software accompanies the camera, but later versions can also be downloaded from the World Wide Web free of charge (Polycom, 2004). The software allows users to resize the screen and offers a picture-in-picture facility so that incoming and outgoing pictures can be checked simultaneously. Excellent echo-cancelling has been built in so that feedback is almost non-existent. The software compensates for lighting conditions automatically, but also allows users to adjust contrast and brightness manually. Useful directory structures can be set up, as well as easy-to-use speed dial menus. Linking to other units is offered up to 512 Kbps. The Polycom ViewStation is a larger stand-alone unit that connects to a television or monitor. It connects directly into a network point through a fly lead. It has all of the facilities of a ViaVideo unit, but offers a number of improvements.

The camera has a remotely controlled tilt/pan/zoom head. This can be operated by all Polycom videoconference systems, including the desktop ViaVideo units. The camera is equipped with a wider angled lens which makes it suitable for small groups. Separate microphones are supplied, which can be muted. Powerful diagnostics are available, as well as the possibility to manage the unit remotely via the web. Additionally, when combined with a ViewStation, PowerPoint presentations can be uploaded via the web. This can then be shown during video conferences to other units. Linking to other units is offered up to 768 Kbps. Later versions improved upon this and offered higher speeds, depending on the choice of models.

Case Study One, Stage One: First Orientation for Participating Students

In order to inform students about the supervisor-student video links, an initial meeting was arranged. In this meeting students were to be informed of the video conference format, and were required to become familiar with the technology. A first presentation was given to the group of students and took place in the first weeks of the student's arrival at the Prahran Campus. The reasons and benefits of remaining in contact with their supervisors, using desktop video conference facilities over IP, were explained. In brief the benefits were:

- Access to powerful visual media would aid their visual presentations.
- For relatively little financial outlay, almost cost-free video conferencing could take place.
- Supervisors/students could be contacted any time whilst in their office (on demand).
- Video conferencing facilities did not need to be pre-booked.

In the orientation, a demonstration was given of the Polycom ViaVideo desktop video conference system. Links were established to other ViaVideo systems within the University as well as to external locations in Australia and the USA. Additionally, a link to a Polycom ViewStation was established, which allowed for remote operation of the far end camera (zoom, pan, tilt). Furthermore, it was demonstrated that powerful diagnostics of the system performance were within easy reach of the user. It was stressed that by linking two Polycom systems, excellent video and audio links would result, making this a uniquely suitable system for their purpose. It was also conveyed that broadband availability was critical to the project.

Acceptable networks were Ethernet, Token Ring, DSL, LAN, FDDI, FRAME, T-1, ATM or Cable networks, or links to ISPs with at least a minimum of broadband access to the Internet, capable of at least 128 Mbps upload and 128 Mbps download (preferably not shared). Because of the critical visual element of the links, it was essential that only Polycom systems were to be used. As Polycom systems have additional features, students were told and shown that these could also be applied. By linking to a non-Polycom system such functionality would be compromised. It was pointed out that their respective places of employment ought to fund the purchase of such a system (at around AU$900) in order to support their studies. Students were asked if this would pose a problem to them in their workplaces. No concerns were expressed and students agreed to be part of this project. To reinforce the importance of establishing a video conference link with their supervisors and to ensure students were as familiar with the technology as possible, a second presentation took place a few weeks before the students returned to Taiwan. Identical information was repeated and reinforced. It was also explained that this research project was attached and that certain data needed to be collected for the research where possible. Additionally, the following documentation was provided:

- A handout covering the reasons for the research.
- A handout covering the reasons for the monthly link.
- The minimal technical specifications of PCs that should be used.
- The operating procedures of the ViaVideo system.
- A key contact IP address of a video conference unit at Swinburne University.
- A letter explaining and guaranteeing confidentiality of the data and identities.
- A letter of agreement that students would need to sign.
- A letter setting out procedures on how to lodge an official complaint.
- A data sheet that students needed to complete with student contact details.
- An information sheet explaining procedures on how to access required. diagnostic data from the Polycom systems in operation.

A few students raised the possibility that their local networks and/or ISPs might not conform to the minimum standards required by the project; however, after questioning each individual about their network specifications, all students said they thought they had at least access to broadband Internet.

These fell within the minimum specifications and were acceptable. No other possible problems were raised; however, a slight uneasiness was sensed. It was not clear why.

Hurdles

Up to this point everything had gone reasonably smoothly; thereafter, some difficulties arose. Some individual students mentioned in passing and in meetings with their supervisors, that they were uncertain about their workplaces purchasing a desktop video conference system. This was to be the beginning of a series of difficulties that arose during the project.

Purchasing a Video Conference System

A subsequent meeting with two students and the supervisor followed after a few days. The two students involved were identified as having good English language skills. It was clear by this time that other students in the group certainly did not possess strong English language skills. In this meeting, it became clear that there were problems to be addressed. First, it was stated strongly that the purchase of Polycom systems was definitely problematic, as their workplaces were unlikely to purchase them. Second, the students conveyed that other students in the group did not fully comprehend the English language used in some of the presentations. It became clear that some of the IT terminology was not understood, even though the use of technical language was largely avoided. However, there were now fears by the supervisors that adequate English language skills were not present in the majority of attending students. This created a significant barrier to both the Doctorate in Design program, as well as to the research project.

Third Orientation

A third meeting was organised in the hope of resolving some of the problems identified. In this meeting, Swinburne University invited a representative of the International Student Unit who had a Taiwanese background, and could also speak Mandarin. The person in question was also familiar with the local Taiwanese culture. The representative acted as an interpreter and conveyed information to students, as well as to supervisors and the researcher. After addressing the group in Mandarin, a lively discussion developed.

It soon became apparent that the following factors needed to be taken into consideration:

- It was unlikely that their respective places of employment would support the purchase of equipment valued at around $900.
- It was unlikely that individual students could afford a Polycom system from their own pockets.
- It seemed that other (low end) IP video conferencing systems were much more within reach, as indeed some already existed at their workplace or at their homes. Students wanted to use these instead.

Alternative Options

As the University, and the research project at this stage, could not expect the students to outlay the funding themselves for the required equipment, the following alternatives were suggested:

1. Students could divide themselves into separate groups that were within an acceptable travel distance of a central point in Taiwan. Each group, could obtain access to one Polycom system that could be shared by the individuals making up that group. Theoretically, it was possible to have 3 or 4 groups. The costs of purchasing the video conference system could therefore be shared between the individuals. A group of four students would lower the individual cost to approximately AU $250 each.
2. Students could try to obtain access to a conventional video conference system within each of their areas. This would enable students to use video conferencing over ISDN.
3. Use could be made of some existing (low end) IP video conference units that already resided at their workplace or at home. These units could be used with Microsoft NetMeeting. If linking up with these units proved not to be satisfactory to the supervisors involved, students would need to upgrade to a Polycom system, either as a group or as individuals.

Scrutiny of the Alternatives

Alternative 1 was discussed by the students but was considered to be inconvenient to most of the students, as most of them would have to travel to the location of the shared desktop facility. The students were geographically too far dispersed.

Alternative 2 was considered, but large group systems were not easily at hand. Also, significant call costs for each video conference call would be incurred either to the students or to the university. These were likely to be twice the cost of a timed international telephone call. This would be a costly path to take. Furthermore, the logistics of arranging both video conference facilities at simultaneously suitable times were seen as problematic, given that the Prahran video conference room was usually difficult to access. Organising group sessions, to keep the cost down, were also briefly considered, but supervisors found them unacceptable.

Alternative 3 was expected to diminish the video and audio quality of the medium. It was also reasonable to anticipate that the Taiwanese end would receive a good picture from Swinburne University, as well as good audio, given the 34 Mb pipeline to the ISP. However, Swinburne University would receive poor quality images from Taiwan because of the low-end desktop technologies used there, combined with the known poor reliability factor of NetMeeting. Significant packet loss of audio as well as video was to be expected, resulting in broken audio and video freeze.

Direction

Much discussion ensued to flesh out the available choices. The three alternatives suggested were limited; however, a choice had to be made in order to advance the project. Students accordingly made up their minds as follows:

Students	System proposed
5	Group A (sharing Polycom)
1	Small camera via I-Visit
1	Buys new camera, perhaps Polycom
1	Small IP camera from home
1	ISDN VC system, will also try small IP camera at work
2	Small IP camera from school

Table 5.4.3 Representation of students and proposed systems

The total number of students enrolled in the Professional Doctorate in Design was fifteen. The total number of students studying full-time in Australia was four (one additional person opted for full-time study, after 4 weeks into the course) and the total number of students studying part-time in Taiwan equalled eleven (needing access to VC facilities). The resulting selected alternatives were an interesting mix: Five students were able to combine into one group and opted to buy one Polycom ViaVideo system. One student already had a camera, using I-Visit and was keen to use this at home. One student elected to buy a camera, perhaps even a ViaVideo. Another student was to borrow a camera from a neighbour and use it at home. Yet another student was not certain of what was available and thought either an ISDN connection or a small camera IP link was possible through the work place. The last two students suggested they could use small cameras at their school. The researcher, as well as the supervisors, had little choice but to accept the alternatives as presented. It was perhaps not an entirely satisfactory outcome, but it was nevertheless worth pursuing. From the research point of view, it opened up an interesting perspective on the realities of implementing video conference technologies in the mainstream. Students accepted the arrangements as set out and subsequently went back to Taiwan to continue their studies on a part-time basis, whilst going back to work (colleges, universities).

<u>The first video conference meetings: Taiwan – Melbourne</u>

Upon return to Taiwan, regular communication with students proved difficult, even via email. Furthermore, both far-end and near-end users experienced severe technical problems such as firewall and bandwidth related obstacles. It is informative to consider the difficulties encountered. Students went home and appeared to hope that the video conference links would not be required after all. But this was not to be the case. A week in October (2001) was set aside in which students were expected to establish contact with a test unit at Swinburne University of Technology. All students were issued with two IP numbers, one to a ViaVideo unit and another to a ViewStation, both situated in Melbourne. The Swinburne University Information Technology Services Department was involved, and both video conference units were set up with fixed (static) IP addresses. This was important because 'floating' (dynamic) IP addresses, that are usually used, run the risk of changing numbers which occurs when a computer is not switched on for a few days. When it is started up again, a new identity (IP address) <u>may</u> be allocated. The original IP number that one previously may have used to dial person A effectively would no longer point to that person, making him/her un-contactable. The IT Department also had arranged to 'punch a hole' (opened a specific port) in the firewall for each of the two video conference units to allow incoming and outgoing calls. The IT Department was not overly happy to do this, but cooperated, because the perceived threat of network vulnerability was small. It was necessary to do this in order for the video conference units to be able to receive incoming calls from external environments. Both video conference units now were directly contactable and were operational 24 hours per day for the duration of that week (7 days). According to the student choices, a total of seven calls was expected - six calls from individuals using smaller cameras, and one call from group A using a ViaVideo system. During the allocated week in which all students were required to establish and test their video links to the provided IP numbers, no incoming calls were recorded, and no communication was received on the reasons why. After reminding all students via email that they were required to test their video conference systems, a new week was allocated. No calls were established during that week; however, two students emailed that they were busy doing other things, while other students did not reply at all. A new (third) week was allocated. The week allocated was now four weeks after the original week as planned earlier. In this new week, three video calls from individuals were received with mixed results. Two students rang using smaller cameras running from their homes via NetMeeting on an ADSL network. One student tried unsuccessfully to ring in with a small camera using software on a Macintosh computer.

Week	**Test Video Links established**	**Received Email**
1	None	None
2	None	None
3	None	2
4	3	3

Table 5.4.4 Communications of first video links

<u>First analyses</u>

The first two test calls delivered poor quality video with lots of visual freezes at the Swinburne University side. Audio was sporadic and at times non-existent. These calls were made during daytime hours in Taiwan.

Students reported (via email) that their ADSL networks are usually very congested at this time. It was suggested to shift the calls to early morning Taiwan time 8 am (10 am Melbourne time). This provided some minor improvements. Video and audio contact was established. Packet loss still occurred. Only three students, ringing in with a small camera using NetMeeting, made calls that came through. Significant packet loss was apparent in both audio and video. The video conferences were not providing adequate real-time interaction suitable for normal conversation.

The video frame rate was as follows for all calls at 8 am:

	Transmit (Tx) fps (from SUT)	**Receive (Rx) fps (from Taiwan)**
Student 1	18-20	8-10
Student 2	12 –15	5 - 9
Student 3	12 - 24	8-14
Student 4	Not established	
Student 5	Not established	
Group A	Not established	

Table 5.4.5 Transmit and Receive frame rates, Part One

The table suggests that the Taiwanese end of the link viewed better quality video than the Swinburne end. According to the students in Taiwan, this was acceptable to them. However, from Swinburne's point of view, the images were not acceptable. The audio seemed to follow suit. Students received acceptable quality audio; however, Swinburne University received 'choppy' audio. One student who had not yet linked-up suggested (via email) to use Ivisit software since this worked with Macs; however, when tested the systems were not compatible as Polycom works with the H.323 standard and Ivisit uses H.263. Additionally, the MAC-PC platforms did not work using the Ivisit software. So far, only three students had tested and linked with Swinburne University of Technology.

First Polycom-to-Polycom Link-up

Communication with the remaining students proved difficult. Email correspondence with the supervisors continued, but some students refused to acknowledge any reference to the required links. As the initial tests were hardly successful, and group A did not seem to make any progress in obtaining a Polycom ViaVideo system, it was decided to send one ViaVideo system from Swinburne University to one of the most IT literate students in Taiwan. This would at least provide the research with the possibility of testing the theory that linking two-Polycom systems across broadband IP was feasible. It could also provide a basis for urging the other students to purchase a Polycom system. Alternatively it could demonstrate that linking video over IP to these locations was a fruitless exercise. The ViaVideo was delivered to the IT-literate student and set up without any difficulties. Suitable times for linking were arranged; i.e. early in the morning Taiwan time to avoid Internet congestion. The student was asked to wait for our call, but a connection could not be made. Again, synchronous communication proved to be difficult. Many emails (non-synchronous communication) went back and forward, often missing each other. Several attempts were made until time ran out and other commitments needed attention. It was suggested to set up MSN Messenger to at least provide synchronous real-time chat communication.

Firewall difficulties

New time arrangements were made, but with similar outcomes; i.e. neither party could call the other. However, the students could make local (Intranet) calls and Swinburne University could make other (Internet) calls successfully. Soon it was discovered that outgoing calls (external to Swinburne University) could be made but not received. This was already the case at the Taiwan end and this was a known problem there. Even though both parties were able to ring out, neither party was able to receive video conference calls, therefore connecting was impossible. Upon checking with the Swinburne University IT Department, it was found that a new firewall recently had been installed. The IT Department had overlooked to inform interested parties that might be affected by this move. This is an important point because the IT Department had been involved up to this point in setting up fixed IP addresses and opening ports for specific addresses to allow video calls to penetrate the firewall. The IT Department in the University, however, is large, and other staff with different responsibilities were involved in the switch who were not aware of the video conference project.

This explained why incoming calls were not coming through. A request was made to the IT Department to set up individual access permissions for all Polycom systems in the project through the new firewall. We now needed to specify each IP address at Swinburne University that expected incoming video conference calls. This would again allow us to open individual ports for each of these locations to allow traffic to flow in. The firewall in question is a Cisco pix firewall running IOS 6.1.1. The opening of ports in such a matter was necessary, as a proper gateway and gatekeeper, to control and run video conferencing over IP was not available to the project. Simultaneously, students in Taiwan were asked to double check with their IT staff to do the same. This proved difficult as it was not always clear to students whom to contact within their organization. Four students could not identify the proper IT staff member, mainly because their campus was away from the main campus. Five students were unable to convey the firewall difficulties to the IT staff, as they were not familiar with the technology and its associated terminology. In other words, they did not know what needed to be asked, because they did not fully understand the problem. The students were mostly designers and not necessarily IT literate. This was a common problem throughout the project. IT issues were seen as a 'difficult' subject matter. When the firewall difficulties eventually were sorted out, mainly at the Swinburne University end, contact with the Taiwan-based Polycom system was finally made. The result was good. The video and audio quality was smooth and virtually uninterrupted. No significant packet loss occurred. This now cleared the way for the student-supervisor links. The link provided good communication in vision as well as audio. A normal conversation ensued and the technology became invisible.

	Tx fps (from SUT)	**Rx (From Taiwan)**
Student 4	25-30	15 -24

Table 5.4.6 Transmit and receive frame rates, Part Two

First Supervisor – Student Link-up

The first supervisor link was actually established <u>before</u> the successful Polycom test occurred. Although a Polycom system was not used, the connection was successful. Even though the picture appeared intermittent it was considered adequate. The audio quality was acceptable, although not without the occasional break-up problem.

Some packet loss occurred, which resulted in some interruptions in both video and audio. The frame rates were as per student three in Table 5.4.5 **-** 'Transmit and Receive frame rates'. Three supervising staff members were involved. Although conditions were not ideal, supervisors felt it worked well enough they considered it achieved its purpose in having a sense of direct contact with the student. As the Polycom test proved successful, it was now necessary to find out if this success was the outcome of the end user equipment (Polycom) or the result of good bandwidth availability at either the near and far end, or perhaps a combination of both. Exact information on the bandwidth availability at each Taiwanese location was required. Swinburne University had a 34 Mbps ISP pipeline, which was suitable for video over IP to anywhere in the world. Other places would most probably have significantly less. Students were asked to check with their ISPs and/or IT Departments in order to provide simple feedback on their Internet pipelines. The results were as follows:

Swinburne University of Technology	34 Mbps
Student 1 (Taiwan)	36 Kbps uplink, downlink not known
Student 2 (Taiwan)	ADSL 512 kbps downlink, 56 kbps uplink (HOME)
Student 3 (Taiwan)	ADSL 512 kbps downlink, 56 kbps uplink (HOME)
Student 4 (Taiwan)	T2 for school, T1 for proxy server
Student 5 (Taiwan)	Not received
Group A (Taiwan)	Not received

Table 5.4.7 ISP speed availability of locations

Subsequent video link-ups with students and supervisors showed that the T1 access was acceptable, but that the ADSL access was very unreliable. The ADSL connection ranged from reasonable to good quality one moment (eight to fourteen fps), to unacceptably poor the next (four to six fps). This sometimes occurred from session to session, or sometimes within a single session. Shifting the link-up times to early morning connections (Taiwan time) to avoid 'traffic' on the Taiwanese networks made some, but mostly insignificant, difference. It was also clear that student 3, with good bandwidth as well as having access to Polycom ViaVideo, had the most successful combination.

It could also be assumed that the Polycom equipment would work reasonably well on ADSL, as this falls within acceptable specifications by the manufacturer. The research was unable to test this from the Taiwan locations as none of the students on ADSL networks had access to Polycom equipment. Successive tests of independent Polycom users on DSL networks in the USA showed that links through ADSL were very good (18 – 30 fps).

Continuation of Video Communication

The video links between supervisors and students were now regularly attempted, but only with three students (student two, three and four) of the original group of eleven. Student 1 had a bandwidth availability that did not meet the minimum standard and video communication in this case was also halted, leaving only two students from the original eleven. Communication with the remaining two students was aided by introducing a real-time chat program, MSN Messenger, which allowed users to check if participants were on-line, as well as allowing communication with the participants synchronously. The six students from Group A somehow just did not get organised at all. Student five appeared to have no access to equipment. Although they did communicate with each other over the phone (student to student), video conferencing to their supervisor just did not enter their communication strategies. The reasons for this is a matter of speculation as surveys and questionnaires sent to them on various occasions, were simply ignored. This caused a great dilemma within the research and the project was scaled back as a result. Data collected from emails, questionnaires and interviews were received from 11 participants; however, the second questionnaire was only completed by the remaining four participating students and their supervisors. Data and comments collected from all participating supervisors were also included.

The Students' Perspective

There are a number of studies that indicate that using educational technology, including the Internet in this case, to complement and enhance learning will aid effective learning outcomes; for example, Ashton and Zalata, (2000), De Villiers (2001) and Hogarth (2001). As video conferencing over IP relies heavily on the use of the Internet, it is useful to obtain the students' perspective on how this impacted on their study programs. Two questionnaires were designed: Q2A was to be completed by students immediately after the first video conference in which they participated.

Q2B was to be completed after a number of video conferences had been established. Q2A was designed to obtain data on past experience of setting up, establishing and using video conference links. Q2B was designed to gauge what impressions students obtained from using the technology after it was integrated in their studies. Of all the students involved in the video conference project, eleven completed questionnaires Q2A, and only four students completed questionnaire Q2B. The students that tried establishing video conferences with the researcher in the trials, but were unable to establish further contact with their supervisors, therefore did not complete the follow-up questionnaire. Two supervisors also completed both questionnaires.

Summary of Questionnaire Results

(Taiwan students):

Only two students had experienced any kind of teleconference before embarking on this project. These experiences were mainly with audio conference facilities using the telephone. One student had experimented with a desktop video conference unit at home. It could be said that all students, except one, were novices in the field of setting up and using desktop video conference facilities. The student that had a desktop unit experienced no problems with setting up the facility, which worked immediately (locally) after setting up. The equipment used was a Logitech QuickCam Traveller. None of the students received any training in the setting up and/or use of desktop video conference equipment, apart from the instructions they received at Swinburne University. All students, except one, felt that even with the minimal training they had received at Swinburne University, they were still unable to set up their desktop video conference facilities without the aid of others. Students that later were able to establish video conference links with Prahran were more aware of the data rate at which connections were attempted. Most selected 128 Kbps and one was successful at 384 Kbps. All first attempts to link to Swinburne University failed. When the video conference links finally did work, students only rated them at 25% useful. All students experienced frequent picture freezes. Half of the students thought that, at some of the better video conferences, good pictures were received from Swinburne University. This created the illusion that all was OK. It is, however, known now that Swinburne University did not experience and receive good quality video pictures. This added to some of the communication problems.

Taiwan students then thought that the video conference worked well as a communication medium, whilst simultaneously the supervisors at the receiving end did not perceive the communications to be acceptable. Most students expressed their opinion that adding further cameras would have complicated the matter unnecessarily and were happy just to work with one camera. The questionnaire also revealed that, although cameras were usually well placed in front of the subjects, the eye lines were not acceptable and the picture size (mainly 320 x 240 pixels) was too small to pick up adequate details. Furthermore, the students felt that they had no control over interactivity. However, students were in principle comfortable with linking up to other, unfamiliar-looking venues. The overall consensus was that video conferences, conducted over the available (mostly low) bandwidth were not effective. After their first desktop video conference experience, all students said that they would prefer not to engage in desktop video conferences again unless significant improvements could be made to counteract the difficulties experienced. This attitude did not change, even after a series of video conferences had been completed. The exception was the one student who had worked with the Polycom ViaVideo system on a DSL link, which worked adequately. This was the same student who was reasonably computer literate, and had experience in setting up his own desktop video conference unit before embarking on this project.

The Supervisor's Perspective

*The continual frustrations faced by teachers, when technology fails more often than not, make them give up completely. If current IT technologies were as user-friendly as audio and videotapes have been, take up of technology would be much higher than it currently is (*Felix, 2003).

In subsequent interviews with the supervisors, the researcher gained an insight into the values of these video conferences (see appendix 3). The words 'frustrating' and 'tedious' frequented the interviews. The intension was that a small group of supervisors would share the meetings with the individual students. In order to evaluate the usefulness of the video conferences, two-supervisor teams began the meetings. They were the Postgraduate supervisor and the Coordinating supervisor. Each supervisor team consisted of one supervisor and two teachers.

One supervisor commented that the picture was too small and could not be enlarged (a problem with Windows NT, which later was rectified with an upgrade to Windows 2000). It was very clear though that once the link was acceptable, then the technology became transparent. Supervisors as well as the student quickly adjusted to using the medium and began concentrating on the dialogue and content of the meetings. After such links, supervisors were pleased to ascertain that students had made progress with their individual projects. Visually, the supervisors were presented with samples of students' work, but only by looking at files sent earlier by email. Although it was possible to point the camera directly at a computer screen to show work, this did not occur, as it did not represent the best quality. This case study confirms similar findings presented by Felix (2003) who reports:

Access to technology and broadband connections varies tremendously between individual institutions and countries. Even though countries have improved a great deal over the last two years, especially in Northern Europe and Southeast Asia, there are still frequent reports of teachers and students complaining about access problems.

These are findings are also confirmed by Zahner et al., (2000) and Davies (2000).

Summary of Findings

1. A total of 27 video conferences were attempted between Swinburne University and Taiwan.
2. All of these conferences were one student to a team of three.
3. Only three students were involved in (more or less) successful links: 8x student ID. 2, 5x student ID.3, 15x student ID.4.
4. 33% of those interviewed thought at least one of the video conferences was perceived to be effective.
5. Reasons for video conferences not being effective:
    - Sound and vision did no occur simultaneously
    - Drop-outs
    - Needed to re-establish calls 3 or 4 times per conference
    - Sound was substandard
    - Conversation was stilted

- Failings of the technology were intrusive, which impeded the flow of the conversation

6. 100% of interviewees thought that most video conferences were **not** completely effective.
7. 33% of interviewees thought no good interaction occurred.
8. 66% of interviewees thought audio was acceptable.
9. 66% of interviewees thought video was acceptable.
10. 66% could not define if the interaction was a combination of video and audio. 33% relied on audio for 90% and vision 10%.
11. 100% of interviewees used email to send electronic files to be previewed. Emails were also sent to confirm key-points agreed to in the video conference meetings. All participants used emails to communicate synchronously when attempting a linkup, mainly to confirm if they were there, ask questions such as "are you dialling? I cannot hear you", etc. Chat or phones were not used at all by the teams.
12. No use was made of additional electronic media.
13. 66% thought the video conferences did not meet the objectives set out; however, they thought objectives were gradually modified along the way.
14. 66% were unable to complete the meetings satisfactorily.
15. An average 3 times during each meeting was the session restarted because of lock-up or freeze frames.
16. 100% were not aware of what equipment was used at the far end.
17. The Prahran office environment was not suitable, as there was no sufficient space. Also the camera pointed to a bright window so the supervisor could not be seen properly as the camera iris made him appear very dark in the frame.
18. All work was sent in emails, before meetings took place. No students showed any visible evidence of work produced live in a video conference.
19. 100% thought the far end environment looked fine, pictures better than sound,
20. Some hindrances were observed, for example, it would have been good if the camera focus and exposures could be adjusted automatically as well as manually.

The Taiwanese video conferences attracted many comments from the supervisors involved and they are summarised as follows:

- You are 'aware of the technology', for example, you are aware of its (the technology) shortcomings when the frame rate is low, and the audio drops out. This is not good!
- It was hard to concentrate on the conversation as too many technical issues were occurring. This distracted from the original intended agenda.
- When the links worked to satisfaction, meetings did not require much more preparation than normal meetings.
- The students do not seem to look at me directly. This is a little off-putting.
- A big screen would improve any detail that was difficult to see on the small screen used. This was not adequate.

For data summary of the interviews with the supervisors: see Appendix 4.

Accepted Values

The investigations for the report "Video Conferencing in Higher Education in Australia" (Mitchell et al, 1992) states that 'the aspects the lecturers involved in video conferencing like best, are as follows':

- Video conferencing is easier to prepare for than other distance delivery modes.
- Distant students like seeing their lecturer.
- The medium enables a lecturer to offer stronger support to their students.
- The medium provides opportunities for real time action.
- The medium provides students with opportunities to interact with peers from other sites.
- The visual medium, used appropriately, is very effective.

The research did not attempt to test or match these findings, but it is interesting to make some comparisons: The preparation required for these video conferences was minimal as they merely consisted of interview-style conversations. An important factor was to place the camera so that a well-composed picture would be visible that was pleasing to the far-end. In this case, it meant two supervisors placed in front of the camera, away from backlight.

The Taiwanese video conferences certainly created the feeling of visual contact at the meetings. Body language was clear enough to be useful. Visually, far end participants needed to be reminded of proper camera placement in order to obtain better eye lines. Visuals were useful mainly with student four; in as much as the design work could be displayed with relative ease. Even though technical problems were part of most link-ups, students were happy to receive visual real-time support as such. They asked a lot of questions and supervisors were able to communicate in most cases. It was clear though that communication was best and relatively worry-free in the case of linking to student four. The immediate comments from the supervisors were very similar to some of the findings in the investigations for the report by Mitchell et al. (1992).

Stumbling Blocks

This case study brought many interesting facets to light that were unforeseen. The video conferences were expected to raise some technical issues, as well as some human factors; however, the human factors largely dominated the study. There were a large number of difficulties to overcome, but the most complex stumbling blocks; the human factor, turned out to be the most challenging.

The stumbling blocks (all of which had related human factors) can be grouped as follows:

- Cultural problems
- Language problems
- Process problems
- Technical problems
- Communication problems

Cultural and Language Problems

It was clear from early in the case study that language was playing an important part. Not only did the students appear to struggle with some of the English language, it became apparent that the use of English computer jargon was inappropriate for the Taiwanese students. The culmination of these shortcomings complicated the case study beyond the research expectations.

Furthermore, it became evident that significant cultural differences and values were playing a part in the communication attempts of the supervisors and researcher involved. The topic of Asian values began to appear in academic discourse in the 1970s and in the media discourse of the West, as well as in East and Southeast Asia from the 1980s (Atalas, 2002). The social science literature distinguishes the process of 'Modernisation' from that of 'westernisation' (Atlatas 1970). There were Asians who insisted that a form of modernisation that selectively kept out Western influences and retrained tradition was possible. Thus even Asian countries that appear to be very modernised still will have retained significant traditional values. This can be misleading to the unsuspecting Westerner. In Western culture we take for granted a communication style that basically consists of relatively straightforward question and answer techniques. In most cases, questions that are raised, either formally or in casual conversation, will be answered more or less directly and there is an expectation that answers obtained in such a manner are usually truthful. We may, at times, not like the answers to our questions, but as a rule this is accepted. It also invites discussion and debate, which is important for two-way communication. As this is the Western way of communicating, we may assume that this is automatically the case elsewhere in the world. In other cultures, however, this may not always be the case. Many students from ethnic minority backgrounds, studying in an unfamiliar cultural environment, have a heightened fear of failure (Dalglish, 1990). This may explain why there was very little opposition from the students when they were asked to agree with something. The research also observed that email messages to students concerning technical and organisational matters appeared to be ignored. This could reflect of fear of failure: students were on unfamiliar ground when technical questions were asked. Rather than reply with a 'wrong' answer, it was possibly easier to ignore the question. Email communication in these matters, therefore, was of little or limited value.

Whitley (1991), commenting upon the social construction of business systems in East Asia, states:

> *'In Chinese society, commitment to one's family overrides all other loyalties, and individual prestige is based on family standing rather than being organisational or occupational'.*

As our Taiwanese students were combining full-time work with part-time study, as well as family life, a few were complaining about "having not enough time" for the project. These complaints were frequently voiced to the supervisors involved in their studies. Additionally, as the research showed, spoken English is not always fully understood, even though students may appear to understand. This may also stem from the possible belief that it is better not to disappoint. When not aware of such customs and behaviour, frustration (in our culture), could (and did) occur. It can be argued that this is a difficult area to work around, even if one is aware of such cultural influences, as it lies at the very base of communication. When communication lines are not open, everything else seems to be open to failure. Some of these issues did play a large part in our communication with the students.Additionally, students were so busy combining study, work and family life that it was entirely possible that the study progress made at the time was not sufficient in some cases. The presence of a video camera that could link with the students 'at any time' was possibly seen as an unwelcome intrusion and one where no excuses could easily be made for not delivering the study results. One supervisor suggested that the camera could make students feel like 'naughty children' being caught not doing enough. It offered the possibility of the student 'losing control'. Claiming not to have received any email or any other form of asynchronous electronic communication appeared to be a very easy way out in such cases.

Process Problems

The research took liberty to assume a number of things, which later turned out to be of serious consequence. A summary of expectations can be listed as follows:

- The performance specifications as supplied by video conference equipment suppliers are 100 % reliable from a user perspective.
- Students will have access to Polycom equipment, or can organise the purchase of these through their respective places of employment.
- All participants of the program understand basic English.
- Participating students will respond to email requests when required.
- Students will be familiar with the technology, after instruction and training.
- Appointments with students will be kept in most cases.

The case study showed that none of the above expectations were met. Indeed, all of these assumptions proved inaccurate and created more problems.

Process Summary

The process followed for this study can be summarised as follows:

- Tested and selected the appropriate video conference equipment.
- Briefed, trained students and staff in main facets of video conferencing.
- Insisted that participants use the same standard VC equipment.
- Awareness of cultural differences before commencing projects and finding a way to work with it *(This was addressed but was clearly under-estimated).*
- Obtained bandwidth information at all locations from participants, before commencing the program.
- Adhered to a rigid timetable, preferably at less busy network times.
- Ensured (local) IT department was aware of the program.
- Ensured (local) firewall issues were cleared.*
- Tested video links with individual students.
- Distributed contact IP addresses of all participants.
- Kept the first video meetings short and increased duration once expertise has developed.
- Obtained answers of the questionnaires from participants.
- Follow-up Interviews with all participants..

* (A list of protocol and port numbers affected by video conferencing over IP can be found at the Internet Assigned Number Authority (IANA) Protocol Numbers and Assignment Services, IANA port number, and the RFC 1700 web pages).

The following items should have been part of the process, but were not addressed formally and adequately, or were overlooked:

- Ensure that students obtain access to identical video conference equipment.
- Ensure language barriers are cleared before the video conferences.
- Use MSN Messenger, or similar, for synchronous backup communication.
- Confirm that the trained students and other participants of the planned video conferences have good understanding of the technology by testing them.
- Ensure far-end, and near-end IT Departments are aware of the program.

- Ensure that bandwidth information from each location is obtained from the local responsible IT person or department.
- Ensure (far-end and near-end) firewall issues are cleared with IT Department.
- Assist first supervisor links.
- Ensure part-time students are happy to participate in regular video links before signing up to a particular course that required this technology for communication.

Technical Problems

The main technical problems identified can be grouped as follows:

1. Firewall, locally and far end.
2. Bandwidth availability.
3. Obtaining identical video conference equipment.

Although the following list is very short, the implications of difficulties in these areas should not to be underestimated.

1. Firewalls are important to IT Departments. These Departments are usually very reluctant to punch holes in them to let certain video traffic through (for good security reasons). Without opening ports in firewalls, communication external to the organisation, is usually not possible, unless sophisticated gateways and gatekeepers are utilised. These separate gateways and gatekeepers are not always available or set up for video conferencing at each location. Where available, they will usually permit bypassing the firewall security, as well as providing better addressing. Firewall blockages are probably the main causes where connectivity in video conferencing from organisation to organisation is obstructed.
2. Bandwidth restrictions are equally as important as firewall blockages. Without the availability of sufficient bandwidth, there is hardly any point engaging in a video conference, as the communication links will be too slow to handle the required refresh rates that are needed to adequately display moving images. The lack of bandwidth can also severely hamper the flow of audio in both directions. Communication is very difficult in such circumstances.

3. Similar video conference equipment of the same brand should be used. This increases the likelihood that quality links can occur, provided the bandwidth is available. This was shown in the only Polycom-to-Polycom link-ups that occurred. It also ensures that additional functionalities are available, such as audio cancelling, camera control, zoom, pan, people and content etc. Although video conferences can take place by linking high-end IP equipment to an $80 camera, it is unlikely that a quality communication will result for both parties.

Communication

Communication can be achieved in many ways, but across a distance one is forced to use electronic media. Communications in video conferences are best when this occurs synchronously. This is especially the case when a video conference link is attempted but fails. A back-up communication system is then required. This can be utilised to sort out any immediate problems, so that the proper video conference can be on its way. Email is not a synchronous communication, so it ought not to be used in such cases. As the case study has shown, sending emails is very ineffective. Telephone is the obvious electronic link, but often there are unacceptable financial consequences to using this, especially where students are responsible for paying for such telephone links. The most effective electronic media are chat facilities, of which there are many. A few students in this case study opted for MSN Messenger, which will inform selected parties when they are on-line. This is an effective way of synchronous communication that can be applied.

Summary of Other Problems Identified in the Case Study

Other identified problems:

- Most parties ignored the appropriate placement of cameras. This led to disappointing visuals in most cases (eye lines, eye level, back light).
- A lack of additional camera or zoom lens for detailed or large visual displays or the lack of a good-sized incoming video picture meant ineffective visual detail.
- Appropriately lit rooms were specified but staff and students ignored these requirements, resulting in less than average pictures. Too bright or too dark.
- Large and distracting objects were in frame; for example, part of computer monitor, windows, passing traffic. These distracted some participants.

- Participants did not have a thorough understanding of IP addressing. This resulted in addresses that were entered incorrectly (no dots) or the use of old IP addresses that had already changed.

Conclusion

An ideal scenario would be to use a medium whilst not being aware of the technologies involved (transparency). This did not occur in this case study as the data clearly shows that the level of frustration with the technology was high with all users. This report indicates the importance of basic technical knowledge that participants still need to have in order to use the medium effectively. Participants also need to be aware of frame rates difficulties and bandwidth requirements. The study showed that, although the medium is a lot more transparent than it used to be, there still is a significant way to go before it can be considered fully transparent. Pedagogically it was clear that the technology was a barrier which is in line with the Thompson project, but one that could be overcome as long as the minimum technical requirements were adhered to, as occurred with student ID four. The medium also proved to be an acceptable visual tool, which aided the students as well as their supervisors as their comments indicated. Body language clearly was visible and helped the supervisors in their communication with the students. The visual presentations of the students' design work that were given, even at a low frame rate, were encouraging enough to warrant persisting with the technology, at least from the supervisors' perspective. Interaction and real time action appeared to flow at an acceptable rate, but only in those rare cases where the technology was acceptable. From interviews with the students, they appeared to like seeing their lecturers/supervisors: supervisors, in return, felt that the medium enabled them to offer stronger support to their students. The additional visual dimensions made students feel that they were communicating effectively. As the majority of difficulties were experienced with all the participating students on low bandwidth access, the video conferences with those students were halted. Video conferences with student four continued until the equipment, which was supplied to him by the University, had to be returned. Although the research expected the focus of this case study to be on its educational values and technology, the outcomes clearly indicated that human factors became major elements in this program. This was partly because of the cultural and language differences between the participants, in particular when 'computer jargon' was used.

The researcher sees the lack of knowledge about the cultural differences of the students as a severe shortcoming of this project. The language and cultural differences ought to have been better addressed by the project supervisors and the researcher before the case study was commissioned. It is entirely possible that, if this had been the case, the outcome of the video conferences would have been the same as there were still significant technical barriers that existed, but this has not been explored in this thesis. Although the supervisor-student meetings were disrupted by this process, supervisors indicated that the results of the meetings are encouraging enough to continue, once technical difficulties have been resolved. One hundred percent of all staff involved indicated that it was still worth pursuing.

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5.5 Case Study 2

IMPLEMENTING IP VIDEO CONFERENCING IN A CRC PROJECT

Abstract

This case study reports on an investigation of video linkage (over IP) with all the partners of the CRC project - CRC Wood Innovations. This is a Cooperative Research Centre, funded by the Australian Commonwealth Government, which receives substantial financial backing from the timber and furniture industries. The mission of this particular CRC is to develop and commercialise new technologies that establish wood as the sustainable material of choice (CRC, 2002).

Background

Introducing video conferencing over IP to this group was considered to aid communications for all the CRC project team members. As most members were widely dispersed geographically, and regular meetings between members were required, the possibility to improve communications as well as to reduce travel was examined. Video conferencing over IP was immediately identified as a purposeful medium that could be applied. The team leader of this CRC recognised its potential from the outset of the project and was keen to implement the video conferencing over IP technology. The research was to document the implementation processes and to examine their effectiveness. As video conferencing in itself was an unfamiliar technology to most partners, it was essential that the technology used was user-friendly. Cost factors were also important. It was clear that significant cost savings could be made, by reducing the amount of travel. Additionally, frequent interstate telephone calls, telephone conference calls or video conferences over IDSN would impact on the cost factors of the CRC project. The CRC project was selected as a suitable case study because it had ingredients that made it ideal for video conferencing over IP. As the CRC project was to develop and commercialise new technologies to establish wood as the sustainable material of choice, it was likely that visual concepts needed to be presented. This called for very good communications to occur between all partners. Communications were to occur through face-to-face meetings with all members of the project. Smaller sub-committees were to meet as well and person-to-person meetings were required for most other communications.

As partners came from geographically dispersed areas as far apart as Perth, Melbourne, Brisbane and Sydney, electronic communications were to play an important role. Partners included the University of Melbourne (UOM), CSIRO Building, Construction & Engineering (CSIRO BCE), Swinburne University of Technology, the Queensland Forest Research Institute, the WA Forest Products Commission, the Furnishing Industry Association of Australia and various private companies. As it was a government requirement in this CRC project to have a rigid meeting schedule, the team leader of the project was eager to use improved communication methods. Video conferencing over IP would allow most members of this CRC to engage in all the required visual communications at a fraction of the cost of conventional travel or communication technologies such as telephone or ISDN video conferences.

Case Study Approach

This case study adopted methods employed by Thompson (1997), and adapted them to the modern desktop IP technology environment. The technology involved in the Thompson's study has changed significantly over the past five years, and its applications have become more embedded into the Internet environment. This case study attempts to set up links with different organisations that are not on the same network. As the Thompson project concentrated on inter-campus connectivity, this case study breaks away from the 'enclosed network environment' and into a global environment. The steps followed were similar to the Thompson case study, namely, to introduce the technology, to train users, to purchase the video conference units, to inform the relevant IT Departments and to provide support where required. Questionnaires were to be administered and interviews were to be conducted in order to gather the relevant data.

Research Approach and Methodology

The CRC group representatives met regularly. At one of these meetings in October 2001, the researcher made a presentation to inform the representatives of the possibilities of introducing video over IP in their respective organisations. Accompanying documentation was presented to the group (Appendix 3.2). In this the argument was made that video conferencing over IP would significantly aid communications between the members of the group.

The benefits were summed up as follows:
There was easy access to facilities through a standard networked PC that most members would have access to. This meant that each member would have video communications in their immediate environment and no bookings of other facilities were required. In most cases there would be no significant call costs involved in making video conference calls. The cost associated with data rates used was different for each user as different ISPs were involved. Some users would pay approx $0.20 p/Mb, other users would pay $0.08 cp/Mb, and AARNet members would only pay $0.03 p/Mb. See table.

Data rate	**ISP – A - 1 Hour $0.20 p/Mb**	**ISP - B- 1 Hour $0.08 p/Mb**	**AARNet - 1 Hour $0.03 p/Mb**
128 Kbps	$ 11.25	$ 4.50	$ 1.97
256 Kbps	$22.50	$ 9.00	$ 3.94
384 Kbps	$ 33.75	$ 13.50	$ 5.91

Table 5.5.1 Costs per hour for average IP video conferencing

It was anticipated that the majority of video calls would occur at 128 Kbps. In all of these cases it would be cheaper to attend a video conference over IP than to travel to a meeting location. The possible exception would be meetings in the same city, between members of ISP services charging at approximately $0.20 p/Mb for a 384 Kbps call.
As CRC members all had access to different ISP, and at widely various rates as can be seen in Table 5.5.1., the costs were different for each user. University partners were the most cost-effective, being AARNet members. Private industries were less well off, paying wildly varying rates ranging from ISP A and B (Table 5.5.1). Further reasons for introducing video conferencing over IP were that calls were easy to set up and they offered additional facilities such as FTP, Chat, Desktop application sharing and a feature called Snapshot that allowed users to take a quality 'stil' (one frame shot) that could be sent automatically and synchronously via a local browser. The group was informed that a limitation of using a desktop system is that it has a small camera with a standard fixed lens. This makes it suitable for "fitting-in" only a maximum of two people in front of that lens. It is designed as a personal unit. For larger groups, larger systems such as a Polycom ViewStation, ought to be used. This is a small unit that can be placed on top of an existing TV or Monitor.

It plugs straight into an existing free network point. Its camera is auto-focus and has a wide zoom lens. This makes it suitable for larger groups. Its camera can be controlled by all Polycom equipment locally or at the far end connection. The group was informed that connection speeds of up to 512 Kbps were possible. The group was further addressed and connectivity issues were explained. It was stressed that it was of the utmost importance that each IT department was involved in the setting up of the firewall clearances for each system. A fixed IP address was also to be an absolute necessity, if no Gateway was present in the organisation. IT departments needed to open a specific port in the firewall to allow incoming video conference calls. MCU bridging was discussed, as members felt that multi-pointing was to be an important part of communications. Unfortunately, an MCU was not available at the time; however, it was explained that it was only a matter of months before this too could be realised. The group felt that there was a clear need for multi-pointing as the team was quite large.

Stage One

It was recommended that the CRC team members take steps to set up a small network between them. This would ensure that IP video conferencing would become an integral part of the CRC project in the long term.

The following immediate steps needed to be taken:

- Members needed to check if minimum technical standards were present in their respective organisations and that their IT Departments would cooperate with the firewall and fixed IP requirements.
- Members were to purchase the recommended equipment.
- Organise to install the equipment (with assistance from AV/IT staff).
- Obtain a fixed IP address (with assistance from AV/IT staff).
- Open the specific firewall port (with assistance from AV/IT staff).
- Test the links with the relevant IT/AV staff.

Video Conference Equipment:

The group was made aware that when the PC hardware, network and ISP connection minimum standards were met, the conditions were suited to using Polycom products over IP. The equipment recommended were:

- A Polycom ViaVideo desktop system for person-to-person calls (approximately AU$900 at the time) OR
- A Polycom ViewStation 512 for group calls (or better) (approximatelyAU$11,500 at the time)

Further discussion took place regarding the possibilities of multi-pointing as members wanted to link up to more than two locations simultaneously.

1. Polycom's ViaVideo desktop system was working on software that would eventually allow multiple parties of ViaVideo users to link simultaneously. The company hoped it would be available within three to six months.
2. Alternatively, a Polycom FX could be used to set up multi-pointing. This required significant funding of approximately $22,000.
3. AARNet in conjunction with CSIRO was about to trial an MCU, which would allow multi-pointing. It was not clear at what stage this could be available to the universities involved. The availability of such equipment would offer enormous possibilities to the CRC project.

All members were asked to check with their respective IT Departments to find out if their local network and ISP connections were suitable.

Stage Two

At a committee meeting in early 2002, the members were asked if they had obtained the required information from their respective IT staff or departments as agreed in the previous meeting. This appeared not to be the case. Members expressed their frustration that it was difficult to obtain 'sensible' answers from their respective IT Departments. The Queensland members had negotiated with one IT staff member who was keen to help. However, this staff member could not convince other IT staff in the head office in Brisbane to cooperate.

The manager's office of this IT Department indicated that bandwidth was not available for video conferencing as this would 'impact too much on all the other data traffic'. In further meetings the topic was raised again, but with very little progress. The committee requested that members check with their main IT professional to see what impact video conferencing would have. It was suggested that interested parties should contact the researcher so that progress could be made. The researcher contacted all of the key IT people that were known to the members, but upon doing so, it was clear that there was a reluctance to address video conferencing over IP for bandwidth availability reasons as well as security issues. At the midyear 2002 meeting, IP video conferencing was again raised. Interest in the topic had significantly diminished. Three members of the committee, however, were interested. These committee members were approached separately by the researcher and help was offered with installation and training. After an initial waiting period, these members were contacted again, but they now indicated their local IT professionals would not support the technologies. Reasons given were firewall security, and a fear that the download/upload costs would increase. There was a clear concern about "everyone was going to video conference anywhere" impacting on "data rate bills growing too much". After discussions it was argued by the committee that the proposed video conference system would not solve the problem of program meetings because there were 4-6 nodes to be connected. The costs of buying and accessing the multipoint equipment itself (the MCU) were seen to be prohibitive (an alternative MCU was not yet available at this time). Some members tried to convince individual Project managers to buy the desktop video conference unit for point-to-point links only. This was not seen to be as beneficial as the video conference system, and would be acceptable only if <u>all</u> organisations agreed to install these. At this stage no such commitments could be made by any of the members. After the diligent work of one IT professional at the Queensland member site who pursued the matter relentlessly, the matter was raised once again in August 2002, approximately one year after the initial attempt to implement video conferences. IP video conferencing had made significant inroads in universities as well as AARNet by this time. As these organisations have significant impact on IT Departments, the Queensland IT Department had a change of heart and now wanted to trial the video conferences. The researcher offered assistance in the following areas: price negotiation and supplier recommendations, as well as installation. All the relevant information was forwarded. No noticeable progress was made.

In October 2002, two MCU's became available to the group, be it indirectly. One FX unit, capable of linking four points, had become available through Swinburne University of Technology. Additionally, a (60 point) MCU based at CSIRO/AARNET was also now operational. Both systems were made available to the CRC project, free of charge, as some partners were universities. This offered the added advantage that no expensive call charges were to be charged. It was put to the CRC group that multi-pointing was no longer a problem. It was also suggested that problems of connectivity between universities were relatively easy to bypass. This was another matter for smaller companies as some members informed the committee that their companies, suffered from having limited access to the required broadband facilities. The Melbourne University partner was now also convinced that IP video conferencing was a good communication solution and indicated that the University was purchasing a desktop unit. Again, assistance was offered in price negotiation and supplier recommendations as well as installation. All the relevant information was forwarded. The CRC project now had two willing partners to trial using IP video conferencing facilities for their meetings. They were to use Polycom ViaVideo systems. After consulting with the CRC group members again in March 2003, no purchases had been made by either partner, although both had agreed to do so. Both partners were interviewed to find out the reasons this project was just not advancing. Both partners gave various reasons: 'Our IT Department has no trust in the technology' (from IT department staff in QLD), 'it is too hard to deal with tech staff (IT as well as AV) (from one CRC member, VIC)', 'There is no suitable coordination of implementing this technology, as the group is so large and covers various organizations' (from convener CRC project). Further reasons were: 'We have to deal with separate IT Departments in different organisations all with different policies and standards' (from one CRC member in WA), and 'Security issues seen as not being able to overcome' (from one CRC member in WA), and 'The IT Department will not act without setting up a gateway; but implementation of a gateway is too expensive' (from IT department staff in QLD). Other assumptions were made; 'The groups are too large: it is even difficult doing phone conferencing'. Additional comments were: 'Meetings have been scaled back. Now we meet with everyone (60 people) every three months with smaller meetings in between' (from convener CRC project). And finally the following comments made were: 'We did not know how to go about it', and 'Some people are against it because people assumed it was too difficult setting up as well as running the meetings: it will be unmanageable'.

This case study began in October 2001. In March 2003 it still had made no progress. No desktop video conference units had been purchased, and no commitments had been made by any participants to further the project. The researcher recognised that time was running out and as no immediate progress could be identified, nor was likely to occur in the near future, the case study was terminated. It had taken one year and six months to arrive at this point. The options and initial goodwill were exhausted.

Conclusions

Introducing and implementing video conferencing over IP for the CRC project proved a big failure. Even though the technology available was more than adequate for most organisations involved, in the end the project was almost unmanageable because too many different businesses/educational institutions were involved. This was the belief of the CRC members who expressed this in their meetings. Too many IT departments and staff were concerned without having sufficient knowledge to implement the video conference project. This was because CRC members, although willing, were generally not capable of cutting through the IT red tape within their respective organisations. According to members accounts in the meetings, IT staff often did not want to know about IP video conferencing or passed on responsibilities to others within their department who appeared just as uncooperative. Additionally it became apparent in interviews with key staff in IT departments, that IT policies at most organisations were not adequate or at the very least were unclear about the implications of implementing video conferences over IP. Most IT Departments were either not willing or too cautious to address the IP video conference security questions. Additionally, bandwidth restrictions were said to be a major factor for the smaller CRC businesses involved. The group started out with regular meetings of approximately 60 people from all over the country. Not only was this a likely travel nightmare, it was also a group that was probably too large to deal with in a regular meeting environment. Good chairing skills were required to run any such meetings. To obtain agreement on any topic or subject in such a large group would be difficult at the best of times, although not impossible. The CRC members' assumptions that video conferencing with such a large group was going to be too hard to handle were just that. As an example, AARNet members had already started running multipoint video conferences to as many as 25 sites which appeared quite manageable from a chairing point of view. Additionally, linking so many sites technically was also no longer a problem.

Hardware and software changes that were introduced in mid 2002 and early 2003 meant that many of the previously raised objections could be resolved. For example, the picture could now be full-screen, an MCU could be used to link up to sixty separate sites virtually free of charge, data sharing was available, people and content on two screens could be achieved, and the data rate increase to 512 Kbps would have provided better quality images.

It can be said that the implementation of video conferencing over IP in the CRC project was unsuccessful because of all the aforementioned reasons. Additionally, it would have been beneficial to have had access to a capable person within the CRC who could have taken on a coordinating role. This person should have been the main driving force and could have liaised with all key people, including IT Department personnel.

At the writing of this conclusion, the CRC project still intended in principle to proceed with the test unit between Melbourne University and the Queensland Forest Research Institute, Brisbane.

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5.6 Case study 3

LINKING SMALL CLASS SIZES OVER IP FROM LINGNAN UNIVERSITY, HONG KONG, WITH SMALL CLASS SIZES AT SWINBURNE UNIVERSITY OF TECHNOLOGY, MELBOURNE.

Introduction

This was the third and final case study of this research project. It was set up between Swinburne University of Technology (Hawthorn) and Lingnan University (Hong Kong). The aims of this project were to set up and provide effective video conference links over IP between small groups of students and lecturers at both educational providers. This project was partly supported by a grant to Lingnan University for the duration of three years. The grant applied only to the Lingnan University part of the video conference links. Swinburne University of Technology and this research did not receive financial backing. Staff involvement at Swinburne University was on a voluntary basis. The research presented in this thesis was attached to this project, as it provided a useful vehicle for the investigation of implementing video conferences over IP in education.

Abstract

The Lingnan brief was to creatively deploy video conferencing and NetMeeting facilities to extend learning beyond the classroom; to engage students in intellectual discussions and exchanges with students and scholars in other institutions, as well as those outside Hong Kong; and to help cultivate an international outlook for analyzing problems from a cultural perspective. The project was now extended to use IP video conference equipment to enable small to medium groups to link up. It was thought that this could be done relatively cheaply and effectively. The major aims of this project were to set up and provide effective video conference links over IP between small groups of students and lecturers of both educational providers as a means of learning beyond the classroom, thus enabling students to exchange ideas with people from a different cultural environment.

Background

Lingnan University has some significant achievements in teaching development through the use of Teaching Development Grants (TDGs) made available by the University's Grants Committee. For the triennium 2001-2004, the Lingnan Teaching and Learning Centre (TLC) is involved in a major project consistent with the liberal arts mission of the University, and entitled 'Liberal Arts Education, Lifelong Learning and Engaging the World'. This project is made up of three components:

1. a Bookworm Club for University students and staff;
2. collaboration between university teachers and students on courseware development; and
3. video conferencing in the classroom for international exposure and collaboration.

It is the third component - 'video conferencing in the classroom for International exposure and collaboration' - that this research is connected. It provided ample opportunities to investigate the use of video conferencing over IP within small groups, using desktop or similar facilities.

Three lecturers at Swinburne University were approached by the Learning and Teaching support groups of both universities and, after having been briefed about the project, became interested, as they could see benefits for their students in the video links. The topics that were to be covered in the video conferences could easily be applied to the Swinburne University lectures.

Case Study Approach

The case study approach followed a similar pattern to case study one (Taiwan). A difference between the two case studies was that in the Lingnan – Swinburne study there were small groups of students at each location who studied similar subjects that could be combined in class sessions. The project therefore investigated using a combination of desktop and smaller group video conference systems over IP. This adaptation to small group systems was a progressive step, as desktop systems over IP had developed significantly at this stage. Indeed, the choice of end user equipment of video conference systems over IP had indeed become staggering.

Office users, who found themselves together in front of their PCs in meetings of two people (one at each end), learned that there were IP units available that could be connected to the network in a similar fashion to a desktop facility. They could also be connected to an existing television or monitor. The IP cameras had developed and were available with pan and tilt heads as well as zoom lenses. These small group systems had the advantage that more people could be seated in front of the camera, as well as being able to view the image on a larger screen. This opened up desktop video conferencing to small groups. At Swinburne and Lingnan Universities there were to be students as well as lecturers at either location. The small group systems, therefore promised to be an ideal medium for the project.

Case Study Methodology

The research approach and methodology was similar to the approach adopted in Case Study 1 (Thompson). All participants (lecturers, students and technicians) were requested to complete an on-line (pilot) questionnaire after the initial video conference session. This was to provide the initial data. After the subject content had been delivered (after a number of video conference sessions), all participants were again asked to complete the main questionnaire. This was to form part of the secondary data gathering. Where it was seen as necessary, the research has followed up with subsequent interviews with key people involved in the processes in order to obtain further information. This was the third part of the data gathering. Following this, the data were compiled and evaluated.

Applying Lessons from Previous Case Studies

As this case study was the third case study to be undertaken, it commenced well after case study one had been completed and not long before case study two was terminated. This case study started in July 2002, well over 1 ½ years after commencing the first case study. This provided a number of benefits to this particular project. First, lessons were learned from case study one and two, which explains why some aspects of case study three are different. It was clear from the start that the AV and IT departments at both universities were to be involved from the very preliminary stages. Key AV and IT staff were identified and involved. This meant that most technical issues could be resolved immediately.

Second, video conference equipment at both organisations was available immediately and was well suited to linking classes over IP. They consisted of a Polycom ViewStation and an FX unit. This allowed for easy multi-point links where required. Finally, the AARNet video conference over IP project was well underway. This meant that good bandwidth was available (nationally and internationally), and that QoS issues were more or less sorted out. Additionally, it meant that more people were now aware of the possibilities of video conferences over IP. Technicians were a great deal more knowledgeable on IP enabled video conferences, which resulted in an increased enthusiasm. This was also the case for academics who could see the benefits of this technology and who were more willing to use the video conference equipment in their classes.

The Initiating Stage

Following initial contact that was made through educational advisers at Swinburne University of Technology and Lingnan University (July 2002), email addresses were exchanged between the researcher and the technical manager at Lingnan University. IP addresses were exchanged and initial linking (over IP) of Lingnan University and Swinburne University of Technology took place to test IP compatibility, and assess bandwidth and firewall difficulties. As both organisations already had used video conferencing over IP independently of one another, a lot of the technical problems were already sorted out and the link was successful on the first attempt. This was also due to the fact that IT and AV personnel at both Universities had been involved in ensuring that all of the technical questions were resolved before the trials. Links of 128 Kbps were established and both parties could call the other, without experiencing blocking due to firewall problems. Further links of 256 Kbps and 384 Kbps were also successful. Even a 768 Kbps link proved to be reliable and provided good frame rates of 25 –30 fps. On seeing that the technical links had been tested and found to be successful, a meeting time was arranged with all parties involved from both Universities. The parties were made up from the technical manager at Lingnan and the project coordinator for the Lingnan University 'Liberal Arts Education, Lifelong Learning and Engaging the World' project. Additionally, at Swinburne University there was an educational adviser and the technical manager. Furthermore, one additional technician was included at another Hong Kong location.

An agenda was set and the link was established. The first meeting was a three-way multipoint meeting: two locations in Hong Kong and Swinburne University of Technology. This was facilitated through a Polycom ViewStation FX at Lingnan University. This equipment is capable of linking up to four separate locations. This meeting was also technically and humanly a success. The data rate fluctuated at 128 Kbps from Tx 20 to Rx 25 and Tx 25 to Rx 25. Amongst the many issues discussed was the need to select a content course (or courses) that could be significantly aided by a visual link. All pedagogical staff at the meeting considered that suitable courses and 'early adopter staff' could be located at each university and could be actively involved. The term 'early adopter' refers to eager users of technology who have the interest and financial wherewithal to buy new products as soon as they are on the market (Bell et al., 2004). It was clear that an entire course would not be selected initially, but that some course subjects would be suitable. A discussion took place regarding the timing of this project. Both Universities are in a time friendly zone, with a time difference of approximately two hours. However, there is also a season difference, Hong Kong being in the Northern Hemisphere and Australia in the Southern Hemisphere. This meant that the academic year was also different. It was decided that there were only a few months in the year that were suitable. It was agreed that September and October (2002) were to be used for testing, training of staff and identifying a suitable course(s). November was also considered, but as exams usually take place then (in Melbourne), this is a difficult time for teachers and students. December to February is the traditional summer break for Australian universities; however, some summer schools are available during this period. Program delivery via video conferencing could, in principle, occur during the months of March, April and May for Melbourne students. The month of May, however, could also present a problem for Lingnan University participants, as this is the usual time that students in Hong Kong take exams. After these exams, the academic year in Hong Kong would be completed and students would leave for their summer break. Effectively, this would leave a maximum of two blocks of two - three months in the year which were suitable for joint classes for the project. Much discussion also ensued on finding common ground for the disciplines involved, what format the session should take, and what topics for discussion. The meeting closed after it was agreed that suitable academics in a number of subjects were to be approached at both universities.

Importance of Testing

The parties further discussed the importance of rigorously testing the video conference links as well as the need to investigate the use of additional features, including multi-pointing. Additionally, discussion took place that highlighted the importance of offering training to all teachers and students involved in the video conferences.

All parties parted with the following tasks:

- The technical managers were to conduct further tests of the robustness of the video conference links. They were also to report on using additional features in the video conferences.
- The project coordinator and Educational Development Advisers went in search of suitable academics and courses.

Following this meeting, several video conference tests were conducted. A Polycom FX at Lingnan University and a ViewStation 512 at Swinburne University were tested. Following the experiences in Case Study one and two, it was decided that both video conference systems were to be set up in such a way that they bypassed the firewalls of each institution. Consequently, for this reason, no connectivity issues were experienced.

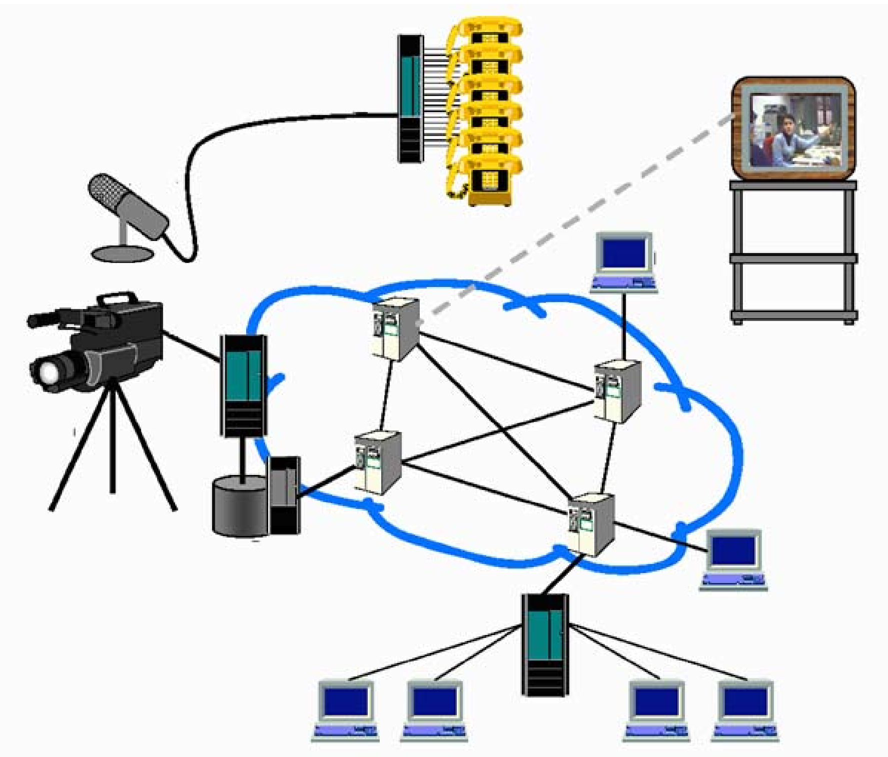

Figure 5.6.1 Schematic H.323 project Lingnan University

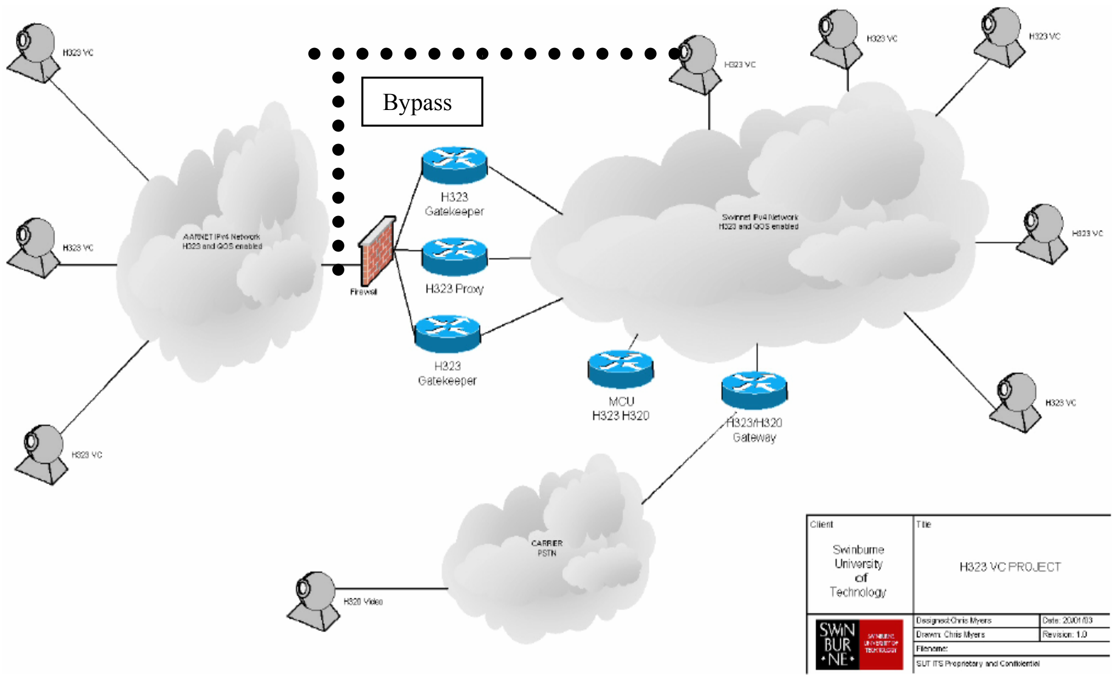

Figure 5.6.2 Schematic H.323 project Swinburne University of Technology

The use of PowerPoint was also tested with both systems and was found to be somewhat limiting. A PowerPoint presentation could be uploaded to a video conference unit via a web browser, and once uploaded to an FX or ViewStation, could be called upon during the video conference. As the PowerPoint presentation within the Polycom environment is utilising frame shots in JPEG format, it was found to be of poor quality and a little slow to load. The quality of the JPEG images was also not comparable with, for example, a standard XVGA display most users are accustomed to. But all things considered, the PowerPoint slide facility could prove to be useful, provided use was made of large fonts only.

The use of NetMeeting was also tested but only as a data-collaboration tool. This too was not totally acceptable to the users. The refresh rates were too slow and the quality was considered poor. The program was also not very user friendly; however, at that stage it was considered a reasonable second option, specifically when electronic media other than PowerPoint on a PC needed to be shown to the far-end.

The Polycom equipment used (FX) at that stage could not accommodate such data collaboration (other than PowerPoint). Polycom also had a product called Polycom SNAP. This product could take snapshots of PC screens and send these to a ViewStation or FX units during a video conference. This feature was a simplified (manual) version of what NetMeeting was offering; however, it did this only on one selected frame at a time. In its simple form it could be made useful and it was suggested that lecturers use it, if needed. It was also confirmed that none of the initial data sharing/collaboration tools discussed would work effectively in a multi-point session, with the possible exception of Polycom SNAP. This was not a problem as the links were all to be point-to-point.

Academic Involvement

The second time the parties met across the video link (November 2002), the participants had formed small groups at each of the universities. Swinburne University had found enthusiastic collaboration from three lecturers, whilst Lingnan University had located four interested academics. Most of the academic staff who attended this video conference meeting had been involved with other video conference links previously, although none had experienced the linking across IP. Furthermore, there were representatives from academic support units present as well as technical support. In the video conference meeting, it was already clear that a commonly available time was difficult to find, but it was suggested that the first classes could commence using video conference technology on 24 January 2003. The class size was estimated to be approximately 25 students on the far-end as well as an additional 20 students on the near-end. The subject for the January class was: international marketing (Swinburne University).The initial topic for the January video conference interaction with overseas students was identified as: using the discussion board, with students writing a reflective piece after the video conference. Upon the successful outcome of this planned video conference, further classes were to be planned for the months of March, April and May. A week before the January class session was to commence, the classes were cancelled because the academics and lecturers involved, both at Lingnan and Swinburne University, were said not to be available. No other reasons were given; however, the January summer school class, being in the middle of the holiday season, perhaps was not the best timing for either University.

In Hong Kong, however, Chinese New Year approached and this meant that Lingnan University was to be on holiday. The timing of simultaneous class sessions in both countries was to be even more difficult than anticipated. The two-hour time difference between the locations was generally not seen as a problem. The main problem was that the academic terms were very different at both Universities as the Southern and Northern hemispheres operate on different seasons. Additional to this were the difficulties with timetabling the classes. Most, if not all, class sessions are confirmed well before the start of the semesters; for example, the timetable for semester one 2003 at Swinburne University was already fixed by September 2002. This left little room to shift classes to coincide with the Hong Kong classes. The commonly available suitable times were from 4 March to 3 May and 1 September to 31 October (Table 5.6.1).

The first lectures were scheduled to take place in the period from 4 March to 3 May 2003 (Table 5.6.2).

	Semester 1	**Semester 2**
Swinburne University of Technology	3 March – 27 June (Exams 6 June – 27 June)	28 July – 21 November (Exams 31 October – 21 November)
Lingnan University	1 September - 6 December	20 January - 3 May

Table 5.6.1 Summary Semester timetables 2003

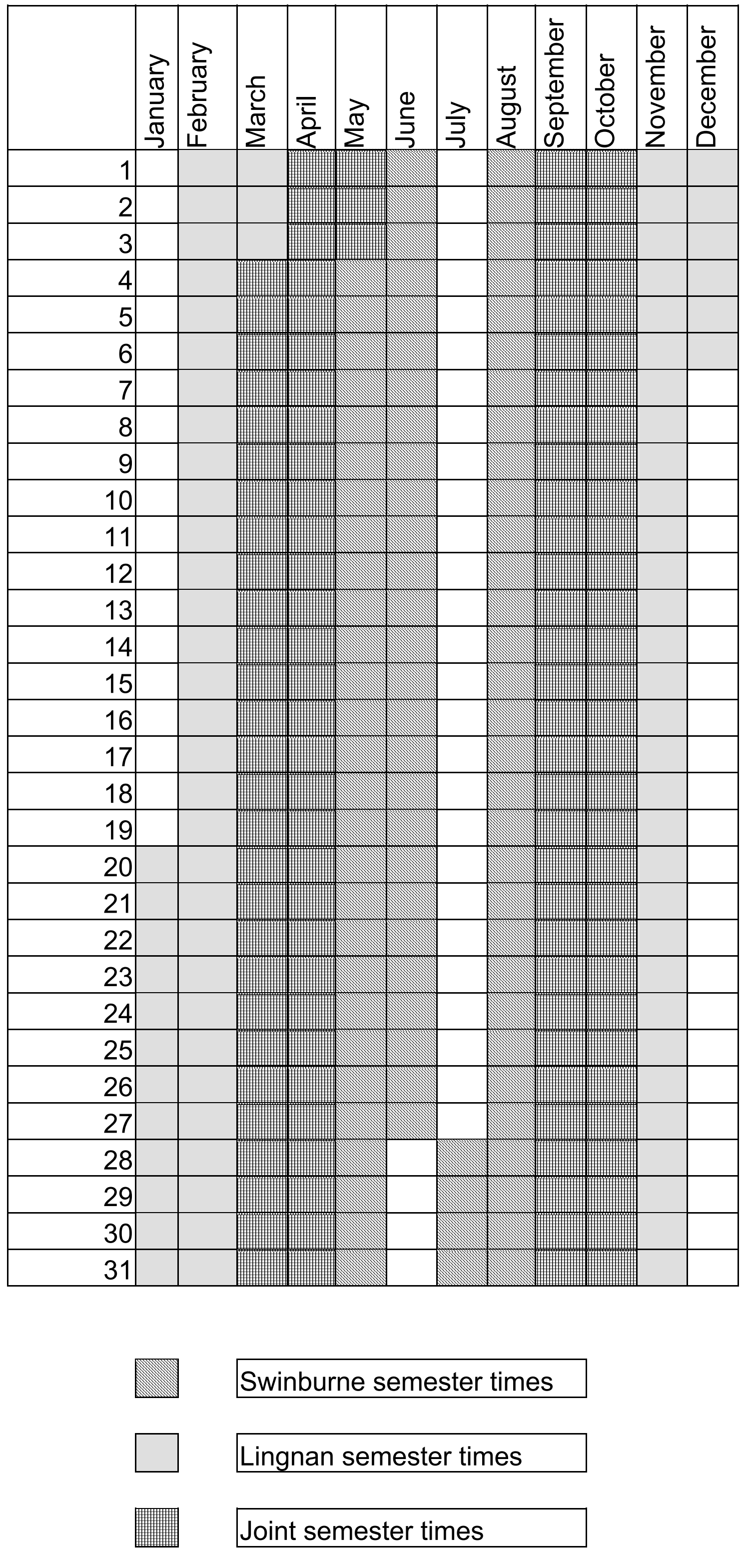

Table 5.6.2 Joint Semester times 2003

In February 2003, another video conference meeting took place between the two Universities. The video conference was arranged so that key players from both locations could get to know one another and exchange and/or draw on each other's experiences. Six key members at Swinburne University (lecturers, Educational Development Adviser and technical support), and approximately 25 participants (lecturers, students, technical support) attended at Lingnan University. This was a lunch time session (Lingnan time). The venue at Lingnan University where the video conference was held was a television production studio, temporarily set up as a classroom. The Swinburne venue was not a classroom, but rather a small office of approximately 4 x 4m in dimension. Neither of these two venues was particularly suitable for a video conference session of this size. The TV studio in Lingnan was large, but rather wide, which resulted in participants sitting very far apart. The technical staff at Lingnan University were well prepared, and had set up (pre-set) camera positions as well as added one additional camera. Switching vision occurred smoothly and effectively so that speakers could be seen when they spoke. The Swinburne room, however, was far too small for six people. When the conference started, some of the attendees at Swinburne had not yet turned up. This resulted in the local convener (at Swinburne) not being able to pre-set positions for the camera. This had the effect that during the conference the operator had to quickly search for an individual who spoke, zoom in, set up a good composition and then store that position. This looked clumsy. After the conference had progressed for a few minutes, the video conference medium became more transparent as all camera pre-set positions had been stored. At the Swinburne room there were also constant interruptions from telephone calls. Even taking the phone off the hook did not help as it kept ringing. Eventually, the cord was taken from the wall socket to avoid further distractions. The convener at Lingnan directed and introduced all attendees at their location. Swinburne tried to do the same, but this was not done smoothly since most attendees had not yet arrived. Most of them arrived within the first few minutes of the conference. This meant they arrived in full view of all the attendees at Lingnan University and this proved embarrassing. The Lingnan University attendees then asked questions regarding Swinburne's experiences with video conferencing. The questions were not directed at anyone specific and were raised in general. This created some uneasiness, as it was difficult to decide who was to answer at Swinburne. At times stilted and uncomfortable conversation occurred. Discussions eventually became a little more relaxed as one person at the Swinburne site actively took charge as a local convener.

This was interesting as it highlighted the importance of a highly controlled or formalized structure that appears to be required. In normal face-to-face communications, both parties can assess the information the other is sending; for example, an eye-line is detected to see to whom a question is directed. A communicator can respond without asking to whom the question is directed. In a video conference, eye lines are very hard to detect and in a group situation are virtually non-existent. All eye contact is usually towards a screen depicting the far end, a point close to the camera. Individual eye contact from one individual to another in a group cannot be made. It is therefore necessary in a video conference to communicate to whom a question is directed specifically. Additionally it appeared that the management problems of these kinds of video conference meetings were really problematic. This can be attributed to the fact that no formal videoconference protocol or etiquette was used by any of the attendants. In hindsight it became clear that attendants needed to be thoroughly trained in such aspects to avoid such problems in future link ups; however this did not occur as the researcher got caught up in other technical and organisational problems that needed to be solved at the time.

Human Communication Block

The image that Lingnan University received was reportedly very good, between 20 –30 fps. The image received at Swinburne University was less desirable, between 10 – 12 fps with significant package loss in between, often when questions were asked. Audio as well as picture freezes occurred at the Swinburne receiving end. This made the flow of the conversation a little difficult, especially at the Swinburne side. The poor frame rate reception was surprising, as this was a problem that had not presented itself in any of the previous video link-ups with Hong Kong. When the conference was completed, several academics at SUT commented that they would find it very hard to teach under such circumstances. One academic said he would not teach at all if no improvements were made. A local discussion ensued as to why. An easy answer could not be given on the spot. There was some speculation regarding appropriate broadband and quality of service (QoS 4). Technical staff were asked to deliver answers. Technicians followed this up with discussions with Lingnan technical staff to see what the problem was, especially since it was an experience far more severe than in any other links with Lingnan. Lingnan University staff was surprised, however, as they had not perceived that Swinburne had experienced significant packet losses.

They were surprised because they assumed, since they received a good quality link, that it would be so for the far end (SUT). It is interesting to note that this is not automatically the case every time a link is established. The fact that the Lingnan University end had not detected Swinburne's difficulties is noted. The difficulties experienced by Swinburne were not mentioned during the video conference by Swinburne attendees. Swinburne staff indicated later that they wished not to disrupt the meeting. Other staff assumed the technology at Swinburne University was inadequate. When the problem was raised at a later meeting, Lingnan University said that they were going to set QoS4 on the network system, similar to Swinburne. It was a process of elimination as we were not certain at this stage if this were the cause of the packet loss problem. Upon further testing, IT staff at Lingnan did not believe QoS4 was impacting on the difficulties that had experienced. They suspected that it was an ISP related difficulty. They were operating on their newly established Internet 2 connections and had experienced some problems. Lingnan arranged access to a new ISP for the video conference (from Internet 2 to HARNET). A further test video conference link was made and this made a huge difference. A frame rate of 20 –25 fps both ways was consistently achieved. The Internet 2 connection proved to be not efficient enough to process the video conference. A good download rate for Lingnan was achieved, but a very poor (restricted) upload was identified as the source the problem.

Pilot Survey - Summary

A number of video conferences had already taken place. All of these were meetings to test the links, flesh out some ideas and discuss the proposals. Attendees had been a mix of lecturers, students, administrators and technicians. At this stage, all participants from both locations were requested to complete a pilot questionnaire which was available on-line (see appendix 7), immediately after one of the video conferences. The purpose of this pilot questionnaire was to gauge the initial impressions of the participants. This was to provide the initial data that at a later stage could be compared with the main survey to see if attitudes had changed and expectations were met. The survey had been designed to measure the participants' experiences with the video conferences so far. Its focus was on the implementation processes, rather than the actual video conferences. The latter would be the focus of main questionnaire, amongst other topics. The respondents came from both Universities.

The survey was conducted over a period of eight months, closing on 14 June 2003. Forty-two questionnaires were returned. The respondents consisted of initial users, from Melbourne as well as Hong Kong, who had been involved in the video conferences up to this point.

The questionnaire had fifty-seven questions that covered the following areas: previous teleconference experience, set up of the video conference systems, other desktop systems, current experience, utilities, quality, appropriate use, local issues, design issues, general feelings and expectations. Twenty-seven students participated in the pilot survey. See details table 5.6.3:

1 Respondents classification:		Count
Student		27
Teacher/lecturer		7
administrator		4
Other		2
Female		23
Male		19
Age 17 - 25		28
Age 25 - 35		3
Age 35 - 45		7
Age 45 - 55		3
Age 55 - over		3
	Total Responses	42

Table 5.6.3 Details of the respondents to the pilot survey

The results of the pilot survey reveal that 52.5% of the participants had experienced teleconferencing in one form or another. Some had been involved in audio conferences, and even audio-graphic conferences, but most of this group (37.5%) had been involved in video conferences, either over ISDN or over IP (Figure 5.6.4). Most of these experiences occurred between 1999 and 2003. The average link-up time experienced during these previous exposures to video conferencing technologies was between 30 to 60 minutes, and its purpose was mainly educational.

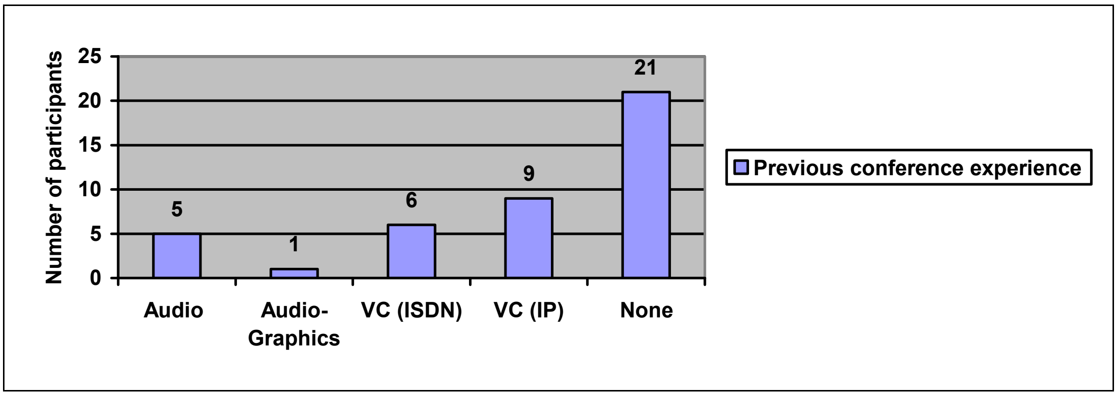

Figure 5.6.3 Previous teleconference involvement

Technical Knowledge

The majority of the participants were students (64.3%), but being part of a pre-arranged group video conference for a class, not many students were involved in the installation of the hardware and software. Of the others (9.5%) that were involved in this process, 75% found it easy to do the installation, whilst 25% of people that were involved in the installation process did not (Figure 5.6.4). This indicated that the hardware and software setup procedures have been simplified significantly since the introduction of video conferencing. As setting up ISDN systems generally would have required specialized technical people from external organisations to be involved, these results indicate that this is no longer strictly necessary in IP based systems.

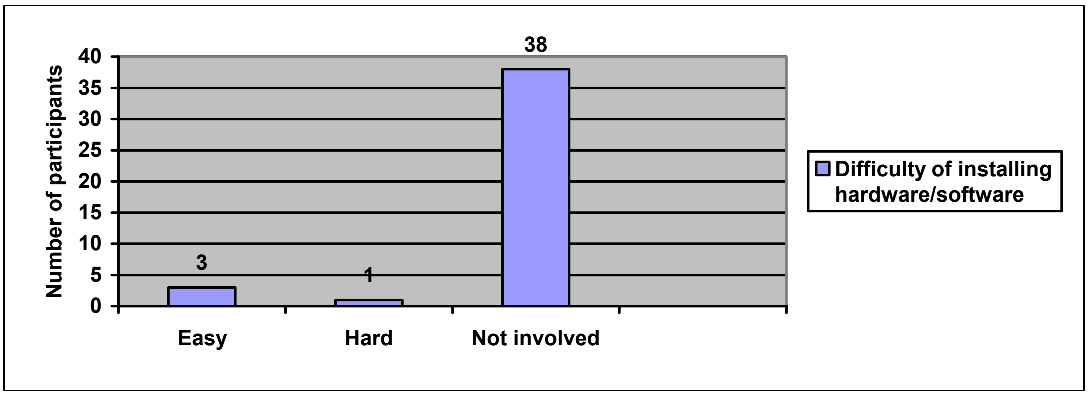

Figure 5.6.4 Difficulty with installing the hardware and software

Of the participants who had been involved in setting up the hardware/software 75% received assistance from the University. Additional to the initial assistance that was provided to set up the initial facilities, participants also were asked what other assistance they had received in getting started in video conferencing and from whom. Figure 5.6.5 demonstrates that the majority of assistance was provided by IT personnel, but that often additional assistance was provided by others such as AV personnel.

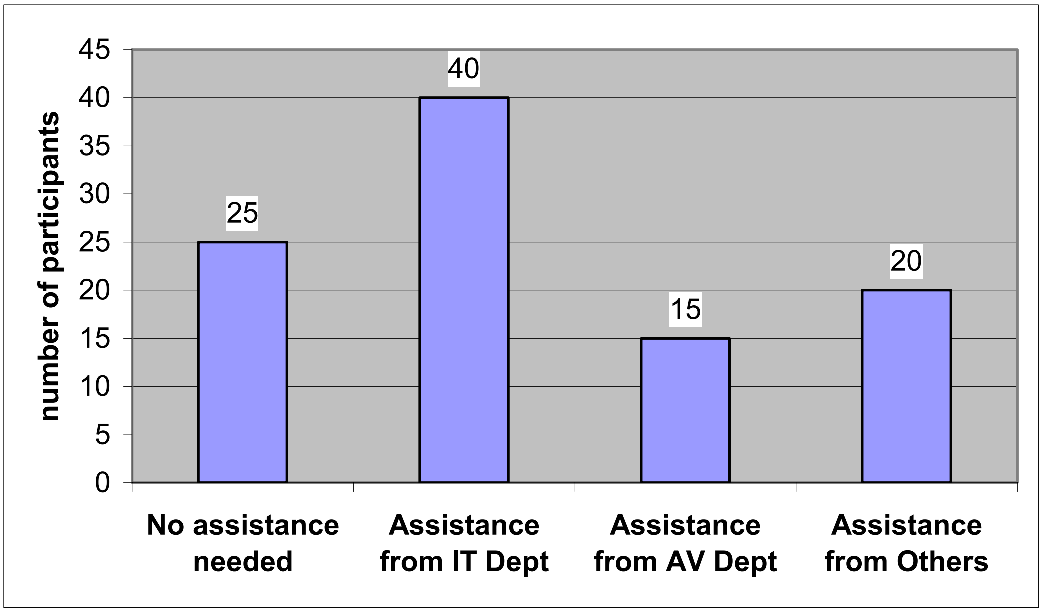

Figure 5.6.5 Assistance provided in installing hardware and software

Most of the help required was for software installation (26.9%), less assistance was required for the hardware (19.2%), whilst some assistance was needed to sort out problems such as firewalls (7.7%) and addressing (11.5%) (Figure 5.6.6).

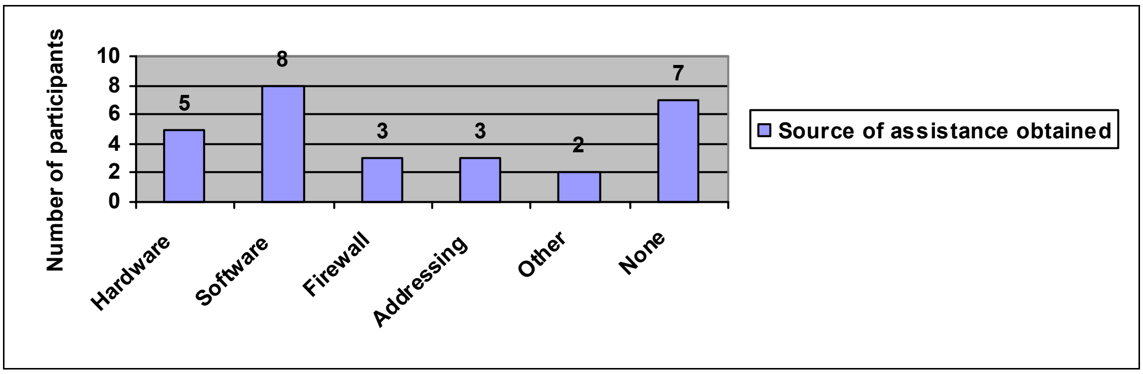

Figure 5.6.6 Issues that needed assistance

Although assistance was required to establish the video conference facilities at each University, a total of 31.2% encountered some resistance from departments and/or individuals involved. Nine per cent of the resistance came from academics/teachers, but 91 % of resistance in establishing video conference facilities over IP came from IT departments (Figure 5.6.7).

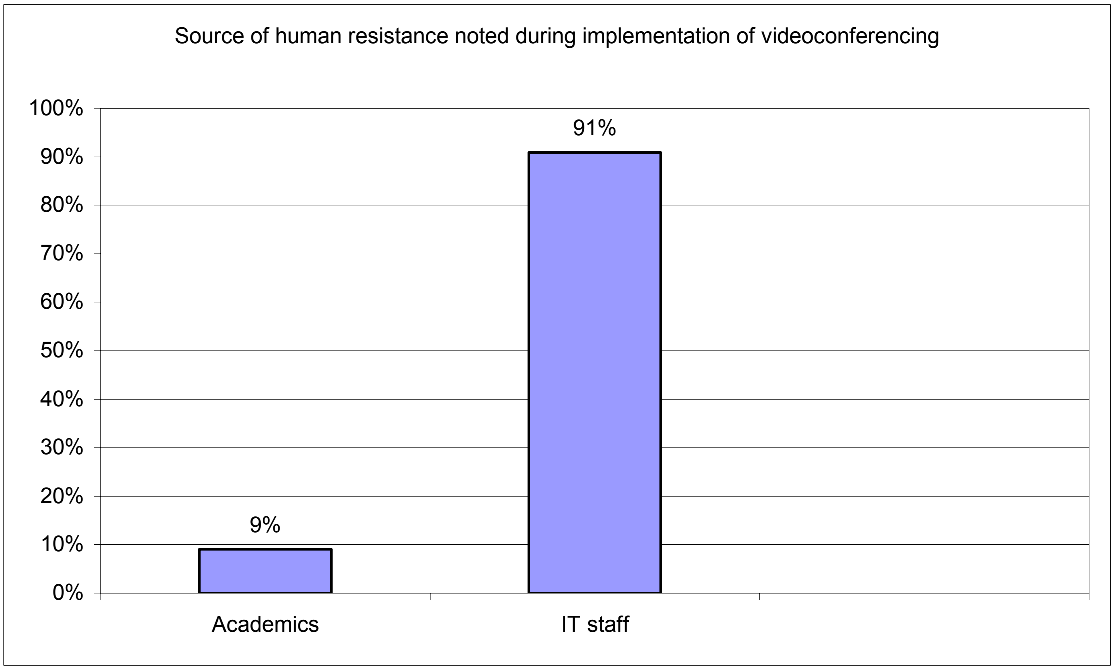

Figure 5.6.7 Noted (human) resistance in establishing video conference facility over IP

This percentage might look alarming, but this should be looked at in relation to the percentage of participants that were involved in the setting-up process (6.9%). As the pilot survey was directed at only a small group of participants, of which 42 responded, this represents a small group. The main survey will shed more light on this issue. These findings indicate that the resistance encountered amongst IT departments and IT staff is important. No resistance was recorded from any other departments involved in this process. It is true that some issues related to establishing video conference facilities do impact on traditional IT areas such as network and software installations. An important area is that of organisational security. IT departments are notoriously protective of their network integrity, for very good reasons. Security infringements can be very serious for large organisations and it is understandable that IT departments tread cautiously in these areas.

What is not clear from the survey results is if this is an official IT department resistance or an individual IT staff reaction. It also is not clear if security is the reason for the resistance encountered. This will be further researched in the main questionnaire. Even though some participants in the survey helped set up the video conference facilities, it is worth noting that nearly 75% did not know what kind of link was used to establish the video conference, nor did they know anything about the technology behind it, such as the use of a gatekeeper. Even during the video conferences, 92.9% did not know at what data rate the link occurred. From an educational point of view this probably is not important, as long as the image and sound quality is good enough for communication.

Training and Coordination

The pilot survey established firmly that the installed equipment (in this case Polycom) worked well immediately after installation (96.3%). This is a clear indication that video conference manufacturers are meeting user requirement, whom for years have complained about the unfriendly complexity of the systems (Figure 5.6.8).

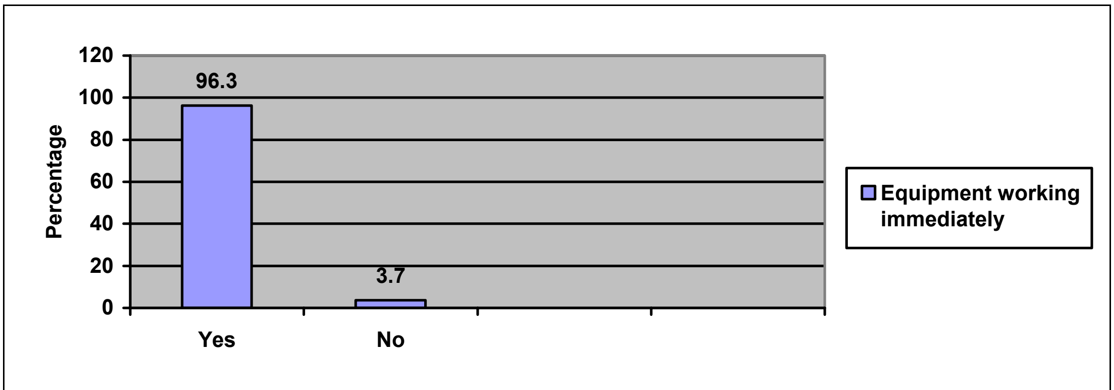

Figure 5.6.8 Equipment working immediately after installation

Most of the participants in the pilot survey did not receive formal training in the use of the video conference facilities and found that starting up without such training was not desirable. Participants that had received introductory training were a lot more confident. The pilot survey also found that if a coordinator was present during the first video conference, it was useful to first-time participants that had not received training, as it provided a cushioning for dealing with the unfamiliar medium. A similar finding was presented by Barlow et al., (2002) who suggest that moderators can make a video conference more enjoyable and even entertaining.

Educational Values

Educationally, participants found that the technology was transparent enough to start "forgetting about the technology". The quality of the pilot video conferences rated as follows:

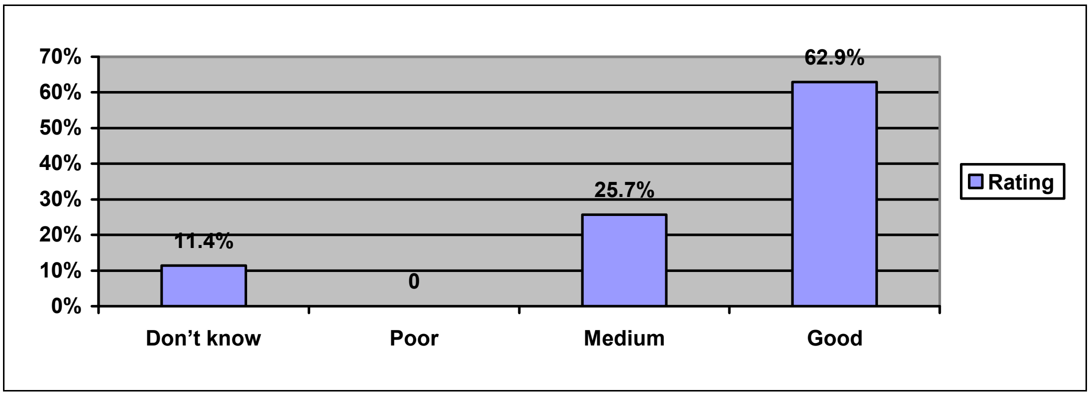

Figure 5.6.9 Rating the video conferences

62.9% of the participants found the quality of the video conferences to be good. There were none who thought the video conferences were poor. Overall the communication went so well that no use was made of a chat facility that was available as a backup. The data sharing facility was only sparingly used. The main program was PowerPoint. No clear opinion was formed if these worked to satisfaction, as 43% did not answer the question related to data sharing. Only 14% expressed the view that the data application sharing used was satisfactory as a learning aid. Overall, 69.2% felt that there was no need for extra educational tools such as software, more cameras or document viewing features. Most participants (83.3%) were happy with the communication (Figure 5.6.10).

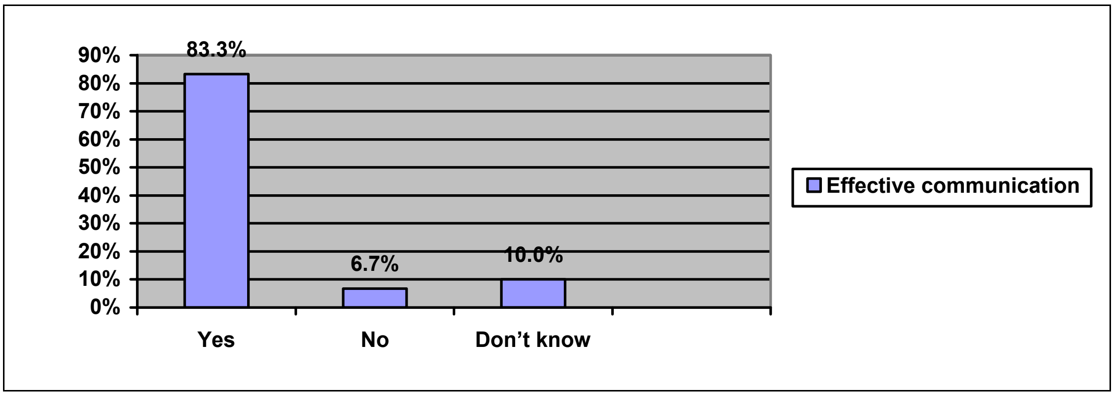

Figure 5.6.10 Effectiveness of communication of the video conference

A total of 70.4% expressed the opinion that the video conferences needed nothing more; however, the remainder thought video conferencing "lacked something", but did not indicate what this might be (Figure 5.6.11).

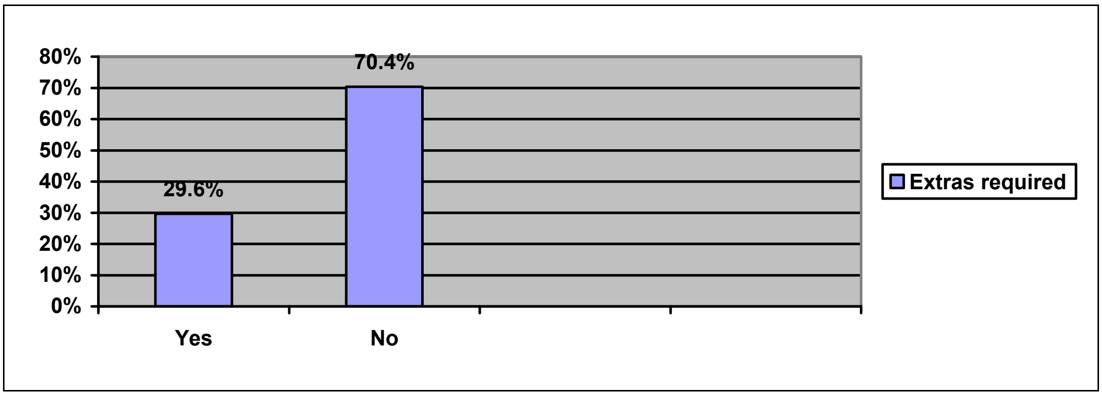

Figure 5.6.11 Need for extra tools required

This could be because not all additional tools and/or alternative communication technologies were offered at the time. Of all the participants, 85.7% would not hesitate to use video conferencing over IP as a communication tool again. A further 10.7% would use it again if some improvements were made and 3.6 % would not wish to be involved again.

Main Video Conferences

In March 2003, lecturers at Swinburne University and Lingnan University were ready to commence joint classes, but an entirely unforeseen event prevented this from taking place. The classes were scheduled to take place just as the disease SARS broke out in Hong Kong. As an immediate result, Lingnan University closed down for some time in an attempt to contain the spread of SARS. This resulted in a further delay in finding an agreeable time. As Lingnan University shut down during this critical time, it meant that all classes and exams had to be delayed. When the University again opened, lecturers were not in the position to make time for the video conference classes, as lost time had to be made up. It was now reasonable to try for a commonly available time in the second semester; for example, the time period between 1 September to 31 October. This was discussed in a video conference meeting in May 2003. The four lecturers involved were to remain in touch via email to further discuss content and to agree on mutually suitable times.

At a subsequent video conference between all the stakeholders, in July 2003, all parties were expected to agree on a mutually suitable link-up time schedule. Swinburne University had available some dates suitable for linking classes and these were all emailed to the relevant staff; however, Lingnan University reported that they had not finalized their timetables as yet. Agreements were made, however, to run video conference classes on one subject. The lecturer responsible for the business subjects (the other topic that was considered) was not at the Lingnan end of the conference, and no such agreement could be made at the time. It was agreed that as soon as the Lingnan University timetables were known, lecturers involved would settle on an agreeable time schedule. This was expected at the end of July.

At the beginning of August, the lecturers finalized their timetables, and dates were set in September and October 2003. Training in the use of video conferencing systems was offered to lecturers at Lingnan University as well as at Swinburne University. It was intended to make them aware of the possibilities and limitations of the technology. Video conferences were set up to show how these were established and what could be done. Although the video conference system was capable of presenting a PowerPoint presentation at both participating ends, it was anticipated that additional software needed to be shown in the video conferences; for example, an Excel sheet, a Word Document, or a web page. The video conference system that was to be used was not capable of integrating such media in the video conference. It became clear that additional technology was required to make this possible and it was decided that an additional Web-conference was necessary. The product 'WebEx' was identified and used as this is a well-established platform that is easy to use and it was already in use at Swinburne University for other web conferences. WebEx was selected to provide users with the option of presenting electronic data in their presentations. This was important as it was anticipated that this was to be a feature to be called upon during the lectures. Demonstrations were given on how to use the software and how to present electronic data. Applications could be presented or shared, whichever was applicable to the lecture.

During the training, the possible layout of room furniture and placement of cameras was also discussed. At this stage it became clear that the student numbers at Lingnan University had increased beyond a 'small group".

Swinburne expected approximately 10–16 students; however, Lingnan expected around 30. This meant that the small group systems and rooms that were intended to be used needed to be modified in order to accommodate the number of students.

The following model was suggested for the Swinburne classroom:

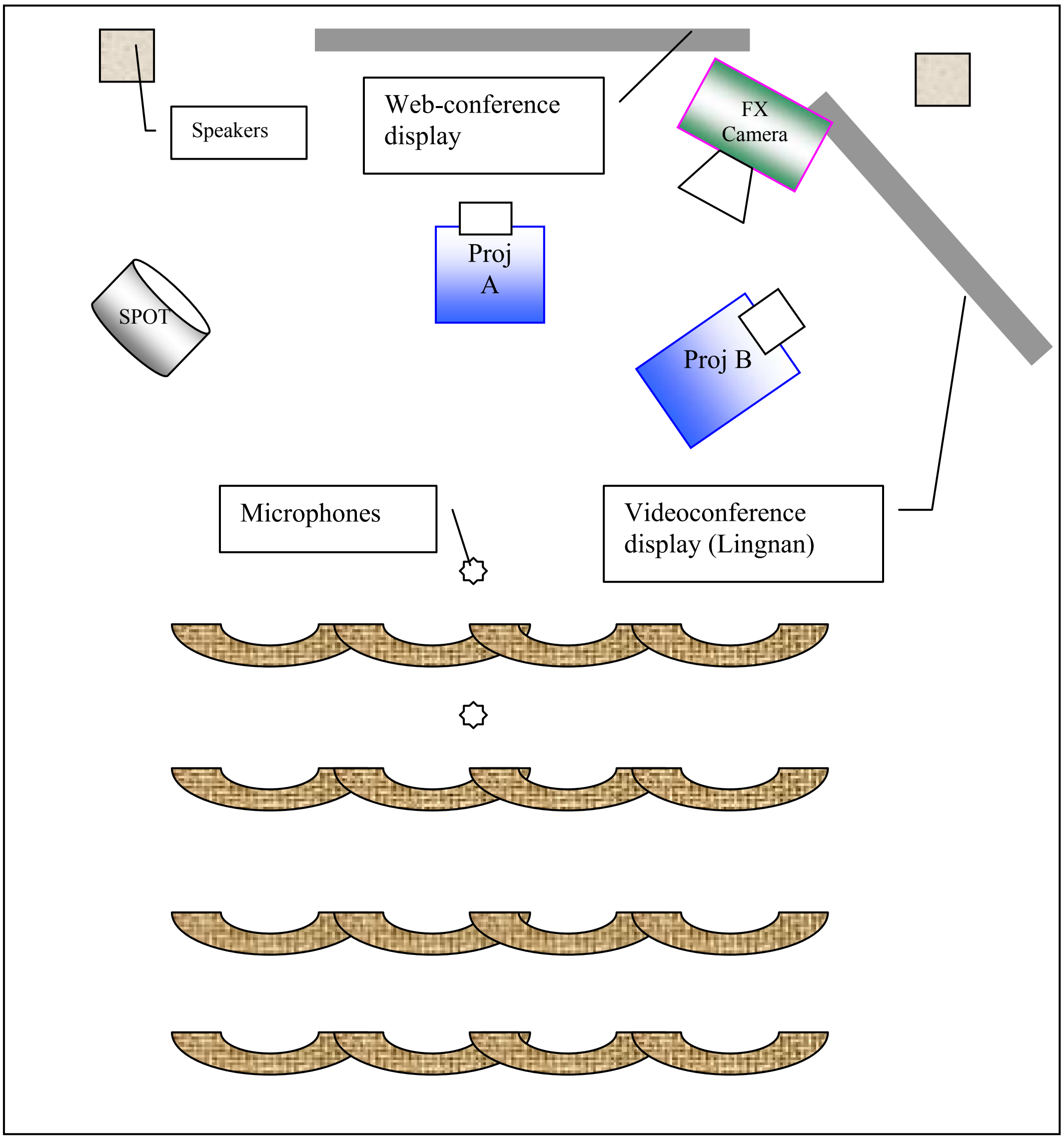

Figure 5.6.12 Room design, furniture and screen placements at Swinburne University

The video display screen was placed at an angle so that a presenter, or convener, standing at the front of the class could see the far-end students as well as the local students simultaneously, without turning their back to one of the groups as would be the case in Figure 4.1 (Chapter 4). The model in Figure 4.4 (Chapter 4) was not chosen as this meant that an additional camera had to be used. Furthermore, this model did not provide an extra screen for the Web-conference display.

The camera that was used (FX) was preset so that it could pan quickly across from showing the students in one pre-set to showing a presenter in front of the other class. Additional lighting also had to be set up as the existing lights in the room were inadequate. An old data projector was used to display the WebEx web conference (an existing ceiling mounted three gun projector). This meant that the Lumens (Lux) were very low. Lights at the front of the class therefore had to be turned off in order for the participant to see the display clearly. A small tungsten light was reflected off the white ceiling to boost light levels at the front row. The light was reflected off the ceiling to prevent 'blinding' the students in the front positions with too much direct light. Two microphones were placed within the seated area. This was considered adequate for the occasion, as the group of participants at Swinburne was not expected to exceed 20.

Lingnan used a TV studio for the occasion. Because of the large number of people attending, over thirty students plus a number of observers, the studio was set up to house them so that various cameras could be placed strategically. Two cameras were used, one for the presenters (FX), and one (DV) that roved to the other students in the large group. As Figure 5.8.13 shows, the six student representatives were seated in the middle of the venue, whilst the main groups of students were on one side. Additional tungsten lighting was used as no natural light was available. One roving radio microphone was used.

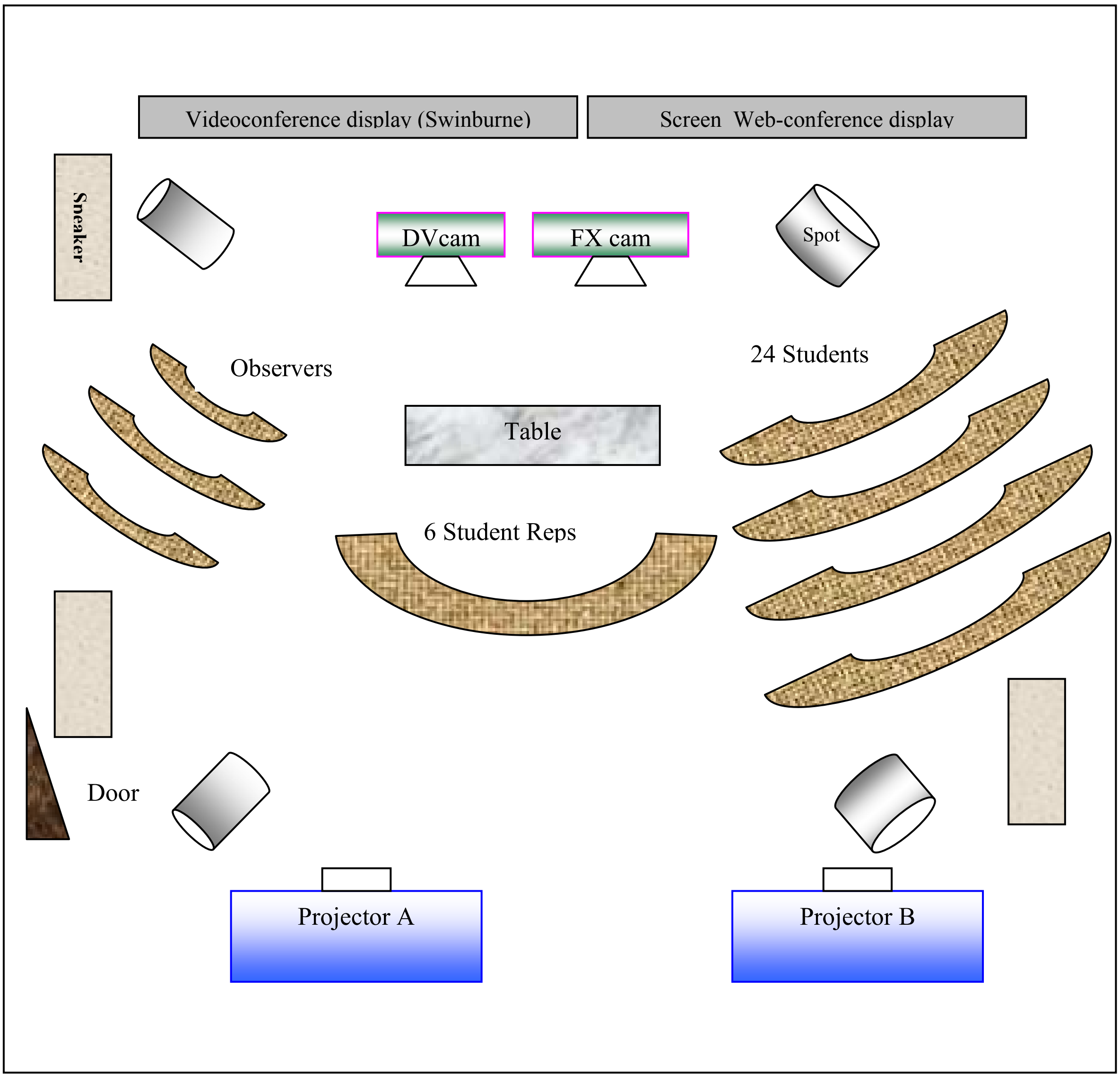

Figure 5.6.13 Studio layout at Lingnan University

The Video Conferences

The first video conference over IP between two classes from Swinburne to Lingnan took place in September/October 2003, 15 months after the project was conceptualised. It ran for a little over one hour, 6.30-7.30 pm Melbourne time, 4.30-5.30 pm Hong Kong time. It was marked as a resounding success by both Universities.

The Brief

Lingnan lecturers had developed a case that was presented to a group of 30 students in Hong Kong prior to the video conference. Six students were selected to represent the case and to argue for and against. Students at Swinburne were then invited to provide feedback and questions afterwards.

The First Observations:

Both classes linked up without incident. Technical support staff at both ends organised this and also checked to see if video and audio came over the way it should. Connection over IP was identified as 768 Kbps. The first noticeable difference between the two video conference sites was the use of the microphones. Lingnan used a handheld microphone, as the group of students was quite large. This resulted in the presentation looking a little like a television show. Students could only talk (and be heard) when the microphone was handed to them. This appeared to slow things down on the first observation. At Swinburne, two microphones were strategically placed among the group of 20 students (see Figure 5.6.14). This resulted in students being able to speak freely at the time of their choice. Lingnan University was to present in this video conference class and thus they formally started the class session. When the class started, Swinburne students were not acknowledged immediately, rather the class just started when the lecturer addressed the local (Hong Kong) students. Only after the first student had made his presentation, and asked for comments and questions, was Swinburne acknowledged. At first, people appeared to be uncertain who the student asked for questions. Most Swinburne students appeared a little camera shy; however, questions were raised and dialogue between students at both ends began. The local camera at both ends looked for a single shot or close-up on students that were talking, wherever possible. Initially, this resulted in some laughter as other students, oblivious to the fact they were blocking such camera shots, were gently pushed out of the way by others. This appeared to be due to students that were looking at the far end picture and not necessarily the local picture. It did not take long for students to ascertain what was going on and to duck or slide out of the way when the camera was focusing on someone in their vicinity. As Figure 5.7.13 shows, the presenters looked at the screen that represented Swinburne. This screen was a little off-side to the cameras, so for Swinburne participants it never convincingly looked like the Lingnan students were addressing Swinburne directly.

It is worth commenting that the researcher was present at the video conferences as an observer and initially was more concerned on getting the technology to work. The failure of observing the correct video conference protocols and courtesies by the leading presenters can be attributed to the little or poor training they received, on proper video conference etiquette, in preparation for the video conferences. This was overlooked in previous video conferences and was still not addressed here. This proved to be a great oversight of the coordinating person, in this case the researcher, who should have provided the training.

Further Immediate Observations:

Other immediate observations were also made. For example, when someone in a large group was asking a question you really had to search for that person to see where he/she was. Students at both ends appeared to have difficulties understanding each other. This was not because of poor audio; rather it appeared to be language-oriented. People appeared to be camera-shy initially, but this became less so during the second half of the conference. Additionally, when questions were asked nobody appeared eager to answer. A considerable amount of coaching by lecturers, tutors and conveners took place to encourage students to answer. As is often the case in groups, some students tended to talk more than others. Furthermore, it was observed that the Lingnan students introduced themselves before addressing the group, whilst Swinburne students did not. It could be that Lingnan students had been exposed to more video conferences than the Swinburne students. Humour was good during the conference: at both ends students joked with one another. The video conference seemed somewhat stilted at the start but appeared to flow more naturally towards the conclusion. It was clear students were concentrating on the incoming picture, whilst also having to get used to seeing themselves on the near picture. This took some getting used to.

Immediate Student Reactions after Class:

When the video conference class ended, initial reactions from students were gauged in interviews. Students mentioned that it took one hour to cover a standard half-hour tutorial, but that it was more engaging doing it in a video conference. All students liked seeing the far end students and commented that they liked the camera singling out people so they could see them properly. Some students wanted it to be more like a tutorial; for example, for the tutor to be more in charge and to speak more.

Swinburne students suspected that Lingnan students were worried about their English. In the first half-hour of the video conference, the international students based at Swinburne asked questions, but in the second half the Australian students were more dominant. All Swinburne students said they did not like the roving microphone at the Lingnan end.

Second Video Conference

Swinburne changed the layout of the video conference room slightly to accommodate the higher number of participants and observers that were expected (See Figure 5.6.14). However, a disappointment was that only five students participated at Swinburne, of whom three had not attended the previous week. The writer has been unable to ascertain the real reason for this poor attendance.

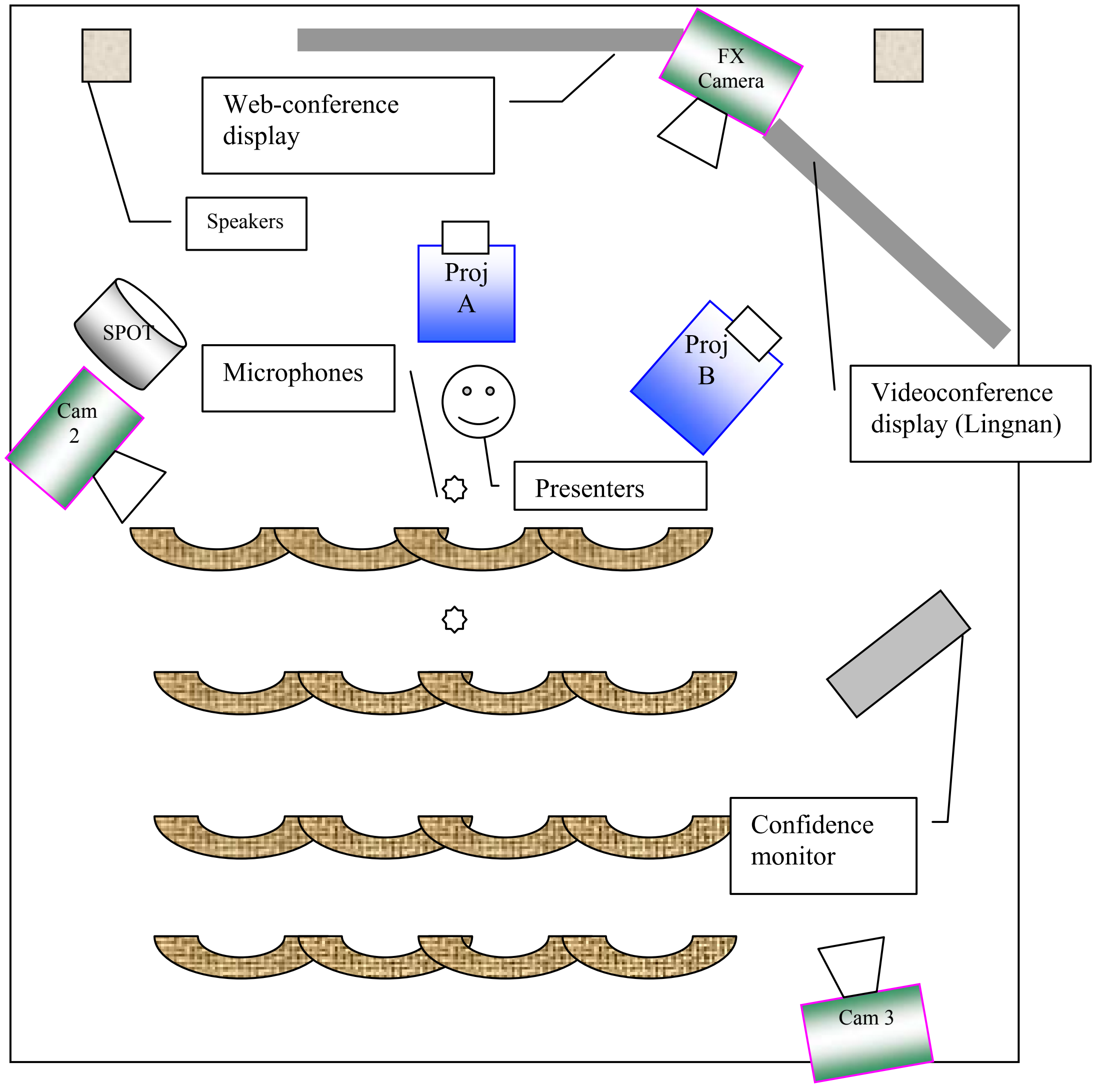

Figure 5.6.14 Room layout video conference 2 (Swinburne)

There was a noticeable difference between this conference and the first. This time, Swinburne students were presenting, and Lingnan students were providing the questions. A separate monitor (also called a confidence monitor) was set up for the Swinburne presenters. This monitor permitted the presenters to view the remote site as well as the images that were being transmitted. It also allowed the presenters to address the local class simultaneously without turning their back to any participating site. This was similar to the experiences of Price and Spence (2002). Students appeared to be more at ease with the medium and were more eager to participate. Conversations were more plentiful and playful. The web-conference provided useful visuals (PowerPoint), which all participants could see on a separate screen. Interaction flowed more easily than previously. Some comments were made immediately after the video conference, one of which stood out: "You see every cringe, especially as it is larger than life on the screen".

5.7 Questionnaire Results (main questionnaire)

After all the lessons had been delivered, and all video conferences had been completed all participants were asked to complete the main questionnaire which was available on-line. All participants in the video conferences completed the questionnaire (See Appendix 6). The survey had been designed to measure the participants' experiences with the video conference implementation processes, as well as to gauge the participants' educational impressions of the actual video conferences. In total, 46 respondents were included, 37 students, five academics/teachers and four administrators. Questionnaires were completed by Hong Kong participants as well as Melbourne participants.

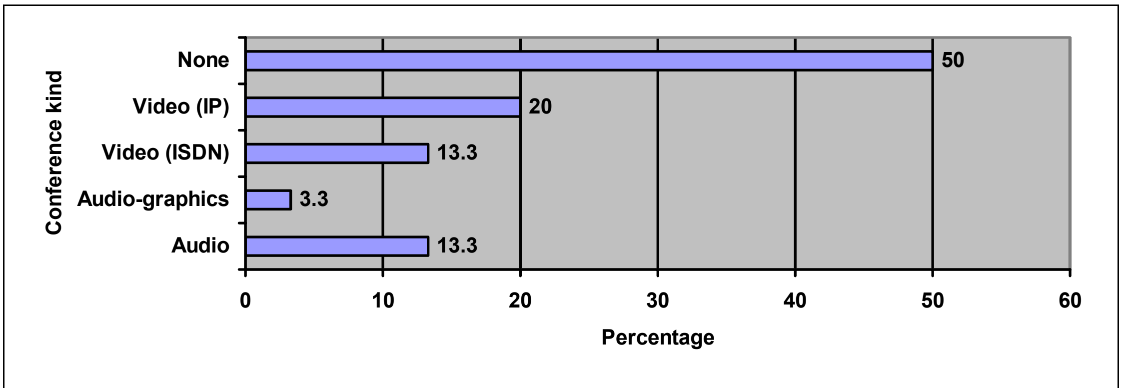

Figure 5.7.1 Previous conference experience by participants

Fifty per cent of all the participants had never been involved in any kind of video conference before, but 13.3% had previous experience in audio conferences, and 3.3 % with audio-graphics conferences (see Figure 5.7.1). Previous video conference experiences were had by 13.3% using ISDN and 20% using IP technologies.

Most ISDN experience was between the period 1998 and 2003, whilst the IP experience was mainly between 1999 and 2003. For most participants this was their first video conference experience, as well as their first video conference experience over IP.

The pilot survey found significant resistance by IT staff to implement video conferences over IP (91%) (See Figure 5.6.7). In the main survey we obtained further data. As most of the participants were students, they were not involved in the setting up and implementation of the video conferences; however, 26.7% of people that had been involved found there was considerable resistance within the organisation to implementing the video conference technologies (see Figure 5.7.2).

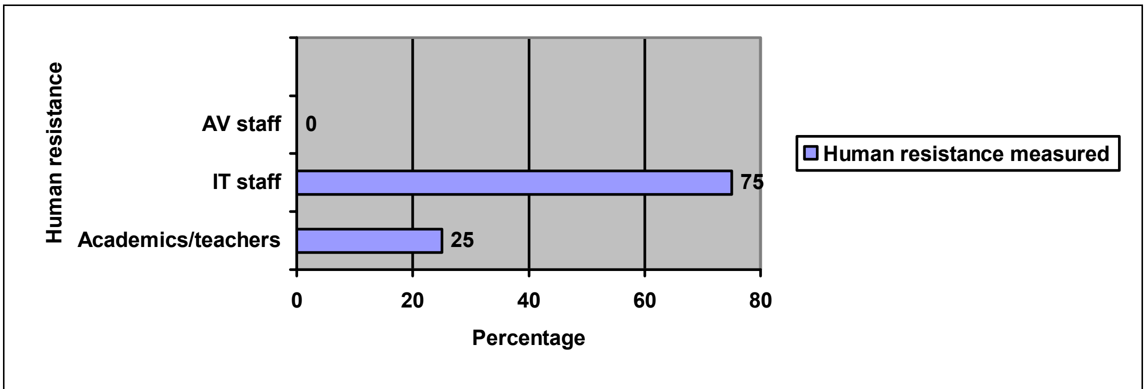

Figure 5.7.2 Resistance (human) in implementation of video conferencing

Although the percentage of 75% is less than the 91 % found in the pilot survey, this percentage is still high. In subsequent interviews with the participants it became clear that the majority of resistance came from IT staff that were concerned by network and security implications. The network points needed to be configured individually to enable incoming video calls and this was something IT departments were not keen to do as it was a perceived security risk (through their firewall).

Another concern raised was that IT staff were worried about the likely increase in data traffic on the network and its corresponding increase in the ISP data rate tally, which in turn would have an effect on the annual data usage that the university is accountable for.

Of the 26.66% of people who had been involved in setting up the video conference systems, the following assistance was received in implementation of the video conferences:

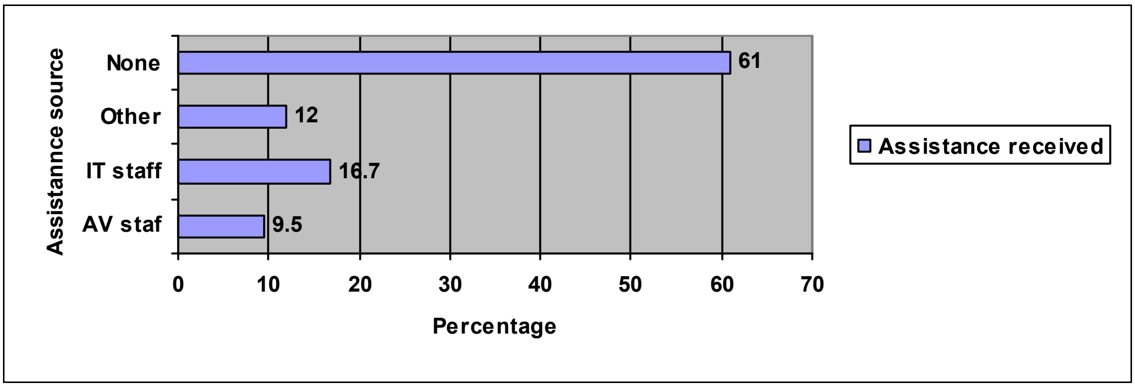

Figure 5.7.3 Assistance provided in implementation of video conferences

Even though a high percentage of staff had required no assistance, the assistance most required was from IT staff. This assistance that was provided can be broken down as follows (Figure 5.7.4):

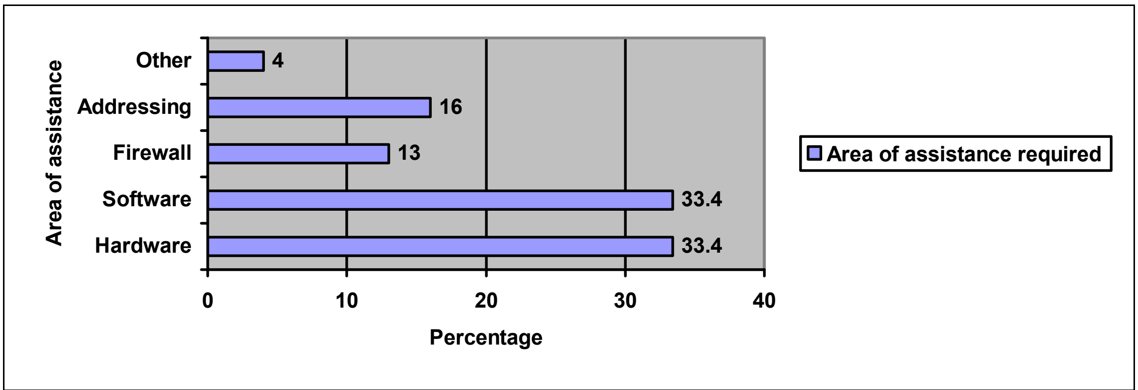

Figure 5.7.4 Area of assistance required

The assistance provided was in a number of areas: 33.4% was for hardware setup, mainly installing the camera in the room or PC's, and 33.4 % for software installation of the Polycom software. Although the software is easy to install, there are a number of technical sections that need attention. This is especially important when peering to a gatekeeper is required for addressing purposes. Firewall problems were gauged at 13%, for opening specific ports in the firewall to allow incoming video conference calls. Usually, this is a task that cannot be executed by any other staff than those from IT departments. And finally, 16% required assistance in addressing. This assistance consisted of helping out users who did not know how to use IP addresses, and/or linking to gatekeepers in order to facilitate the use of ENUM.

Of the participants, 72.7% were involved in the video conferences because it formed part of their studies, but 20.5% of participants were there because they chose to be. These were mainly the tutors/academics and organizers, as well as administrators and/or observers (Figure 5.7.5).

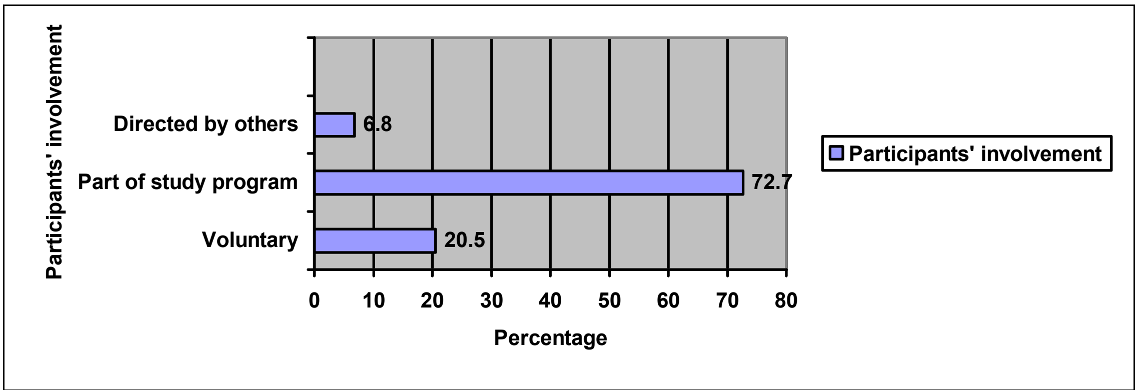

Figure 5.7.5 Participants' involvement in video conferences

60% of participants did not have a clear idea of what kind of facilities were used (Figure 5.7.6). This is due to the high number of participants that were not involved in setting up the facility. It was also due to the fact that a high percentage of the participants had not received any training (Figure 5.7.7).

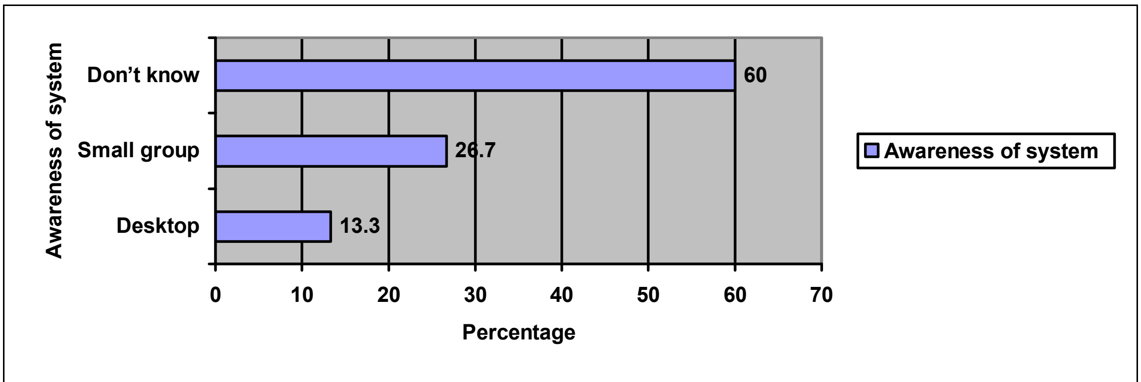

Figure 5.7.6 Awareness of video conference system used

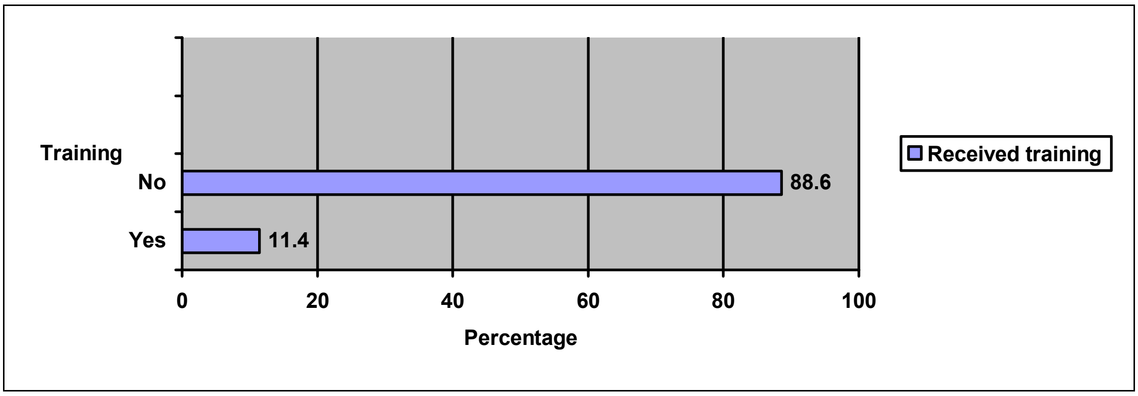

Figure 5.7.7 Training received

As figure 5.7.7 shows, 88.6% of the participants had not received any training in video conferencing. The 11.4% who had received training, mainly consisted of the tutors and academics who were involved. They needed to know the systems in order to conduct the lectures appropriately, and it was provided to them as a matter of course. Nobody thought of also training the students! If training had been provided to all participants, it is likely that the majority would have been aware of the video conference systems used. Also, they would have been more aware of the data rates used (Figure 5.7.8). It is important to have a base knowledge of these matters in order to set up effective links across good data rates. As key staff had been trained, this proved to be effective. Of the people who had received training, all felt that this was sufficient to get them started.

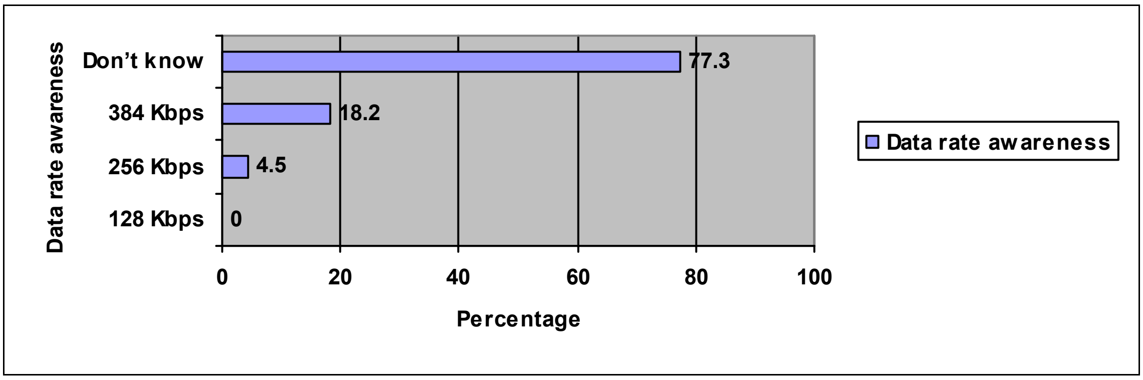

Figure 5.7.8 Data rate awareness

The actual links were provided at 768 Kbps.

Interaction

The participants were generally impressed with the medium used. Based on their experiences after completion of all the video conferences, 61.4% of participants were happy with the technical quality of the video conferences, 36.4% thought it was acceptable and 2.2% considered it bad (Figure 5.7.9).

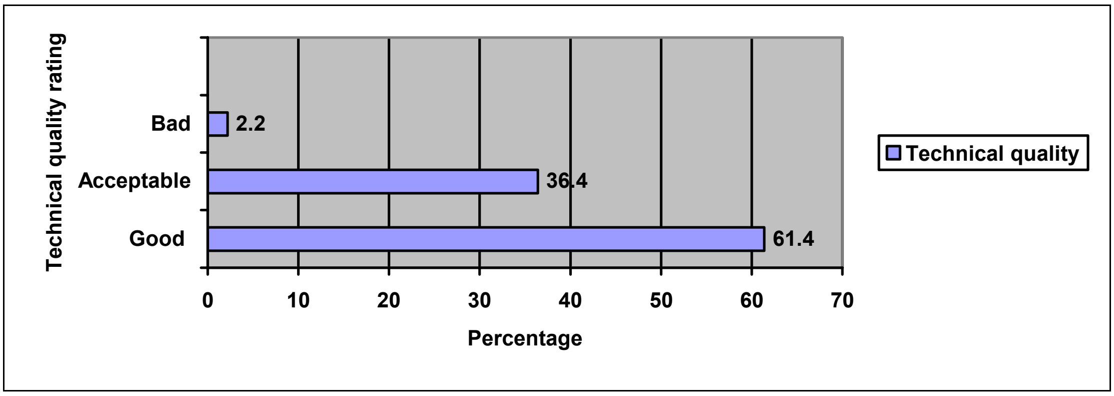

Figure 5.7.9 Perceived technical quality rating of video conferences

For good communication and interaction it is essential to have good audio as well as video. Of the participants, 79.6% said the audio quality was good, whilst 9.1% found it was unacceptable (Figure 5.7.10).

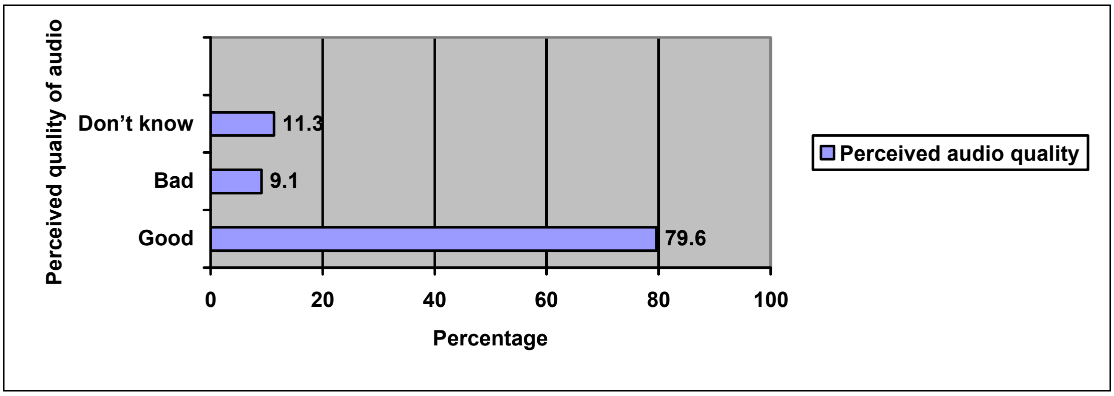

Figure 5.7.10 Perceived quality of audio of video conferences

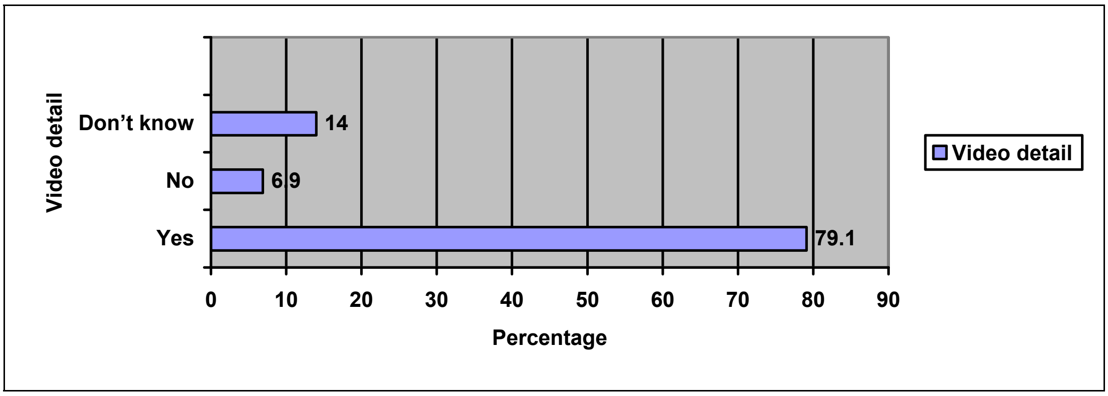

Figure 5.7.11 Video detail of video conferences

Figure 5.7.11 reveals that video detail was acceptable. This indicates that enough detail was visible. On the question of how easy it was to interact and raise questions, the results are varied see (See Figure 5.7.12).

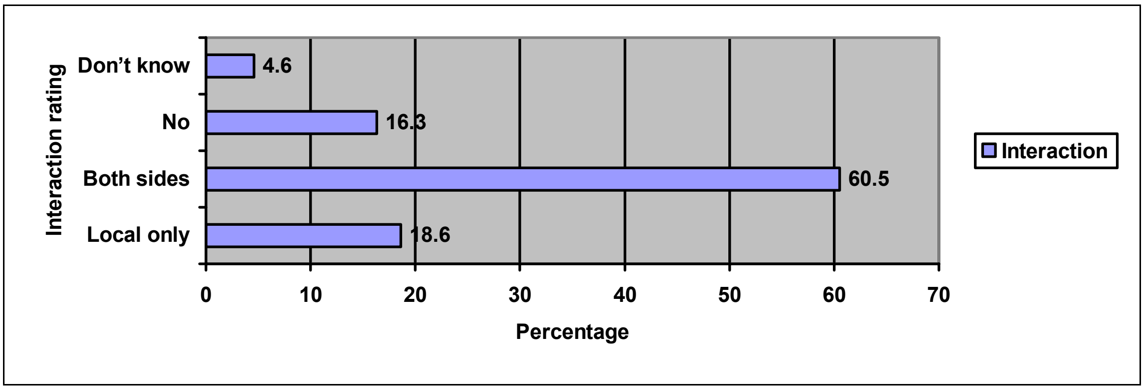

Figure 5.7.12 Interaction rating

The figures indicate that interaction was perceived to be good at both locations; however, some participants thought it was only good enough locally (18.6%), whilst some (16.3%) were not happy about the level of interaction at all. Interaction impressions can be fluctuating depending on where participants were sitting in relation to the screen. Participants were seated at various places in front of the presentation screens. This did have an immediate effect on eye-lines that could not easily be established. Figure 5.7.13 shows the viewing positions of the participants and Figure 5.7.14 reveals how participants felt about establishing eye contact with the other site.

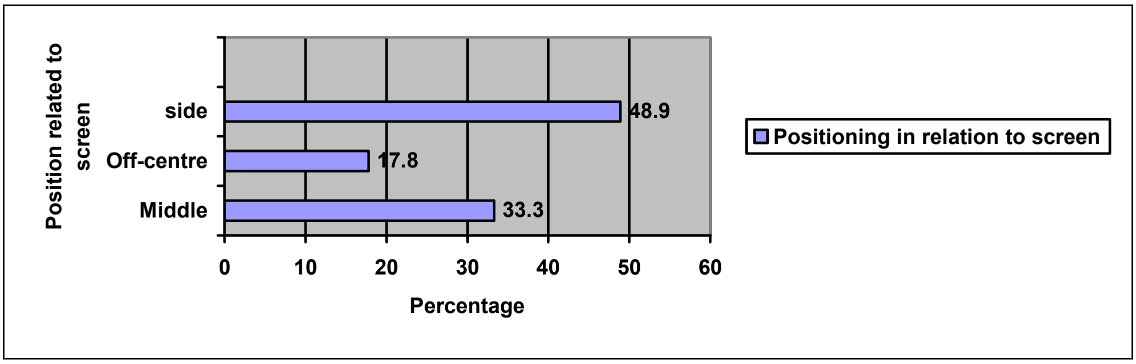

Figure 5.7.13 Viewing positions in relation to the screen

It is problematic that the majority of the participants were sitting either off-centre or to the side of the screens. It is difficult to establish eye-lines at the best of times, especially when cameras and screens are spaced apart. Sitting away from the centre of the screen will only add to the eye-line problems experienced. Figure 5.7.14 looks at the eye-line problem in more detail.

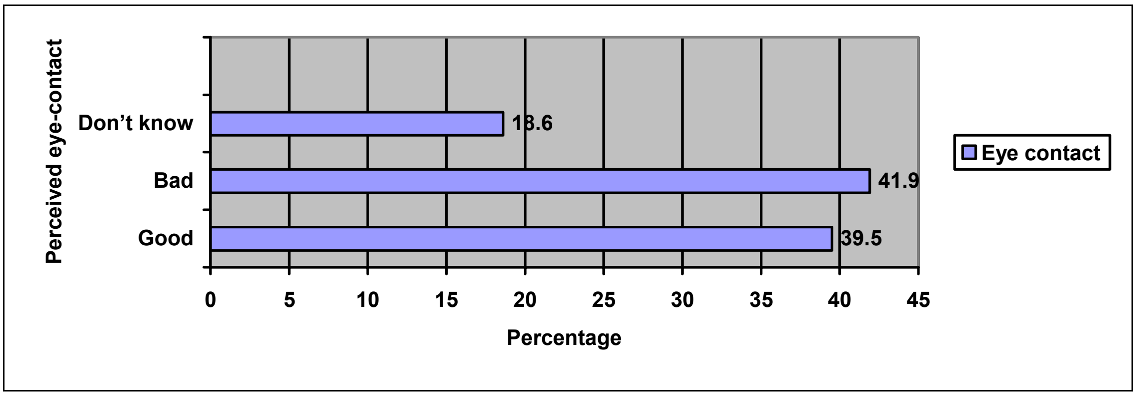

Figure 5.7.14 Eye contact with other side

Even though 79.1% felt they obtained good detail during the video link (Figure 5.7.11), this did not reflect the seating arrangements. Only 33.3% of the group was able to position themselves immediately in front of the screen. The remaining participants had to place themselves off-centre and even to the side. This did have an effect on eye-lines. Only 39.5 % of participants thought they had good eye contact with the other participating side. These comments were mainly coming from people placed in front of the centre of the screens.

The remaining participants all struggled to establish eye-lines e.g. they were unclear where to look and who to look to when addressing the remote class. It is perhaps surprising that the interaction was only partly affected by this. The eye-lines are important as they greatly affect the perception of interaction which was 60.5% for the conferences (Figure 5.8.12). The researcher feels that improving the eye-lines for all participants, would result in an improved interaction score, but this could not be proven in the survey as correct eye-lines did not exist and therefore could not be measured against the real (non-eye line) situation. However, 81.4% of the participants still felt that they were part of one group, while only 18.6% did not (Figure 5.7.15).

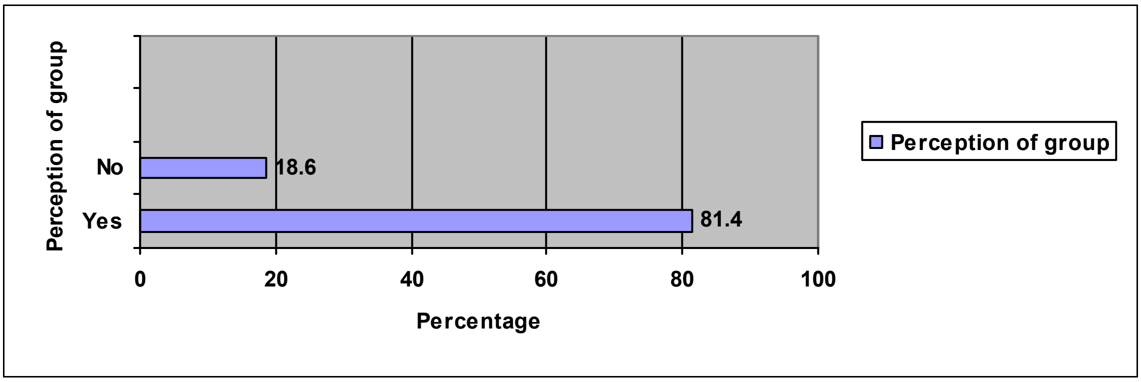

Figure 5.7.15 Perception of being part of one group

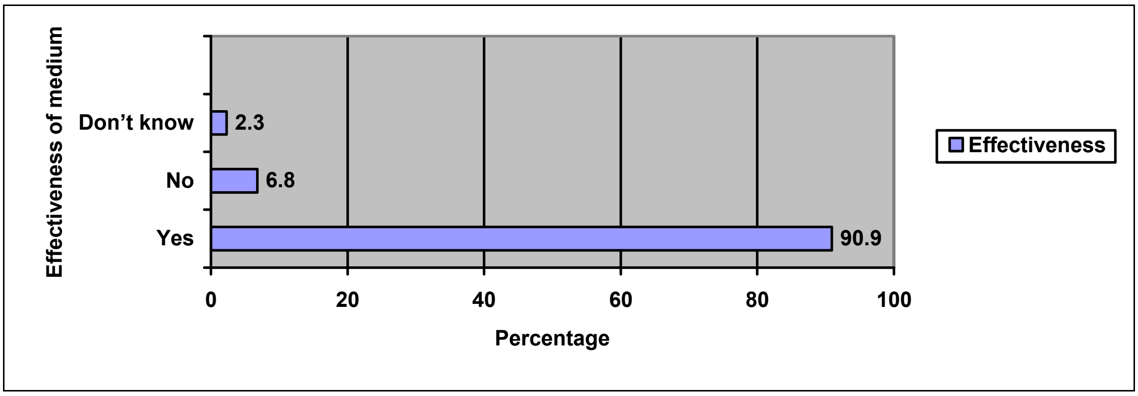

Figure 5.7.16 Effectiveness of a video conference as a learning medium

Overall, the survey indicated great satisfaction (90.9%) using the videoconferences as an effective learning medium (Figure 5.7.16). This was because due to the technology becoming transparent. This was also reflected in the question for the need for extra tools (Figure 5.7.17). Nearly three quarters of participants were happy with the medium, without feeling the need for extra tools such as cameras, document viewers or additional software.

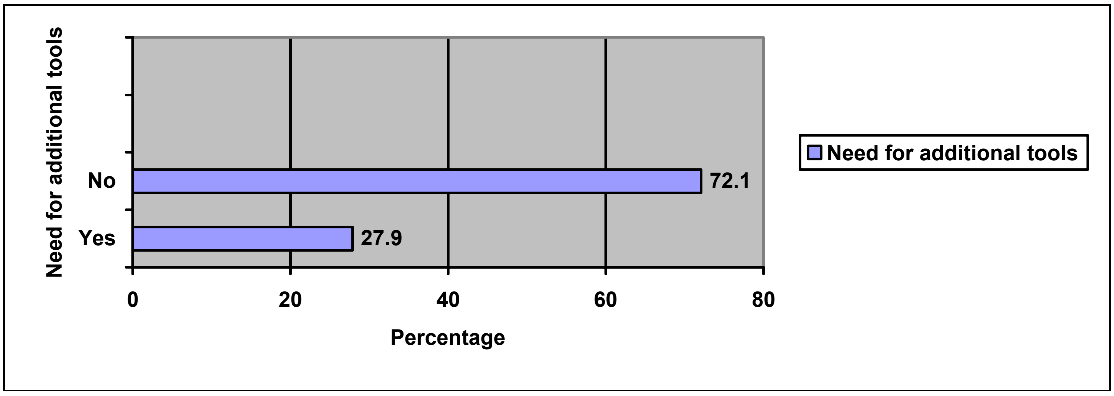

Figure 5.7.17 Perceived need for extra tools

The need for extra tools was minimum in this case study, as the web-conference PowerPoint was sufficient; however, in consequent interviews with lecturers all said that it would be desirable if other electronic programs could be shared and displayed. Of all the participants, 60.5% felt that the video conferences were not distracting them from learning as compared to a normal class (Figure 5.7.18); however, 32.6% did find it distracting.

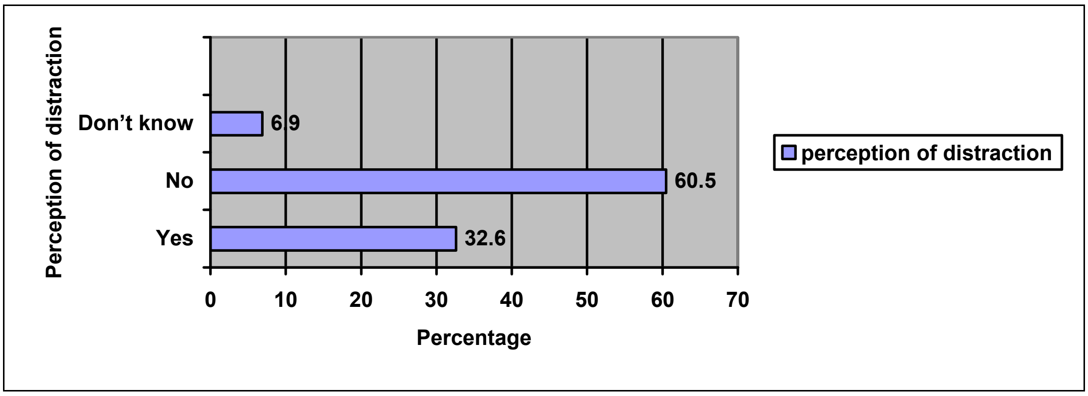

Figure 5.7.18 Perception of distraction using the technology

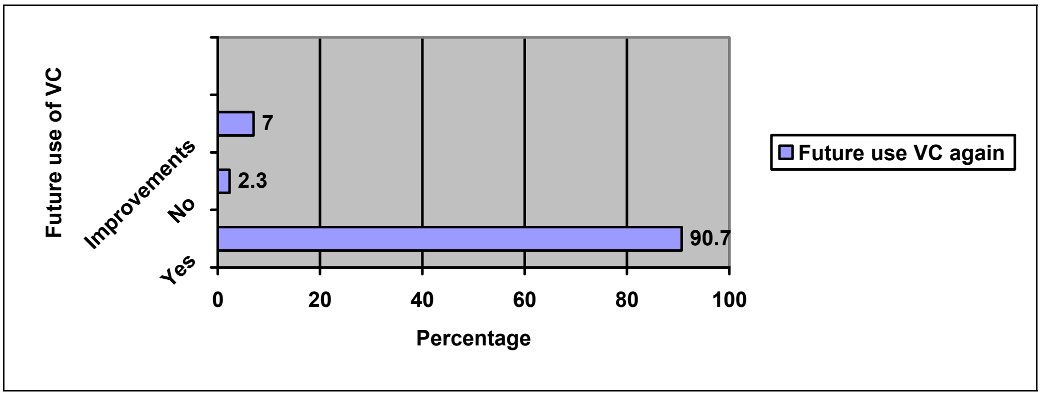

Figure 5.7.19 Future use of video conferences over IP

The above figure (Figure 5.7.19) indicates that 90.7% of participants would use video conferencing over IP again in the future while 2.3 % said they would not, and 7% said they would, but only if improvements were made. The improvements were not specified, but in interviews with participants, comments were made in relation to eye-line improvements. Further participants' comments are provided in Section 5.9 Summary. Regarding participants' views on using videoconferencing over IP within education, there is some concern about personal appearance (Figure 5.7.20).

How do you feel about the use of this technology in education?		Percentage
I am confident with technology		30.9%
I am not confident using technology		2.8%
I worry about me being seen on the screen		16.9%
I find it hard to concentrate on the session using the technology		4.2%
I find it not a problem concentrating on the session using the technology		18.3%
I felt I was part of a group in both locations (far end and near end)		12.7%
I felt I was part of a group in the near end location only		11.3%
I do not know		2.8%

Figure 5.7.20 Impressions of the use of this technology in education

5.8 Summary

This case study provided data and positive feedback about the use of video conferences over IP as an effective learning medium. There were no major differences between the pilot and the main surveys, except for one area. The human resistance measured in the implementation of video conferences over IP was noticeably higher in the pilot survey. In both surveys, staff at IT departments was seen to be un-cooperative in the initial implementation phase. The pilot survey identified 91% and the main survey identified 75% of human resistance from IT staff. As some of the same participants completed both surveys, it is reasonable to accept the figures in the main survey as being 75%. This is still high. Although the feedback from the participants through the questionnaires and the follow-up interviews, was generally positive, some observations were contrary. Students commented that although the teachers may have been well trained and prepared to use the video conference technologies, the students were not, and in many cases were overwhelmed by the initial video conference. Some students wished that they were told in advance what to expect. They also wished that they too could have been trained or prepared and suggested there ought to be a prepared hand-out to supplement some of the language barriers that appeared to be present. The language barrier was clearly identified by most students as being of significance, and one that was slowing down the class significantly. Indeed, some students said they covered in one hour what they would usually cover in half that time. For some students the lectures where too structured and they would have liked to see a format that was less formal. Some students felt that: “We should know each other more first, so we can talk more freely”, whilst others thought it: “Critical that participants are told beforehand what will happen, what is expected of them and what they can expect from the other end”. Students were nervous about the entire concept, partly because the Hong Kong side of the class was large compared to the Swinburne side. All in all, most students enjoyed it but thought the sessions were “very intense”. Although the classes were discussion-oriented, some felt that better use could have been made of the data application sharing that was available. As far as this case study is concerned, the preparation by teachers/academics, administrators and technicians involved had paid off. Not only were there no technical problems (gatekeeper difficulties, etc), there were no pedagogical obstructions either.

The academics involved where able to reach their learning goals, even though teaching using this medium was perceived to be “different and more draining”. Academics were pleased to observe the success of the video conferences as the educational outcomes they set to achieve were met.

Most distance educators argue that we should first set our learning goals and then select technologies to support those goals. In this regard we have tried to do it the wrong way around. We started off with the technology and then tried to fit it into a learning experience. This seems to have been a successful approach, but it was not done on purpose; rather it was executed because of a strong desire by both universities to explore the video conference medium as a learning tool, especially from the perspective of cross-cultural boundaries. In today’s world, where technologies are developing so fast, it is often the technology that comes first. The technology is being acquired by early adopters, who then find a use for it. Once educators know what technology is available, they too may become early adopters.

This case study has shown that teaching using this media can be successful, but only after it has been accepted by all involved. It must also be accepted there is a need for better planning, and it is necessary to follow new strategies with participants required to develop new skills. Additionally, it was clear that conventional teaching methods needed to be adapted and that students needed to be prepared better to build skills to learn to work and learn using the medium. The case study also highlighted the need for better system design, especially to improve eye contact between the various sites. This is an important issue that has come to the fore and which will need addressing in future video conferences. The eye-line question is problematic for desktop video conference as well as group conferences. Better camera placement can slightly reduce the eye-line problems experienced, but system designers need to improve the equipment so that those participants appear to look at each other more directly.

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Chapter 6 REFLECTIONS ON THE CASE STUDIES

6.0 Introduction

The three case studies presented in this research have resulted in some surprising outcomes. As the research set out to examine the implementation of video conferences over IP for desktop systems, as well as small group systems, it expected to come across both technical and human hurdles. It is very easy in a topic such as video conferencing over IP to over-focus on the technical elements, and under-focus on the human and social behavioural elements. This research, however, supports the view that the technical performance of the equipment is irrelevant if you can't get people interested in using it. This study found that, although there were significant technical and design issues, these were often overcome more easily than some of the human problems

6.1 Cross Case Comparisons

Human Problems

Human problems were most apparent in case study two (CRC), and to a large extent in case study one (Taiwan). They dominated both those case studies. In case study one, the resistance, clearly came from people who did not want to use the technology, for three main reasons:

1. the financial outlay to purchase the desired desktop equipment was unacceptable;
2. a lack of technical knowledge by the users who found it very difficult to obtain technical help from their respective organizations; and
3. the language barriers that existed between students in Taiwan and their supervisors in Australia which made communication difficult. This resulted in students feeling uncomfortable being confronted 'live' with their supervisors.

Human Stress Factors

It may be easier to 'hide' behind the relatively sterile email message, which may contain information that could or could not be entirely truthful. Slow progress made by students, for example, can easily be camouflaged in such correspondence.

Answering questions about any progress made in their studies with a 'live' camera and one or two supervisors is an entirely different matter. The stress for students created in such video conferences was clearly noticeable. Stress could be due to a number of factors. Students could be nervous about their appearance on camera or could be worried about being singled out. In the case of participants whose first language is not English, language problems also create stress (Dalglish, 1990). This occurred in case study three (Lingnan), where many students said that the intensity of the video conferences and their anxiety levels were high. This was probably accentuated by the language barriers that existed. Students were often embarrassed about their English skills, whilst Australian students were clearly uncomfortable with the notion that students could not be easily understood. Stress factors are not uncommon (See, for example, Andrews and Klease, 1998).

Human Organisation

Rhodes (2001), states:

> *"The biggest challenges in video conferencing are less about the technology itself and more about the way that organisations deal with the impact of these technologies"* pp.8.

Human problems were also present in case study three (Lingnan); however, important lessons had been learnt by key people involved and the human processes were less problematic. Nevertheless, significant delays in the implementation of the video conferences existed in this case study, that were caused by human interaction that did not flow easily across the distances.

This research indicates that the use of video conferencing is not just one of surmounting technical and operational problems. For example, there may be IT staff who were not willing or able to assist (because of policy) in the implementation phases. However, these problems can all be solved. The research also indicated that once the technical difficulties had been solved, they generated a whole raft of other human and organisational problems. These problems often are unique. Timetabling the video conferences in conjunction with facilities, as well as support staff across two Universities, in two countries, and in two different time zones, can create many problems.

There are logistics to contend with such as different stages in the academic year, the appropriate shared topics that may be useful, and the language barriers that may exist. Cultural differences are important and students, as well as educators, should be aware of them before commencing the joint classes. Staff need to be professional, skilled and trained to deal with all aspects of using the technologies. This is a cascading effect. Research in video conferencing has tended to focus upon the technologies and the effectiveness of communication; however, as discovered here, the human and organisational barriers need considerable attention. These are perhaps less apparent, but equally critical to the success of video conferencing. The abject failure of case study two can be attributed to human factors entirely.

Human Cooperation

This study showed that the technical performance of the equipment is irrelevant if you cannot get people interested in using it. All of the video links demonstrated in the trials and meetings to convince the CRC partners were technically successful. The study found, however, that there was unwillingness, especially by IT support staff in the respective partner organizations, to implement the video conference technologies, even though this would have made sense from a financial perspective, as well as from a human and logistics viewpoint. It has shown the importance of having key decision-makers in organisations having either good IT knowledge, or at least good negotiating skills to persuade IT departments to implement such new technologies. With this, the outcome of case study two might have been very different. The same is true for case study one. Case study three, however, revealed that these human problems can be addressed successfully. Undoubtedly case study three benefited from the advances in IP video conference technologies, since this case study commenced well after the first case study. The time difference of approximately one and a half years is considerable with regard to advances in the IT environment. This put case study three at an advantage, as IT staff were better prepared, networks were more robust, and ISP providers were more geared to handle video conferences over IP.

Human Training

A significant deficit in all of the case studies was the observation by participants that more training was required. Although some training was provided, this was clearly insufficient to satisfy users.

This is a common finding. Thompson (1997) stresses the need for adequate training for both students and academic staff. Thompson also adds that those who are involved with technical support need to be adequately trained, and if their role includes training others, they need not only technical competence but the ability to communicate effectively with those they are training. Thompson further notes that “the trials gave compelling evidence of the stress placed on lecturers”. This is consistent with the finding in the present research, where students as well as academics observed that the video conference sessions were very “intense and draining”. It is also consistent with McNamara and Strain’s (1997) observations that educational institutions urgently need to address the human factors that are required in multimedia environments.

Pedagogy

Daunt and Towers (1997) argue that video conferencing is not necessarily a lower form of communication, but needs to be considered in its own terms. It is clear that teaching via video conferencing is different from face-to-face teaching because it requires role changes, additional planning, new strategies and additional skills. Interaction is a key element in video conferencing. The present research suggest that when video conferencing is being used to promote interaction, and therefore taking advantage of the qualities that are inherent to the medium, it can bring new ways to learning. This supports similar findings by Amirian (2003). It was also apparent in case studies one and three that the technology itself could be a major barrier. In case study one staff and students were given training on how to use the technology but not on videoconference protocols. This was overlooked. In case study three this was overcome with practice, even though the practice occurred in real-time video conferences. There simply was not enough time to teach groups, at each location, how to use the equipment and how to apply appropriate video conference protocol. Once the students and lecturers became familiar with the video conference medium, protocols were automatically being accepted and learning using the technology appeared effective. However, the medium itself appeared to impact upon pedagogical styles and was inhibiting. Two classrooms connected via an IP video link are still considerably more difficult to address than one classroom on its own. The teaching styles adopted in the video conferences between Lingnan University and Swinburne University were adapted as lecturers realised that video conferencing is a different form of communication.

Most distance education literature argues that we should first set our learning goals and only then select our technologies to support those goals (Schiller and Mitchell, 1993, Treadwell et al., 2000, Amirian, 2003). In an ideal world this would be logical; however, technology is changing rapidly and innovation can provide a spur to pedagogy. Also, educational providers can make a case for "build it first and they will come." It was clear in all three case studies that video conferencing over IP should have been a significant help pedagogically for all involved as is the case in many other video conference projects such as Daunt and Towers (1997) and Thompson (1997). Install the technology first and they will use it. However, this only was effective in case study three. Parallels with other (initially) slow take-up of technologies can be made. The Internet was created first and, in the beginning, users were slow to use it. It was only when user-friendly GUI's were introduced, that the take-up increased dramatically. Initially, the business and private worlds took it up followed by educational institutions. Some educators did this reluctantly. Murphy (2001), for example initially took the stand that "the pressure to have a web presence derived more from a marketing initiative to attract potential students than from a real desire to improve students' learning". Murphy found that in the new environment the rules of traditional learning had changed. He argues that few university teachers have ever been students in online courses. Few have much experience in this new environment, yet an increasing number of teachers and their students rely on the new communication technologies in teaching and learning. He comments: "New conventions, new rules and a new grammar need to be developed, articulated and learnt. In fact, a new way of working and a new way of thinking about teaching and learning are needed if we are to take full advantage of new possibilities".

Sometimes the technology has to be implemented first before people adopt it and shape it to use it in an effective pedagogical manner. The take-up of desktop video conferencing is, however, slow. Thompson (1997) argues that "it is improbable that desktop video conferencing in the next few years will move into mainstream distance education". Although this is still the case in 2004, there is a trend to use desktop video conferences over IP as the preferred link over ISDN between universities. The limited bandwidth availability that still exists at the students' homes, even though some might have cable access, is still the main factors (apart from cost) that prevent traditional distance education providers from delivering video conference teaching direct to the home.

There are exceptions, especially in the case of Video-On-Demand (VOD) services, which are now becoming more commonplace for students. It must be noted though that these services are good for revisiting lectures and presentations but still offer poor quality vision. The major downside to VOD is that it only offers video and audio, with video being the poorer of the two. The new trend, however, is to provide video, audio and electronic content. A large number of providers offer such technologies (for example, Horizon –Live, ACU-Le@rn), and educational providers around the world are adapting these technologies to offer such VOD services as add-ons or stand-alone distance education facilities. Interaction is limited or non-existent in most VOD services. The design of desktop systems and group systems needs improving. The major design flaw identified in the present research is that the camera(s) and display units are so far apart that eye-lines are problematic and therefore distracting to users. The field of Human-Computer Interaction (HCI) is a multi-disciplinary approach to conceptualising how technology can best support people in their various endeavours. A primary role of HCI is to indicate how design and interactions between machines/computers and people can best be configured to meet the needs of people or users of the technology (Fabre, 2000). Designers of video conference systems might be aided by HCI specialists to overcome design flaws. This is an area that needs great attention. Technically there are problems with combining display areas with cameras. One area that shows promise is the teleprompter principle (a one-way mirror in front of a camera lens, which reflects the incoming image). While this could work for small screens, large screens are a little more complicated.

6.2 Principal Findings

- **Technical issues can be overcome with appropriate coordination across different organisations.** Appropriate training of technical staff was lacking in most of the case studies. Even though the technical problems encountered were major, they can be overcome when a coordinator works to identify the problems and 'brokers' to solve those problems with the right people across the various organisations involved.

- **Human elements are under-estimated.** Once technical problems have been solved, there is a whole raft of human and organisational problems that need to be overcome. These problems are likely to be unique, especially when different organisations and countries are involved. There is a cascading, spreading effect. Research in video conferencing tended to focus upon the technologies and the effectiveness of communication; however, as discovered here, the human and organizational barriers need attention. These are perhaps less apparent, but equally critical to the success of video conferencing. The human elements in all three case studies were under-estimated. People were initially skeptical and wary about the technology. They were not convinced it would work for them. The lack of adequate training for academics and students added to the difficulties experienced. Additionally, people tried to 'hide 'behind the technology, either as an excuse for not wanting to become involved or because technically it was all too hard. Human behaviour can also account for people not wanting to appear on camera, as this might 'reveal' too much information. For example, students might not want their lack of progress to be known to be known. In the case of organizations, the implementation of video conferences at different locations is extremely time consuming. Local policies may stand in the way of arriving at a common solution.
- **Coordination is required between all parties**. Proper coordination was required for all of these projects. All three case studies could have benefited from having access to a commonly available coordinator. This more-or-less occurred in case study three where a small group of people coordinated all of the efforts. This made an enormous difference. The first two case studies would have greatly benefited from having access to such a person.
- **IT/AV staff need to play a key role.** Projects like these three case studies cannot be successful without significant input from IT expertise in <u>all</u> involved organisations. It is necessary that IT expertise be at hand at <u>each</u> location when implementing the technologies. It is also essential that IT Department Managers are included in discussions so that the project can be given the IT support that it requires. Complexity exists when more than one organisation is involved. A coordinator ought to be appointed to 'broker' differences between such organisations.

- **Equipment needs to be identical.** The case studies showed that in order to have successful and useful video links, especially with desktop video conference units, it is essential that organisations work with high-end compatible video conference equipment. It is easier to find common faults and resolve them when identical equipment is being utilised. When different systems are in use it is much more difficult to provide back-up support. This is related to the availability of appropriate training.
- **Training is underestimated.** Video conference users can greatly benefit from training. Even though users in all three case studies were provided with some basic training (with the exception of the students in case study three), it was clear that this was insufficient. The training provided needed to be more hands-on and perhaps spread out over two sessions to enable familiarity. Training is essential for students, academics, as well as technicians.
- **People and content add key information.** An essential part of communication in a classroom environment is the extra data that is being used. This can be as simple as a whiteboard, right through to PowerPoint slides, videos and multi-media software displays. A facility in the video conference that allows the display of such extra data greatly enhances the classroom experience. Video conferences are greatly enhanced using other additional electronic media.
- **Room design has an impact on effective communication.** This study found that video conference systems have a major design flaw that prevents participants from having eye-to-eye contact. When cameras are not placed close to the incoming pictures, eye lines tend to be unacceptable to viewers. When the eye lines are absent, proper communication behaviour is often obstructed.
- **A high data rate contributed to the video conference quality and success.** The availability of high speed data transmissions greatly enhances the quality of the video conference experience. The low speed transmissions of 128 Kbps and less were less favoured by participants and often caused viewing fatigue as learners strain more to view the images.
- **Technical ease of use adds to user confidence**. When the technology is not obtrusive, the video conferences are more successful, as participants concentrate on the learning content rather than on the technology. This study found that participants were more eager to participate in seamless links.

- **Group dynamics need careful attention.** It proved very difficult to feel united as one group using the video conferences. This was more apparent with the larger to medium size groups.

6.3 Summary

This research supports the view that the technical performance of the equipment is irrelevant if you can't get people interested in using it. The under-focus on human and elements is a serious neglect within the field. This study found that although there were significant technical and design difficulties, these were often overcome more easily than some of the human difficulties. This may not be uncommon in the take-up of new technologies. There is more to video conferencing than equipment providers lead us to believe. Often people are happy to sell equipment, but prove poor on any follow-up on use of the facilities, training of staff, and appropriate use of the facilities.

Chapter 7 CONCLUSION AND DISCUSSIONS

7.0 Conclusions

The study investigated the effectiveness of implementing digital video conferencing over IP in geographically separate locations between various organisations by looking at three separate case studies. It found that there is much more to implementing video conferencing over IP in educational environments than simply installing the equipment, training staff and starting classes. Based upon three case studies, it found that the implementation of video conferences over IP within an educational setting involves many people in addition to technicians, lecturers and students. Human factors emerged as the major hurdles to be overcome, rather than technical difficulties associated with equipment. This accords with Bates (2001) who notes, 'Moving an institution to the appropriate technologies is more about human change than about technical decisions, and hence requires patience and long-term strategy.' The technology, in this case desktop and small group systems running over the Internet, benefited interactive class sessions at an international level, as the students otherwise could not have been exposed to such communication with culturally diverse groups of students. It clearly shows that the use of this technology enhances the delivery of education and its programs.
Some human problems were also identified by Oliver and McLoughlin, 1996; Skippington, 1998, Daunt, 1999 and Yates (2003). As technology development accelerates, educational providers and administrators are struggling to keep up with implementing these technologies in the educational environment. The introduction of new technologies in educational environments is presenting a challenge for technicians, educators and administrators, as well as the students.

> "Before you become too entranced with gorgeous gadgets and mesmerizing video displays, let me remind you that information is not knowledge, knowledge is not wisdom, and wisdom is not foresight. Each grows out of the other, and we need them all." (Arthur C. Clarke, 1993)

The study consisted of three case studies and documented them from their conceptual stage to fruition. All three case studies were fraught with difficulties, some technical, but most human related. Although some human difficulties were expected, they proved to be more significant than anticipated. In case study two, this resulted in the abandonment of video conferences being realised. Although the video conferences in the three case studies were mainly video and audio, case study three did use additional web based learning and presentation materials. Most people in the surveys flagged the need for such 'electronic' materials. As the surveys suggest, the majority of the information in video conference classes comes first in audio, second in electronic media, and finally in the video. This is a very common outcome, but it is only recently (in video conferences over IP) that the electronic media can be presented synchronously, and in the quality intended. Compare this to findings by Caladine (1999) who argues that study materials are to be sent in advance of the video conferences. These can then be used in the session but also act as a contingency plan. Caladine proposed that, 'Some materials, at each site, that can be used in the event of a breakdown (such as student-centred learning package) will minimize the reduction in motivation.' This notion is less relevant in 2004 as the technology has improved significantly. It does, however, raise the importance of the preparation of proper learning materials that are suitable for electronic presentation. Learning materials may need to be adapted slightly; for example, OHP slides need to be converted to PowerPoint slides, or, if document cameras are used, to be prepared in landscape formats with the use of large fonts.

D'Arcy (1998) wrote:

> *'An audience that doesn't understand the data you are presenting will remember little. Nor will they be persuaded to buy your product, fund your research, accept your bid, or be influenced by your ideas'* pp.19.

As a large proportion of our communication is via the use of such electronic data, it is essential presenters prepare their materials in the most effective way. Implementation of video conferences over IP is a significant task within any organisation. It is therefore important to understand that the use of video conferencing is not just one of surmounting technical and operational problems.

Research in video conferencing tended to focus upon the technologies and the effectiveness of communication and learning; however, as discovered here, the human and organisational barriers need greater attention. These are perhaps less apparent, but equally critical to the success of video conferencing. Managements in organisations and/or faculties need to factor this into their planning processes.

Lidstone et al., (2002) state:

> *'In considering the broader learning community, it is clear that a proactive approach is needed at the faculty level to ensure that the work of innovators and early adopters is recognized and shared in a way that contributes to wide scale and sustainable implementation of new ideas.'*

As technology development accelerates at previously unknown speeds, it is clear that educational providers and administrators are struggling to keep up with their implementing in the educational environments. This may be because of a lack of funding, as with every technology breakthrough there are usually large costs associated. It is, however, not impossible to, at least keep pace with new developments in technology that can be applied in education. It is not so much the leadership that is available in educational institutions that determine this pace, but the availability of enthusiast academics, teachers and technical staff who are often willing to research or try new methods or tools of learning. It is much harder for lecturers and teachers to stay abreast of new learning styles and the use of new technologies, as they usually also have to spend a large amount of their time doing regular teaching. As to the question of technical staff being able to implement and service equipment, this is part of their duties, albeit a challenging one. The most difficult part is not so much one of doing these tasks, it is more one of testing to select the right technology to concentrate on the myriad of technologies newly available. Students usually are willing to keep pace with technology implementations on campus, but cannot often afford this at home. Even in today's Internet environment the majority of students only use dial-up modems rather than the fast cable or ADSL modems. This is not likely to change in Australia in the foreseeable future.

Student feedback indicates that two-way, interactive videoconferencing was very effective for the delivery of the programs. This is in line with findings by Greenberg (2004) who summarises a subset of recent research on interactive video conferencing for distance education. This is further supported by Russell (2001) who argues that from the perspective of learning outcomes, distance education technology is no better – and no worse – than the traditional classroom for delivering instruction. As far as the technology and its user-friendly design are concerned, the present study found that although IP video conference systems have improved significantly over the past few years, there is still scope for improvement. Designs and operability of systems should become more intuitive and logical to most non-computer literate users. The environments in which we apply the new technologies should be made more suitable and often need to be re-designed to be more effective. Colour, lighting and equipment placements all need attention.

This thesis shows that rapid technological developments of which IP video conferencing is only one, may move ahead faster than the interest and ability of potential users and it is essential that appropriate attention be paid to the human factors involved in attempted innovations based on them.

It is useful to have strategies in place that can be followed when institutions embark on the implementation of video conferences over IP. The following strategies are provided as a guideline. They are based on the findings from this study as well as others. Although the list has been drawn up for video conferences over IP, some items also apply to conventional forms of video conferences. The strategies are divided up into; *Technical, Human, Pedagogy, Assumptions, Room Elements, Etiquette Utilisation.*

The advice that follows is based on the experiences of case studies presented here, the experiences described in the literature review and the writer's own observations of he use of these technologies.

Technical

Technical difficulties will almost certainly arise. These can be considered locally, but for good conferences they should be considered in conjunction with location partners.

A coordinated approach that is applied across the various departments or institutes is recommended. Simple processes can be as follows:

- Test and select the appropriate equipment for your situation.
- Ensure your IT department is aware of your program.
- Ensure firewall problems are cleared, preferably on both the far and local end.
- Insist on using the same standard VC equipment, this simplifies problem-solving.
- Obtain bandwidth information at all locations from local IT staff before commencing the program.
- Keep close contact with key IT staff in each organisation.
- Use MSN Messenger, or similar, for synchronous backup communication if telephones cannot be used easily (for international use mainly).

Human

The human issues dominate implementation of new technologies. To minimise human difficulties the following should be taken into account:

- Train students and staff **thoroughly** in all facets of video conferencing and give them plenty of hands-on experiences before commencing classes.
- Ensure students obtain access to identical video conference equipment.
- Ensure language barriers are cleared before the video conference commences.
- Consider cultural differences before commencing project.
- Be aware that poor asynchronous communication with students may exist when they are overseas. Select synchronous communication tools such as MSN messenger.
- Ensure a coordinator is appointed during the implementation process who can oversee and deal with problems between connecting parties.
- Maintain someone in the room during every video conference. Both a local facilitator and a technical support person (close by) are mandatory (Greenberg and Colbert, 2003).

Pedagogy

Pedagogy issues will arise when using video conference technologies. Pedagogy has already been covered in many studies; for example, Fetterman (1996), Van Horn (1996), Treadwell et al., (2000), Amerian (2003), Twigg (2001) and Zelman (2002). When delivering content in classes in video conferences it is important to that it is 'interesting'. Greenberg and Colbert (2003) note that, when beginning, it is essential to make the program 'spectacular'. They further add: 'if your first programs are spectacular, you'll win over many converts and will never fail to find support for your initiatives'. The following additional observations from this study could aid teachers and lecturers:

- Adhere to a rigid timetable, start on time, finish on time.
- Keep the first video meetings short, increasing duration once expertise has developed.
- Do not assume your English is understood during foreign link-ups.
- Be aware of technical limitations.
- Be aware of human limitations.
- Be aware of educational limitations.
- Use 'people and content' where possible to aid communication.
- Use continuous presence to ensure all parties can be seen at all times.
- Use hand signals to attract attention when raising questions.
- Encourage interaction by asking participants for feedback and addressing them directly.
- De-brief after classes where possible to obtain useful feedback.

Assumptions:

It is easy to assume many facets of video conferences.

- Before embarking on a video conference, perform a needs analysis to ascertain that this is the right medium to use (Rhodes, 2001).
- Do not assume performance specifications from equipment suppliers are 100 % accurate.
- Do not assume participating students will respond to your e-mail requests.
- Do not assume e-mail alone is a good way of communicating.

- Do not assume that students are comfortable with the technology, even after training sessions.

Room Elements:

The design of venues is often overlooked, but as this study found they are imperative to a successful outcome. Although it is difficult to get all of the ingredients that are required correct, because of equipment constraints, we can get close to a good environment:

- Check appropriate equipment is set up and check camera alignment.
- Audio takes priority over vision (place microphones close to source and away from speakers).
- Use an additional camera or zoom lens for detailed or large visual displays.
- Use a reasonably well lit room.
- Do not have very bright objects in frame.
- Seek neutral background settings, with no backlight.
- Be aware that a very bright screen takes longer to transmit.
- Seat participants in front of visual displays and cameras where possible.
- Place participants not further away from the visual display than five times the diagonal length of the display.
- Allow easy access to facilities without disturbing the class.
- Avoid seating that results in extreme close-ups as these make people feel uncomfortable

Etiquette Utilisation

Etiquette may be defined as:

1. 'The customs or rules governing behaviour regarded as correct in social life' or
2. 'A conventional code of practice followed in certain professions or groups' (The Collins Concise Dictionary).

There are numerous aspects to video conference etiquettes; for example, body language, where to look, eye-lines, how to raise questions, how to present, when and how to talk, dress code and even room colours, furniture and lighting. A summary of such developed etiquettes is available at http://www.capemaytech.net/ettc/links/distancelearning.htm

7.1 Relevant Emerging Technologies Impacting IP Video Conferencing

Human behaviour and the use of technology is related. In order to consider future scenarios, as well as to suggest areas of future research, it is important to look at some of the emerging technologies that are and could be impacting on IP video conferencing. It is pointless to try to predict what areas of IP video conferencing need further research without first attempting to ascertain where the future of this technology, and its use, is heading. As we know, the convergence of technologies, as well as the advent of new technologies, is undoubtedly going to play a major part in this future direction. As this section attempts to address these directions, it needs to be apparent to the reader that it cannot be a complete overview. The reality of emerging technologies is occurring at such a pace, that since the preparation of this document, other new technologies will undoubtedly have appeared, whilst existing new technologies have been improved and/or been replaced.

Wireless Video Conferencing

Wireless local area networks are now becoming common in the tertiary sector, and their relevance to video conferencing should not be overlooked. There are universities that have put complete IP video systems on trolleys, with a wireless LAN card, including a UPS. Although this can work well, simple laptops with low-end IP conference desktop systems can be just as effective when linked on a wireless LAN. Factors that work against wireless video are realistic. Video and audio are more demanding of network quality than the transfer of other data such as email and web browsing. Dropped packets and network traffic priorities can cause video and audio to fail, whilst other data such as email and web browsing keep flowing. A common expectation is that the wireless distance that can be achieved for video is significantly less than that for other applications. Add to this that all users, usually on one local hub or station, commonly share wireless networks. Traffic congestion on such a local hub could easily occur, especially when using high-speed video conferencing over IP. Quality of Service (QoS) may help in some cases, but the local hub would generally have to be of reasonable capacity for QoS to work effectively. QoS will not be effective on the Internet itself, as it is beyond anyone's control.

Wi-Fi

IEEE 802.11B is the communication standard for Wi-Fi, the wireless fidelity (IEEE, 2004). Wi-Fi services are local networks that provide ultra high-speed wireless Internet connection usually within a radius of a few hundred metres. They are becoming popular, not only in education but also in airport lounges, hotels, internet cafés, pubs, ships, and shops. There are fixed links in many cities: these provide up to 1.5 or 2 Mbits/s over point-to-point microwave links (Austerberry, 2002). Wi-Fi also has a significant impact on mobile phones. Cisco Systems Inc. is selling mobile telephones based on a short-range wireless technology as part of efforts to boost sales of systems that use Internet technology for phone calls. Cisco Systems Inc has targeted wireless local area networks and Internet phone calling, known as IP telephony, as growth markets. The phones use Wi-Fi to connect callers to a Web-based phone network, allowing them to roam without missing phone calls (http://www.cisco.com/au).

'The impact of Wi-Fi will be substantial, and has been underestimated. North America and Europe already have over 5000 WI-FI hot spots in public places, a figure expected to rise to nearly 90,000 by 2007 (Kecman, Boston 2003). Instead of setting up isolated wireless hotspots, companies like WAN are building Wi-Fi zones, or long-distance wireless networks. The largest has a radius of 12 km. WAN has built its own radio antennae to transmit Wi-Fi signals over long distances, allowing users to move between local Wi-Fi networks and WANs. As IP telephony is already impacting on many organisations, it is a natural progression to start using these in mobile form on these networks. Additionally, mobile phones are now capable of basic video calls. IP video conference calls over Wi-Fi are virtually a reality.

Satellite Video

Video conferencing is also being executed via earth satellites, with significant success. The downsides of linking up are the same as for wireless video. Additionally, the latency is inherently greater due to the delay of the signals to and from the satellite. This is at least one second, but often more. Most users quickly adjust to that effect as it can be very similar to an international telephone call. Other problems are that the satellite data rates can be different for uplink than for downlink, making symmetrical video conferencing more difficult. This is very similar to IP video conferencing on say a cable network where upload and download speeds usually differ greatly.

The satellite usually operates in a store-and-forward transmission mode, thus freezing pictures if the stream is broken and continuing when the stream becomes available again. This is still very common in satellite link-ups for the television news, for example; The Iraq war in 2003 was a clear indication on how videophones, using satellite technology, were applied in the media. In a broadcast sense it is a very expensive way to provide a video conference; however, the videophones (satellite phones) are a great deal less expensive (but a broadcast picture cannot be expected for this). The video satellite phone is still much more expensive than a standard video mobile phone, such as those available in 2004.

Application and Data Sharing

Video conference equipment developers have put a great deal of emphasis on the audio and video aspects of collaboration, as this is seen as the most immediate need for good communication. With the benefit of H.323 standards, most of the video conference products can interoperate with each other. This is resulting in an increased acceptance of the medium, and the use of these video conferencing systems is becoming more widespread. In applying this technology in communication strategies, the demand for sharing data and applications (as in a normal face-to-face meeting) is increasing. This might be a PowerPoint presentation or a word document, whiteboard or notepad, but in an educational environment it would also have to include other computer software packages, video, animation and other multimedia applications. Such sharing can be made available in two ways: 'Push and receive' or 'Push and pull'**.**

'Push and receive' is the sharing of an application by two locations, where one location is pushing the images out and the other is merely receiving them. Interaction on the same media is only one way. 'Push and pull' is a true interactive way of sharing the media. Both locations can actively engage in adapting and altering the image media. This is sometimes also called people and content. People are on one screen and electronic content is available on a second screen. Two-way interactions are possible on both screens. Initially, data sharing was mainly handled using the T.120 standard. This defines how to establish and manage interactive communications between two or more participants' desktops.

Effectively, T120 runs independently of a video conference using different network protocols in a manner that enables data communication services independent of the underlying network. But the future of T.120 is being challenged as web enabled tools are becoming more widespread.

Web-Conferencing

The rich functionality of the Web offers a growing number of competing ways to implement sharing of resources, including your personal ones. Although video conference manufacturers are trying to convince users that data application availability and sharing can be part of the video conferencing equipment sphere, this is not the only option. Web-conferencing is fast making deep inroads in this market. Web-conferencing offers the opportunity to meet across the internet at any time and at any place. The conference can be data application sharing only or can include audio and/or video linking as well. Participants only need a web browser and an Internet connection. NetMeeting provided one of the first very basic web data application sharing facilities, but today there are more and vastly superior products on the market that do this job better and faster. Some manufacturers of web conferencing operate from their own servers and hire out time to their clients on a needs basis. Others are happy to sell the software and/or hardware so that this can be set up independently of such providers; for example, Smart Bridgit (Smart, 2004) or Latitude Communications with MeetingPlace® (Meeting Place, 2004).

There are many makers of web-conferencing software and hardware. For a comprehensive list see: http://www.webconference.org/products_results.asp.

There is a trend to run video conferences simultaneously with web conferencing: one supplies the video and audio, the other provides the electronic data. Developments are becoming more impressive as well as more affordable. Some providers are convinced that they will be able to offer an all-in-one solution across the Internet that will provide high-end video, audio, data and sharing simultaneously at very high quality in real time.

Videophones

Videophones are appearing fast on the market. They are available as desktop videophones, as well as mobile phones, usually using IP technology to establish links.

Older type analogue videophones have been around for a while, but have never really been commercially successful, mainly because of poor quality video and audio. They also tend to work only as pairs; for example, you had to purchase two phones which were capable of communication with each other. IP phones, however, have improved significantly over the years. IP phones and videophones are most often used within closed networks such as are available in universities. Many mobile telephones are also capable of transmitting and receiving video calls. These can link across conventional digital mobile networks and others can work using satellite technology. Some mobile phones are now also capable of providing a video conference capability through a modified mobile telephone network. The picture quality is poor and the call costs are expensive (approximately $1.00 AU per minute). We can expect considerable improvements to be made in the mobile telephone video capabilities in the near future.

HDTV

HDTV will also offer changes in the video conference market. As HDTV is becoming more accepted, it is expected to be fully integrated in the mainstream by 2008. At that time, it is also expected to make inroads in video conference technology. This is for a number of reasons. First, there is the Australian Government requirement that analogue TV broadcasts will cease by 2008, to be completely replaced by digital television. This has an impact in the hardware that is being made available. Already we see that wide-screen televisions are becoming more accepted. The majority might still be analogue, but video conference suppliers are noticing the 16: 9 aspect ratios (wide screen). Many manufacturers already allow for this ratio by stretching the 3:4 ratio images. The 16:9 format is much more friendly for video conference users, as classrooms or boardrooms are well suited to the wide-screen format. As audiences become more accustomed to the high quality of HDTV (1080lines) they will demand that image quality on video conference systems be of similar quality (Bird, 2002). It is expected that HDTV will be affordable by 2008, and video conference systems will have this option available. It can still only be used if sufficient bandwidth and/or new high performance compression standards are available.

3D and Teleportation Technologies

Several companies have developed systems which "teleport" a full-sized 3-D holographic image of a person into a room. The virtual image of a real person can be placed behind a lectern or desk, in front of a wall, curtain, or other background. This virtual person can see the person or audience in front of him or her and can make eye contact with them. They can hold a normal conversation. This form of virtual presence makes it appear as if the whole person is right there in the room. Of course, we can still see that this is a projected image, nowhere near the visual image of a real person; however, it is a beginning that can be improved upon. High quality audio and video components eliminate audio latency problems. While the systems operate over ISDN, ATM, or IP, the unique features require specialized lectern and desk equipment. Teleportec (2004), Realityinterface (2004). This technology is very much in its infancy but promises to be an important future direction for video conferencing. 3DTV is a technology that is being developed by Pioneer, Philips, Samsung, Sanyo, Sony and LG. Some prototypes are already running that allow 3DTV watchers to view images without the need for special glasses. The technology is very young, but will eventually spill over into video conferencing (Preston 2003).

Mega-Conferences

There are now over 200 organisations around the world registered to participate interactively in video conferences via H.323. Many presentations related to distance learning occur regularly, as well as other events. Usually there are three sessions during the day, to provide convenient times for participants in all parts of the world. These Mega-conferences are more or less experimental and because of the sheer number of participants around the globe, interaction is very difficult. It is likely that these conferences will be perfected over the next few years. Interaction systems will be invented, similar to such already available for web conferencing systems. It is unclear how such Mega-conferences can be applied usefully within organizations or universities, as interaction is limited. See http://www.mega-net.net/megaconference for information and the detailed program of events.

H.264

The adopted ITU standard H.264, ratified on 14 July 2003, offers twice the quality of existing bandwidth. This has potential for students at home with cable modems who now are able to video conference at low data rate, whilst not having to compromise picture and audio quality. The standard increases upload capacity and makes it more suitable to join video conference classes through MCUs. Video conference system manufacturers are now integrating the standard into their systems. The standard halves the usage cost for IP video conferences if the same link-up speed is used as before the standard became available. New high speed compression technologies will become available in the future. These will offer even better compressions so that video conferences will be easier to implement over the Web.

SIP

Session Initiation Protocol (SIP) is the newest means for data transfer offering a single global signaling standard. It is designed to provide a simple form of creating and ending connections for real-time interactive communications over IP networks. It is currently mainly used for voice, but increasingly for videoconferencing, gaming or even application sharing. Today there are SIP-enabled phones and proxy servers all over the world. Microsoft has built support for SIP into their Windows XP operating system enabling companies to run a cost-effective single wire to a desktop (using IP) and have the PC operate as a telephone that enables a user to click on a name in a PC directory. SIP will eventually be used in all IP communications and will simplify use for end-users of any IP enabled technology.

Converged Networks

Voice, video and web collaboration over converged networks is fast becoming the norm for larger organizations and universities. Cisco AVVID (Architecture for Voice, Video and Integrated Data) defines a framework for building and evolving customer networks that support Internet business solutions. The industry's only enterprise-wide, standards-based network architecture, Cisco AVVID, provides a roadmap for combining business and technology strategies into one cohesive model.

Cisco AVVID describes network elements for clients (devices with which users access the network), the network infrastructure (network platforms and intelligent network services), Internet middleware (software and tools), Internet business integrator interaction, and Internet business solutions. Video conferencing systems will be just one of many end elements that work on a converged network.

It is clear that of all the technologies discussed above, the IP technology is making most use of the developments today. Because the IP standards are evolving rapidly, the network services cannot easily keep pace (Yafchak, 2004). While this is slowing down the roll out of IP technologies, they promise to deliver connectivity in a range of technologies that are converging because of the shared common link. Voice, video and data over IP are already a reality, and soon it will be normal to use the same equipment to do a range of things, all over IP; for example, video conference, voice conference, send, receive and share data, listen to the radio, watch television, listen to audio on demand, view video on demand, have internet access. It will be possible to do all of this on each device; for example, a mobile phone, a desktop pc, an IP phone, a cable television or a laptop. You can do this at home, on a train, in a car, train, plane or ship, or at the office. Although video conferencing so far has been a separate end user technology, the future suggests that the fine lines that exist between the various technologies will be harder to define than ever.

7.2 Future Scenario

It is impossible to predict the future with accuracy; however, assumptions can be made on the current technology trends, as described above. We can take these into account and develop a likely scenario of what education will be like, using IP video conference technology, in five years time. An important factor in developing such a scenario is to take into account universities and other educational institutions' policy trends. Most universities have a very strong web presence and a significant number of courses available on-line. Distance education is bigger than ever and is venturing overseas as many institutions have either real or virtual campuses established overseas. Many educational institutions have this virtual growth, and the marketing of their courses to distant students is encased in their policies.

It is likely that students enrolled in these distance education programs will want to communicate better with their teachers as well as with their peers. As the World Wide Web grows and bandwidth becomes broader, it is likely that in five years time, video conferences of person-to-person will be common place at good data rates. Almost certainly the H.264 protocol, or better, will be used to minimize the use of bandwidth and maximize the quality of such video conferences. Distance education students will use desktop video conferences to communicate, as it will be cheaper and more effective than emails, chat facilities or conventional telephone calls. It is very likely that, through the convergence of technologies, web conferencing as we know it today, will no longer be stand-alone but will be part of video conference applications and incorporated software. Application and data sharing will be effortless, reliable and fast. It is also highly probable that significant inroads will be made in the implementation of HDTV and that it will start to have an impact on the video conference world. Desktop video conferences will start to convert to the wide screen format of 16:9. It will also be possible to make calls from the desktop to a laptop via WI-FI at high speeds and additionally to mobile telephones. The standard office telephone in universities and other commercial organisations will be replaced by IP (SIP)Video phones. It will take a little longer to reach the domestic market, but the revolution has already started. The party-line as we know it now via the telephone will be replaced by the Mega-video conference; however, 3D video conferences are still closer to science fiction than reality at this time. So what does this mean in educational environments? The distance education student is likely to be the person to benefit most from the development of these technologies, as they have lacked significant 'real-live' communication. The students will video conference from home to their supervisor, teacher or peers. Some students will also benefit from being able to participate in 'Mega- conferences' on a small scale; for example, a lecturer delivers a lecture from his or her desktop, or lecture theatre, which is linked into a 'Mega-conference' to other students. The class size could be anything from two sites to two hundred sites or more. Some interaction will be possible, so students can raise questions in real-time and have them answered in real-time. Any electronic data that is being used will come across in real-time and will be of high quality. Students could be at home, on a river or bay, in a library, café or restaurant and still participate in a class. In reality, some of this scenario is possible now, but because it is in its infancy, it is not yet reliable.

Significant difficulties need to be sorted out between now and then, and as we know, not all of them are technical. The human elements involved in such a scenario raise the bar significantly for educators.

7.3 Future Research Directions

Several interests motivated the present research. This thesis is the end result.
We can assume that video conferences will become more popular given the fact that broadband availability is increasing worldwide. As equipment manufacturers of video conference systems are abundant, it is likely that the equipment itself will become cheaper, thus more acceptable by the mainstream. In five to ten years time, video conferences will be cheap and as commonplace as telephone calls. Most, if not all of the video conferences, will make use of IP technologies, as this will be by far the most accessible communication technology available around the globe. Compression techniques will have increased dramatically, thus enabling high quality data traffic to flow. Firewall problems should be resolved by then. ENUM and SIP ought to be standard which will resolve the problems now experienced with dynamic IP addressing. In education this will have a significant impact. Potentially this will change the face of traditional face-to face learning. Additionally, it will propel educational institutions into a much wider global community. Furthermore, it opens up arguments for reduced real-estate. Today vast amounts of money are spent on infrastructure, bricks and mortar, but what if students could access lectures and classes from home - live? They already obtain much of the learning materials from the web. Access to libraries is also available on the web, and books, papers and journals are rapidly becoming available in electronic format. In the future, this will be more so. There will be large numbers of students who will no longer need to physically go to a university building. Universities around the globe might find themselves with lots of empty buildings. Money spent on building, maintaining, cleaning and securing these buildings can be spent elsewhere. This notion of students studying from home has been around for a while, but in ten years time this could be close to reality.

Given the rise of 'virtual education systems', what then could be further researched?
A number of areas that will need further scrutiny, for example:

- Is anybody concerned if indeed our students want to study from home using new technologies such as video conferencing?
- Will 3D virtual video conferences add another educational dimension?
- Is convergence of technologies going too far; are learners becoming 'virtual isolated'?
- Are educational providers going global and, if so, is this good for learners and teachers?
- Can lecturers and teachers deal with teaching on a global scale?
- We know that learning through video conferences can be effective, but will learning though Mega-conferences be effective?
- Can students learn adequately without having daily contact with their peers?
- Can money saved from infrastructure, bricks and mortar be redirected to fund IT infrastructure at students' homes?
- Are lip-sync problems affecting students' ability to learn effectively?
- What are the benefits (community, economic) of reaching distance education students with the new technologies?
- What economic benefit exists for universities that implement new technologies?

7.4 Conclusion

The convergence of technologies that are potentially applicable in educational institutions around the globe is considerable. This is not something that will go away or can be ignored. It has changed the world of education already and will continue to do so over the coming years. There is ample related material that is emerging that needs to be probed and investigated further. In today's world, it is a fact that technology is driving progress on many fronts. Education is no exception. How this is going to affect students and teachers will have to be investigated on a much wider scale. Video conferencing over IP, from the desktop or small group systems, is only a small part of this convergence.

Appendix 1 Glossary

10BaseT is the most frequently used wiring scheme for Ethernet. The "10" indicates 10 million bits per second. The "T" indicates use of twisted-pair wires of the sort used for telephone circuits. 10BaseT uses two pairs between the computer interface and the "hub," one pair for transmitting and one for receiving.

100BaseT is the family of wiring schemes used for Fast (100 million bits per second) Ethernet.

AARNet Australian Academic and Research Network.

ADPCM Adaptive Differential Pulse Code Modulation.

ADSL Asymmetric Digital Subscriber Line

Aliasing is the perception as noise of high-frequency sounds or visual components, due to insufficient sampling frequency. Proper filtering avoids aliasing.

Analog signals have voltage directly analogous to the strength of the corresponding physical signal, that is, the loudness of a sound or the brightness of a light source. The voltage of the signal alternates (between positive and negative) at the frequency of the sound or light source.

ASP Application Service Provider.

Aspect ratio is the ratio of the pixel width of the visible display to the height of the display area.

ATM Asynchronous Transfer Mode.

Audiographics is a means to augment telephones with graphics such as shared documents.

Basic rate ISDN (BRI) is the most common form of ISDN. BRI provides hive B-channels with one 16,000 bit per second D-channel for signalling, using ordinary telephone wiring.

Chair control (see conducted conferences).

Chrominance refers to the colour components (hue and saturation) of aluminance-based representation of colour.

CIF stands for Common Interchange Format. *352 x 288* is the most frequently used resolution for motion video.

Circuit switching is what the telephone network is based on, which means that once a call is established, there are circuits (B-channels) dedicated to the call.

Codec is a term for coder/decoder.

Coder is a device for coding.

Coding is one of two terms, along with "compression," used almost interchangeably in referring to processes for reducing the bit rate.

Composite video is the most common form of electrical signals used to transfer video between components. Luminance, hue, and saturation are multiplexed together on a single signal wire on the sending end and separated at the receiving end. Most inexpensive cameras, VCRs, and televisions use composite video. Composite video usually uses single-pin "phono" connectors, the same as the ones that are typically used for audio connections.

Compression is an alternate term for coding.
Conducted conferences allow one site to be designated as the conductor of the conference. Conducted conferences are sometimes called “chaired” or “chair controlled”.

Continuous presence refers to the capability in a multipoint conference to make video from many of the sites continuously present on the screen.

CRC, Cooperative Reseach Centres Program, (Project for Innovative Wood Manufacturing).

CSIRO Commonwealth Scientific Industrial Research Organisation.

Digital signals are a representation of physical signals using numbers, usually called "samples," to represent amplitude or intensity. The range of the numbers in a sample is the major determiner of the signal-to-noise ratio.

Document sharing is a conferencing capability to allow the participants to view and manipulate the same document.

Document stand is a device with a built-in video camera for capturing images of paper documents and similar items.

DPCM Differential Pulse Code Modulation.

DSL Digital Subscriber Line

Duplex Full duplex systems generally allow sound to travel in both directions simultaneously. For the user, this means all parties can be heard at all times, unless of course the microphones are turned off. When microphones and speakers are open at both locations it generally results in ‘feedback’.

ENUM is a technology "protocol" that offers the translation of a standard telephone number into a format that can be used to store and retrieve Internet addressing information, which can in turn be used to route communications over the Internet.

Ethernet is the most widely used form of local-area network (LAN). In the original form, signals are broadcast on coaxial cables, analogous to radio transmission through the mythical "ether." 10BaseT wiring is now preferred over coaxial cable in most environments.
FPS frames per second. The amount of frames that are displayed per second in order to represent a moving image.

Frequency is the number of cycles per unit of time (of a sound or radio wave, for example).

FTP File Transfer Protocol. A system that allows data files to be transferred from computer to another computer across the internet.

Full duplex is simultaneous bi-directional transmission, as opposed to alternating bi-directional transmission (half duplex).

G.711 is the default audio representation used in H.320, providing roughly 3.5-KHz frequency response in a 64,000-bit communication channel.
G.722 is an optional audio representation used in H.320, providing roughly 7-KHz frequency response in a 48,000-, 56,000-, or 64,000-bit communication channel.

G.723 is an audio representation used in H.324, providing roughly 3.5- KHz frequency response in a 6,300-bit communication channel.

G.728 is an optional audio representation used in H.320, providing roughly 3.5-KHz frequency response in a 16,000-bit communication channel.

Gatekeeper A device that provides a management service between terminals, gateways and MCUs.

GrangeNet GRid And Next GEneration Network is a joint venture program that is installing, operating and developing a multi-gigabit network to support grid and advanced communications services.

H.221 "Frame Structure for a 64 to 1920 Kbit/s Channel in Audiovisual Teleservices" defines the usage of *P* B-channels to transmit multiplexed audio, video, other data and control signals.

H.261 "Video Codec for Audiovisual Services at *P* x 64 Kbit/s" has been known informally as *"P* x 64" because it defines video coding based on *P* 64,000-bit per second channels. *(P* is typically two or more.)

H.263 "Video Coding for Low Bit Rate Communication" is the coding method designed for H.324, using the techniques of H.261 plus significant enhancements.

H.320 "Narrowband Visual Telephone Systems and Terminal Equipment" is the summary ITU-T recommendation for standard video conferencing using ISDN or similar telephone circuits.

H.323 "Visual Telephone Systems and Terminal Equipment for Local Area Networks which provide a Non-Guaranteed Quality of Service" is the summary ITU-T recommendation for standard video conferencing with conventional local-area networks.

H.324 "Terminal for Low Bit Rate Multimedia Communication" is the summary ITU~ recommendation for standard video conferencing using POTS.

Half duplex is bi-directional transmission in alternating (not simultaneous) directions.

HDTV High Definition Television

Hue is the relative proportion of green and red in a luminance-based representation. The hue control on a television is often called "tint."

Internet is the proper name for the worldwide computer *network* that evolved from the 1970s ARPANET.

Internet2 is an effort by a group of US Universities to develop advanced network applications and the network technologies needed to support them.

IP address – Internet Protocol Address, a unique number, separated by dots, that identify a specific computer or system.

IP stands for Internet Protocol, the network level protocol used in the Internet and other computer networks.

IP~SPX stands for "Internet Packet eXchange/Sequenced Packet eXchange," the family of protocols originally used on NetWare networks. (Some NetWare networks use TCP/IP).

Iris is the device behind a camera lens that controls the amount of light admitted, and thus controls brightness of images.

ISDN stands for "Integrated Services Digital *Network."* ISDN is a standardized approach to providing digital service from digital telephones.

ITU-T is the International Telecommunications Union--Telecommunication Standardization Sector, which establishes "recommendations" for standard protocols.

ISP, Internet Service Provider

ITS Information Technology Services Department

JPEG is the Joint Photographic Experts Group standard for coding of still images.

LAN Local-area network is a computer network, designed for a localised geographic area, that is capable of higher speed connections than typical networks for wider geographical areas.

Luminance is the brightness intensity of a visual image. The luminance control on a television is often called the "picture."

MCU Multipoint control unit is a device for implementing multipoint conferences.
Modem (MOdulator/DEModulator) is a device used to transmit digital data across analog telephone circuits.

Motion estimation is the estimation of which pixels in a frame are different from those in the previous frame.

MPEG Motion Picture Experts Group is a standard form of coding used for stored video and television.

Multimedia is data that include multiple forms of natural media, typically including audio and video.

Multiplexing is the process of combining separate streams or channels into one logical stream of data.

Multipoint is the usual term for conferencing with more than two sites.

NT1 (network terminator one) is a device for BRI that converts the two off premises signal wires to four-wire connections suitable for an ISDN telephone. An NT1 is often designed to support more than one of these four-wire connections, for example, one for a telephone and one for a fax machine.

NTSC (National Television Standards Committee) is the standard for television broadcasting in North America.

OSW Open Speech Web. The era where speech-activated services abound are connected into one global speech network.

Overlaying video (see video overlay).

Packet switching is the approach used in most computer networks for carrying different logical streams of data on the same shared physical network.

PAL (phase alternating lines) is the standard for television broadcasting in Europe and other countries.

PCM Pulse Code Modulation.

PIP Picture in Picture. A picture superimposed over the incoming Video picture, usually at ¼ size of the normal screen size.

Pixel ("picture element") is one of many small dots used to represent a picture.

Plain Old Telephone Service (POTS) is a common term for conventional analog telephony.

PRI stands for primary rate ISDN.

Primary rate ISDN (PRI) is a high-bandwidth form of ISDN. A PRI circuit has 23 B-channels and a 64,000-bit D-channel for signaling (1,536,000 bits per second) in the United States, and 30 B-channels in Europe and Asia.

Private branch exchange (PBX) is a telephone switchboard designed for private use (as opposed to a *"central* branch exchange" used in telephone company offices).

Program sharing is a conferencing mechanism allowing more than one person, each on different computers, to use the same copy of the same program, working with the same document, and seeing the same displays on screen.

P x 64 is an informal name for H.261.

QCIF (Quarter Common Interchange Format) is a variant on CIF with 176 x 144 resolution.

QoS (Quality of Service) refers to the capability of a network to provide better service to selected network traffic over various technologies.

Radiographic is a term for computerized radiology (diagnostic "X-rays").

Resolution is a measure of detail in a digital visual image, measured either in number of pixels in the horizontal and vertical directions, or in pixels per unit of physical measure of the display device.

RGB is a representation of colour using the intensities of the primary colours of red, green, and blue. Appropriate mixtures of these primary colors can be used to represent any colour. For example, black is represented by R(ed), G(reen), and B(lue) , 11 at zero intensity, white is R, G, and B all at one (full intensity), yellow is B at zero, R and G at one, etc. This representation facilitates design of both hardware and software for manipulation of images and colours at the pixel level.

Roll-about is a medium-scale video conferencing system intended for use by small groups in typical meetings. It can be transported from room to room, as long as the room has appropriate connections to telephone or local-area networks.

Router is a device in packet-switched networks for routing packets from one sub network to another.

Sample is a number representing the strength of a signal at a particular time, used with other samples in digital signal representation.

Saturation is the overall intensity of colour in a *luminance-based* representation of a colour image. On a television, the saturation control is often called "colour".
Scaling is the process of converting resolution.

Scan converter is a device used to convert the computer video output to a television representation, or vice versa. This device must perform the appropriate scaling to convert between square pixels and rectangular pixels.

SCN switched circuit network.

SECAM Sequential Couleur A'Memorie, a colour television system used in France and some other countries. It has 625 horizontal scan lines and 25 frames per second.

Simplex A simplex system generally sends audio down the line in one direction; however, if a sound at the receiving end is louder than the sound it is about to receive, the travelling of that initial sound is halted before it arrives. The louder sound now travels to the first location, again only in one direction, although be it the other direction this time.

SIP Session Initiation Protocol, (also sometimes called Simple Internet Protocol) is a protocol for Internet conferencing, telephony, presence, events notification and instant messaging. SIP was launched in 1999 by the Internet Engineering Task Force.

SDSL Synchronous Digital Subscriber Line.

SDTV Standard Definition Television is a standard form of digital television.

SUT stands for Swinburne University of Technology, which is based in Melbourne Australia.

S-VGA 1024 x 768 is a common resolution used for desktop PCs and Macintoshes.

S-Video is a form of electrical signal used to transfer video between components. S-Video keeps the luminance and chrominance component signals separate on separate signal wires, using multi-pin connectors. S-Video leads to higher image quality, compared to composite video, because of the degradation that results from combining and separating the components.

Switched 56 is a 56,000-bit per second circuit, designed for dial-up customer use, which became available in the United States before ISDN. Though similar to BRI, Switched 56 is harder to attach to than BRI, because of the equipment needed at the customer premises. A typical link requires two Switched 56 circuits versus one BR1 to get comparable bandwidth. As BRI becomes readily available it is expected that use of Switched 56 will diminish.

T1 is a higher speed telephone *circuit* used in the United States for dedicated connections, capable of 1,544,000 bits/second. The electrical connection uses two pairs of telephone wires. T1 circuits are widely used for connecting PBXs to central telephone *offices.* T1 circuits are also used to connect distant LAN segments.

T.120 "User Data Transmission using a Multi-Layer Protocol (MLP)" is a comprehensive ITU-T recommendation for data conferencing. It is an ITU international umbrella standard that allows document conferencing and application sharing similar to VNC, XTerm, or Microsoft Virtual Terminal.

TCP/IP (Transmission Control Protocol/lntemet Protocol) is the name usually used for the family of protocols used on the Internet and in many other networks.

TDG Teaching Development Grant.

Telecommuting is the practice of working at home but "commuting" to an Office by computer networking and/or video conferencing.

Telemedicine is the practice of medicine across a distance by computer or video.

Temporal filtering is the process of dropping frames and otherwise filtering excess detail across successive frames as part of video coding.

Terminal adapter (TA) is an ISDN device to manage dialling and answering the call (using the D-channel) and convert the bit-serial data on the B-channels to and from a form suitable for management by the conferencing software.

Touch panel is a touch-sensitive display device for controlling equipment.

VGA stands for "video graphics array". The default resolution for VGA is 640 x 480. Higher resolutions of 800 by 600, 1,024 x 768 and 1,280 X 1,024 are known as "S "Super" VGA. 640 x 480 is also frequently used for still images in video conferencing.

ViDe Video Development Initiative.

Video-ASP is an Application Service Provider giving streaming video to its own clients.

*Video ove*rlay is the combining of multiple images in mosaic fashion. In broadcast television, a common example is that of showing forecaster in front of a weather map. In computer-based video conferencing, a common example is that of showing a video image of people "in front of" a computer-generated image.

Visual artifacts is a term for discrepancies between a coded image and the original source.

VoIp Voice over IP.

Voice-activated switching refers to multipoint conferences where the sites generally display the video from the site with the strongest audio signal, with that site seeing the video from the previously selected site.

VRVS Virtual Rooms Video conferencing Systems is a web oriented system for video conferencing and collaborative work over IP networks.

Wi-Fi wireless fidelity.
World Wide Web is one of the most commonly used applications on the Internet, providing hyper linked access to data in an easy way.
YUV is the luminance-based representation of colour used in PAL and in many video-coding approaches.

Appendix 2 Evaluation Questionnaires

Case study 1 Questionnaire A

Project Title:
An investigation of purpose-designed digital video in a multimedia educational environment
Investigators: Prof. Allen Whitfield, Paul Meulenberg.
(Desktop video conferencing)

Dear participating student,

Thank you for your assistance with this survey. It will only take approximately 15 minutes of your time to work through this questionnaire. The questionnaire will examine the processes involved in setting up and using the video conference facility. It will also monitor the available generated data of the system and looks at application and design aspects of the system. Lastly, it will try to assess its educational value from start to finish of this program. The answers in the questionnaires will be used as part of a wider study on the use of video conferencing as a teaching aid in Education.

The data collected in these questionnaires will be of value to Swinburne University of Technology for future educational programs. We hope to improve the video conference facilities as well as enhance the current video conference methodologies as a result of the findings. The questionnaire also contains a number of sections to assess your experience with using video conference facilities.

Please note that the information you provide in this survey will remain *confidential.*
The information you provide *does not form part of any grading for any subject* at this University whatsoever. Additionally, no individuals, staff or students, will be identified at any stage.

Any questions you may have regarding the project entitled "An investigation of purpose-designed digital video in a multimedia educational environment" be directed to Paul Meulenberg via Prof. Allen Whitfield of the National School of Design, Ph. 9214 6882.

We thank you for your considered responses to the questions put forward.

Thank you,

Paul Meulenberg
Manager Educational Production & Services
Learning & Teaching Support
Swinburne University of Technology

Dear participating student,

If you have any reason for complaint about the project entitled "An investigation of purpose-designed digital video in a multimedia educational environment" in the way you have been treated during the project, or a query that the Senior Investigator has been unable to satisfy, you may lodge an official complaint.

A detailed report with reference to the project, relevant School and researcher are to be forwarded to:

The Chair
Human Research Ethics Committee
Swinburne University of Technology
P O Box 218
HAWTHORN. VIC. 3122
Phone: (03) 9214 5223

Any other questions you may have regarding the project entitled "An investigation of purpose designed digital video in a multimedia educational environment" be directed to Paul Meulenberg via Prof. Allen Whitfield of the National School of Design, Ph. 9214 6882.

Thank you,

Paul Meulenberg
Manager Educational Production & Services
Learning & Teaching Support
Swinburne University of Technology

AGREEMENT

I……………………………………………………………………………………………… have read and understood the information above. Any questions I have asked have been answered to my satisfaction.

I agree to participate in this activity, realising that I may withdraw at any time.

I agree that research data collected for the study may be published or provided to other researchers on the condition that anonymity is preserved and that I cannot be identified.

NAME OF PARTICIPANT... ....
SIGNATURE.. DATE..

***** NAME OF AUTHORISED REPRESENTATIVE... ....
RELATIONSHIP TO THE PARTICIPANT ....
or
POSITION.. ....
SIGNATURE.. DATE..

NAME/S OF PRINCIPAL INVESTIGATOR/S.. ....
SIGNATURE.. DATE..
SIGNATURE.. DATE..

Additional clauses would be required for a parent to consent to a child's participation, the tape or video recording of interviews or activities or events.

***** Use this signature block only in such cases where the participant is not capable of providing his/her informed consent. See Section B Item 1(d) and Item 7 of the application form.

[1] Personal privacy protection in health care information systems, Australian Standard AS 4400-1995.

[1] Privacy Act,1988 Commonwealth of Australia.

[1] The December 1991 Guidelines for Good Clinical Research Practice in Australia, published by the Therapeutic Goods Administration of the Commonwealth Department of Health and Family Services, recommends retention of data for at least 15 years.

[1] Uniform Requirement for Manuscripts Submitted to Biomedical Journals as presented in JAMA 1993: 269:2282-6

Introduction

(Q2a)

Desktop video conferencing

Firstly, we need to ask you some important information about yourself.
Please remember that this information will **remain completely confidential**.
It is important to complete the questionnaire as truthfully as possible so the results can be analysed with a degree of accuracy.

Personal details (Only used to match the 2 surveys Q2A, Q2b)
(All fields in this survey will expand automatically)

Name	
Place of employment/study	
Occupation	

Double click on 'check box' to select: "checked"!

Which group do you belong to?

☐ I am a student
☐ I am a teacher/lecturer
☐ I am an administrator

☐ Female
☐ Male

☐ Age 00 - 20
☐ Age 21 - 30
☐ Age 31 - 40
☐ Age 41 - 50
☐ Age 51 - over

1.0 Previous Teleconference experience

1.1 Have you ever been involved in any kind of teleconference before?

Please indicate what kind:

☐ Audio conference
☐ Audio-Graphics conference
☐ Mac/Fax/Duct
☐ Optel
☐ Video conference
☐ Other (describe):
☐ Non *(go to question 2.0)*

1.2 When did you have this previous teleconference(s) experience?
☐ 1999 - 2001
☐ 1995 - 1998
☐ Before 1995

1.3 How much time did your previous average teleconference(s) last?
☐ 0 - 15 Minutes
☐ 15 - 30 Minutes
☐ 30 - 60 Minutes
☐ Longer than 60 minutes

1.4 What was the purpose of your previous teleconference(s)?
☐ Educational
☐ Administrative
☐ Other

2.0 Set up of Polycom video conference facility

(if you are not using a Polycom ViaVideo unit go to Question 2.1a

2.1 How difficult was installing the hardware and software?
☐ Easy
☐ Hard

2.2 Did the equipment work immediately after installation?

☐ Yes

☐ No, please describe fault:

2.3 Have you received any training using your current (Polycom) facilities?

☐ Yes

☐ No (go to question 2.5)

2.4 If YES was the staff development sufficient to get you started?

☐ Yes

☐ No

2.5 Could you still get started without training?

☐ Yes

☐ No

2.1a Other desktop video conference facilities

(only complete this section if not using a Polycom ViaVideo)

Please describe the desktop video system you are using:

☐

2.1a.1 How difficult was installing the hardware and software?

☐ Easy

☐ Hard

2.1a.2 Did the equipment work immediately after installation?

☐ Yes

☐ No, please describe fault:

2.1a.3 Have you received any training using these facilities?

☐ Yes

☐ No (go to question 2.5)

2.1a.4 If YES was the staff development sufficient to get you started?

- ☐ Yes
- ☐ No

2.1a.5 Could you still get started without training?

- ☐ Yes
- ☐ No

3.0 Current video conference experience

3.1 **From** which location did you establish your **first** with Swinburne?

- ☐ Hawthorn
- ☐ Prahran
- ☐ Lilydale
- ☐ Wantirna
- ☐ Other, please describe:

3.2 **To** which Swinburne University campus was your **first**?

- ☐ Hawthorn
- ☐ Prahran
- ☐ Lilydale
- ☐ Wantirna

3.3 What kind of link did you use?

- ☐ ATM
- ☐ LAN
- ☐ DSL
- ☐ Cable network

3.4 Do you know what data rate you linked up with?

- ☐ 128 Kbps
- ☐ 256 Kbps

☐ 384 Kbps
☐ I don’t know

3.5 How much time was spent on the video conference ?

☐ 0 - 15 Minutes
☐ 15 - 30 Minutes
☐ 30 - 60 Minutes
☐ Longer than 60 minutes

3.6 What was the purpose of the video conference?

☐ Educational
☐ Administrative
☐ Other

3.7 Did you link up successfully the first time?

☐ Yes
☐ No, not at all
☐ Took several attempts

3.8 Did the link up work well (please rate)

☐ Worked well to 25%
☐ Worked well to 50%
☐ Worked well to 75%
☐ Worked well to 100%

<u>4.0 Utilities</u>

4.1 Was any use made of a chat facility?

☐ Yes
☐ No (if no go to question 4.4)

4.2 Was use made of the chat facility because some technology failed?

☐ Yes

☐ No (if no go to question 4.3)

4.3 Which part of the technology failed?

☐ Video, Please describe fault:

☐ Audio, Please describe fault:

4.4 Was any use made of a data sharing facility?

☐ Yes

☐ No (if no go to question 5.0)

4.5 Which data sharing did you use? (Describe)

☐ Word document

☐ PowerPoint

☐ Other, please describe:

4.6 Did the data sharing facility work to your satisfaction? (Rate to scale)

☐ Worked well to 25%

☐ Worked well to 50%

☐ Worked well to 75%

☐ Worked well to 100%

4.7 Was video or audio affected by the use of data sharing?

☐ Video, Please describe fault:

☐ Audio, Please describe fault:

5.0 Quality

5.1 With which system was your link up?

☐ Polycom ViaVideo

☐ Polycom ViewStation

☐ Polycom FX

☐ Other (describe):

☐ Don't know

5.2 If you could control the far end camera, was the switching of the cameras of the **far end** location satisfactory?

☐ Yes

☐ No

5.3 Did the **far end** pictures you saw provide enough detail? (Wide shot, close up)

☐ Yes

☐ No

5.4 Did the **near end** pictures you saw provide enough detail? (Wide shot, close up)

☐ Yes

☐ No

5.5 Would an additional camera have been useful? (Describe)

☐ Yes, describe:

☐ No

5.6 Was the audio of good quality?

☐ Yes

☐ No

6.0 Appropriate use

6.1 Was it effective as a means of communication?

☐ Yes

☐ No

☐ Don't know

6.2 If graphics and/or text were used were they well set out (readable)?

☐ Yes

☐ No

6.3 Did you feel the need for extra technology for example, more cameras, document viewing, other tools, etc?

☐ Yes, describe:

☐ No

7.0 Local issues

7.1 Was your local location suitable for video conferencing?

☐ Yes, describe:

☐ No, describe:

7.2 Was the size of the venue you attended:

☐ The right size, describe measurements

☐ Too small, describe measurements

☐ Too large, describe measurements

7.3 Were you in relation to the screen:

☐ Well placed in the middle?

☐ Off centre but acceptable?

☐ Too far to the side?

7.4 Did you feel that participants at the far end looked at you in the following manner:

☐ Direct (good eye line)?

☐ Off centre but acceptable?

☐ Too far to the side?

8.0 Design issues

8.1 Did you feel you had good eye contact?

☐ Yes

☐ No

8.2 Did you have enough control over interactivity?

☐ Yes

☐ No

8.3 Was the incoming video picture large enough?

☐ Yes

☐ No

8.4 Was the fact that you are linked up with a different looking room distracting?

☐ Yes

☐ No

8.5 Did you feel you were communicating effectively using the medium?

☐ Yes

☐ No

9.0 General feelings

Please tick one or more of the boxes that apply to you.

9.1 How do you feel about the use of technology in education generally?

☐ I am confident with technology

☐ I am not familiar with using technology

☐ I worry about me being seen on the screen

☐ I feel confident about interacting to the **far end** site

☐ I feel NOT confident about interacting to the **far end** site

☐ I find it hard to concentrate using the technology

☐ I find it not a problem concentrating using the technology

☐ I felt I was part of a group in both locations (**far end** and **near end**)

☐ I felt I was part of a group in the **near end** location only

10.0 Your expectations

10.1 How did you find that the video conference worked for you ?

☐ Good

☐ Average

☐ Bad

10.2 Did it meet your expectations?

☐ Yes

☐ Partly

☐ Not at all

10.3 How well did the video conference deliver the content?

☐ Good

☐ Average

☐ Bad

11.0 Comments

11.1 Would you use video conferencing as a means of communicating again?

☐ Yes

☐ No

☐ Only if improvements were made

12.0 Your suggestions and/or comment/criticism:

Please return this questionnaire to:

Paul Meulenberg, Manager Educational Production & Services,

MAILBAG H21, HAWTHORN CAMPUS.

Appendix 3 Evaluation Questionnaires

Case study one 1B

Introduction

(Q2b)

Desktop video conferencing

Firstly, we need to ask you some important information about yourself.
Please remember that this information will **remain completely confidential**.
It is important to complete the questionnaire as truthfully as possible so the results can be analysed with a degree of accuracy.

Personal details (Only used to match the 2 surveys Q2A, Q2b)
(All fields in this survey will expand automatically)

Name	
Place of employment/study	
Occupation	

Double click on 'check box' to select: "checked"!

Which group do you belong to?

☐ I am a student
☐ I am a teacher/lecturer
☐ I am an administrator

☐ Female
☐ Male

☐ Age 00 - 20
☐ Age 21 - 30
☐ Age 31 - 40
☐ Age 41 - 50
☐ Age 51 - over

1.0 Current video conference experience

1.1 **From** which location did you make yours with Swinburne?

☐ Office

☐ Classroom

☐ Conference room

☐ Home

☐ Other, please describe:

1.2 **To** which Swinburne University campus were most of your video conferences?

☐ Hawthorn

☐ Prahran

☐ Lilydale

☐ Wantirna

1.3 What kind of link did you use?

☐ ATM

☐ LAN

☐ DSL

☐ Cable network

1.4 Do you know what data rate you linked up with?

☐ 128 Kbps

☐ 256 Kbps

☐ 384 Kbps

☐ I don't know

1.5 How much time was usually spent on the video conferences?

☐ 0 - 15 Minutes

☐ 15 - 30 Minutes

☐ 30 - 60 Minutes

☐ longer than 60 minutes

1.6 What was the purpose of the video conferences?

☐ Educational

☐ Administrative

☐ Other

1.7 Did you link up successfully?

- [ ] Yes
- [ ] Mostly
- [ ] Took several attempts

1.8 Did the link-ups work well (please rate)

- [ ] Worked well to 25%
- [ ] Worked well to 50%
- [ ] Worked well to 75%
- [ ] Worked well to 100%

2.0 Utilities

2.1 Was any use made of a chat facility?

- [ ] Yes
- [ ] No (if no go to question 2.4)

2.2 Was use made of the chat facility because some technology failed?

- [ ] Yes
- [ ] No (if no go to question 2.4)

2.3 Which part of the technology failed?

- [ ] Video, Please describe fault:
- [ ] Audio, Please describe fault:

2.4 Was any use made of a data sharing facility?

- [ ] Yes
- [ ] No (if no go to question 3.0)

2.5 Which data sharing did you use? (Describe)

- [ ] Word document
- [ ] Powerpoint
- [ ] Other, please describe:

2.6 Did the data sharing facility work to your satisfaction? (Rate to scale)

☐ Worked well to 25%

☐ Worked well to 50%

☐ Worked well to 75%

☐ Worked well to 100%

2.7 Was video or audio affected by the use of data sharing?

☐ Video, Please describe fault:

☐ Audio, Please describe fault:

3.0 Quality

3.1 With which system was your link-up?

☐ Polycom ViaVideo

☐ Polycom ViewStation

☐ Polycom FX

☐ Don't know

3.2 If you could control the far end camera was the switching of the cameras of the **far end** location satisfactory?

☐ Yes

☐ No

3.3 Did the **far end** pictures you saw provide enough detail? (Wide shot, close up)

☐ Yes

☐ No

3.4 Did the **near end** pictures you saw provide enough detail? (Wide shot, close up)

☐ Yes

☐ No

3.5 Would an additional camera have been useful? (Describe)

☐ Yes, describe:

☐ No

3.6 Was the audio of good quality?

☐ Yes

☐ No

4.0 Appropriate use

4.1 Was the video conference effective as a means of communication?

☐ Yes

☐ No

☐ Don't know

4.2 If graphics and/or text were used were they well set out (readable)?

☐ Yes

☐ No

4.3 Did you feel the need for extra technology; for example, more cameras, document viewing, other tools, etc.?

☐ Yes, describe:

☐ No

5.0 Local issues

5.1 Was your local location the same as the first time you linked up?

☐ Yes, go to question 6.0

☐ No

5.2 Was your local location suitable for video conferencing?

☐ Yes, describe:

☐ No, describe:

5.3 Was the size of the venue you attended:

☐ The right size, describe measurements

☐ Too small, describe measurements

☐ Too large, describe measurements

5.4 Were you in relation to the screen?

☐ Well placed in the middle?

☐ Off center but acceptable?

☐ Too far to the side?

5.5 Did you feel that participants at the far end looked at you in the following manner?

☐ Direct (good eye line)

☐ Off centre but acceptable

☐ Too far to the side

6.0 General feelings

Please tick one or more of the boxes that apply to you.

6.1 How do you feel about the use of technology in education generally?

☐ I am confident with technology

☐ I am not familiar with using technology

☐ I worry about me being seen on the screen

☐ I feel confident about interacting to the **far end** site

☐ I feel NOT confident about interacting to the **far end** site

☐ I find it hard to concentrate using the technology

☐ I find it not a problem concentrating using the technology

☐ I felt I was part of a group in both locations (**far end** and **near end**)

☐ I felt I was part of a group in the **near end** location only

6.2 Do you feel more confident using desktop video conference facilities now that you have been involved in a few?

☐ Yes

☐ Partly

☐ Not at all

7.0 Your expectations

7.1 How did you find that the video conference worked for you?

☐ Good
☐ Average
☐ Bad

7.2 Did the video conference meet your expectations?

☐ Yes
☐ Partly
☐ Not at all

7.3 How well did the video conference deliver the content?

☐ Good
☐ Average
☐ Bad

8.0 Comments

8.1 Would you use video conferencing as a means of communicating again?

☐ Yes
☐ No
☐ Only if improvements were made

8.2 In your view is desktop video conferencing a good way of communicating?

☐ Yes
☐ No
☐ Only if improvements were made

8.3

Can you identify any innovative uses of this medium?

☐ Yes, please describe:
☐ No

8.4 Is desktop video conferencing useful as an educational tool?

☐ Yes

☐ No

☐ Only if improvements were made

8.5 If you could make improvements (technically or educationally) what would they be?

☐ Please describe:

8.6 Which feature of the system did you like best?

☐ Please describe:

8.7 Which feature of the system did you like least?

☐ Please describe:

8.8 Would you be prepared to be interviewed further on this topic if required? (This can be via Video conference or otherwise)

☐ Yes, (complete contact details below)

☐ No

Contact details for example, Ph, FAX, IP address, Email address:

9.0 Your suggestions and/or comment/criticism:

Please return this questionnaire to:

Paul Meulenberg, Manager Educational Production & Services,

MAILBAG H21, HAWTHORN CAMPUS, Swinburne University

Pmeulenberg@swin.edu.au.

Appendix 4 Supervisor interview questions

Supervisor's feedback

1. How many video conferences did you engage in with the Taiwanese students?
2. Were these conferences person-to-person?
3. Were these with different students?
4. How many of these conferences were effective?
5. If they were not effective, why not?
6. If they were effective, why?
7. What is your definition of an effective student supervisor meeting?
8. Did good interaction occur?
9. Was the interaction audio only?
10. Was the interaction visual only?
11. Was the interaction a combination of video and audio and if so what %?
12. Was any use made of chat or phone or email to assist in real time interaction?
13. Was any use made of other electronic media? (PowerPoint etc)
14. Did your meeting meet the objectives you set out?
15. Were you able to complete the meeting?
16. Did you have to re-start the meeting? If so how often and for which reasons?
17. Were you aware what kind of equipment the far side were using?
18. Was your environment suitable for VC?
19. Did student show any visible evidence of work produced?
20. Was the far end environment suitable for VC?
21. Were there any other hindrances you observed?
22. Do you want to make any comments or have you any observations that you want to share?

Appendix 5 evaluation Questionnaires

Case study 2A

Cancelled. Did not occur.

Appendix 6 evaluation Questionnaires

Case study 2B

Cancelled. Did not occur.

Appendix 7 Questionnaire 1 Lingnan case study (Pilot)

Report: Digital video conferencing over IP in geographically separate locations.

1	Which group do you belong to:	
I am a student		
I am a teacher/lecturer		
I am an administrator		
Other		
Female		
Male		
Age 17 - 25		
Age 25 - 35		
Age 35 - 45		
Age 45 - 55		
Age 55 - over		

2	Have you ever been involved in any kind of teleconference before?	
Audio conference		
Audio-Graphics conference		
Video Conference (ISDN)		
Video Conference (IP)		
Other (describe):		
None (go to question 6)		

3	When did you have this previous teleconference experience?	
1999 - 2003		
1995 - 1998		
before 1995		

4	How long did your previous average teleconference(s) last?	
0 - 30 Minutes		
30 - 60 Minutes		
Longer than 60 minutes		

5	What was the purpose of your previous teleconference(s)?	
Educational		
Administrative		
Other		

6	How difficult was installing the hardware and software?	
Easy		
Hard		
I was not involved (go to question 12)		

7	Did you receive assistance?	
From Audio-Visual department		
From IT department		
From other		
None		

8	Describe the assistance you received:	
Installation hardware		
Installation software		
Firewall		
Addresses		
Other, (Describe):		
None		

9	Did you know who to ask for assistance?	
Yes		
No		

10	Did you notice any resistance from anyone in trying to set up video conferences over IP?	
Yes		
No (go to question 12)		

11	If YES (you did notice resistance) from whom?	
Academics/Teachers		
IT support staff		

12	Did the equipment work immediately after installation?	
Yes		
No (Describe)		

13	Have you received any training using your current video conference facilities?	
Yes		
No (go to question 15)		

14	If YES was the staff development sufficient to get you started?	
Yes		
No		

15	Could you still get started without training?	
Yes		
No		

16	Was there a coordinator who cleared issues between both sites, BEFORE, the video conference?	
Yes		
No		

17	Please describe the desktop video system you were using:	
Desktop		
Group system		

18	How did you get involved in this video conference?	
Voluntary		
Part of study program		
Directed by others		

19	Where was your location?	
Melbourne-Australia		
Other (Describe):		

20	Where did you connect to?	
Melbourne-Australia		
Other (Describe):		

21	What kind of link did you use?	
LAN		
DSL		
Broadband Cable network		
Don't know		
Other		

22	Does your location have its own Gatekeeper?	
Yes		
No		
Don't know		

23	At what data rate did you link up?	
128 Kbps		
256 Kbps		
384 Kbps (or more)		
I don't know		

24	How much time was spent on the video conference?	
0 - 30 Minutes		
30 - 60 Minutes		
longer than 60 minutes		

25	What was the purpose of the video conference?	
Educational		
Administrative		
Other		

26	Did you link up successfully the first time?	
Yes		
No		
Took several attempts		

27	How would you rate the video conference?	
N/A		
Bad 1		
2		
Good 3		

28	If you did have technical problems during the link, how did you overcome these?	
Did not have difficulties		
I did have difficulties (Describe)		

29	Was any use made of a chat facility?	
Yes		
No (if no go to question 32)		

30	Was use made of the chat facility because some technology failed?	
Yes		
No (go to question 32)		

31	Which part of the technology failed?	
Video (describe)		
Audio (describe)		
Other (describe)		

32	Was any use made of a data application sharing facility?	
Yes		
No (if no go to question 37)		

33	How did you facilitate data application sharing?	
Through a separate computer using Netmeeting (or similar)		
Through the video conference system		

34	What applications did you use?	
Word document		
Powerpoint		
Drawing/Graphics		
Other, (Please describe):		

35	Did the data sharing facility work to your satisfaction?	
N/A		
Bad 1		
2		
Good 3		

36	Was video or audio affected by the use of data sharing?	
No		
Yes (describe):		

37	How many participants were there at your end of the video conference?	
Describe the number in the text box below		

38	If you could control the far end camera, did you find this useful?	
Yes		
No		

39	Did the far end pictures you observed provide enough detail? (Wide shot, close up)	
Yes		
No		

40	Did the near end pictures you observed provide enough detail? (Wide shot, close up)	
Yes		
No		

41	Was the audio of good quality?	
Yes		
No		

42	Was the video conference effective as a means of communication?	
Yes		
No		
Don't know		

43	Was the video conference proceeding at a good pace?	
Yes		
No		
Don't know		

44	If graphics and/or text were used were they well set out (readable)?	
Yes		
No		

45	Did you feel the need for extra tools e.g. more cameras, document viewing or other software etc?	
Yes (describe)		.
No		

46	Was your local location suitable for video conferencing?	
Yes		
No (describe)		

47	Was the size of the venue you attended:	
The right size, describe measurements		
Too small, describe measurements		
Too large, describe measurements		

48	Where were you in relation to the screen:	
In the middle		
Off centre		
To the side		

49	How did the participants at the far end look at you:	
Directly to you (good eye line)		
Off center (but acceptable)		
Too far to the side (bad eye line)		

50	Did you have enough control over interactivity?	
Yes		
No		

51	Was the fact that you are linked up with a different looking room distracting?	
Yes		
No		

52	Was there something lacking in the video conference?	
No		
Yes (Describe what?)		

53 How was the lighting at the far end?	
N/A	
Bad 1	
2	
Good 3	

54 How do you feel about the use of this technology in education?		Count	Ratio
I am confident with technology		17	40.48%
I am not confident using technology		6	14.29%
I worry about me being seen on the screen		2	4.76%
I find it hard to concentrate on the session using the technology		5	11.9%
I find it not a problem concentrating on the session using the technology		4	9.52%
I felt I was part of a group in both locations (far end and near end)		6	14.29%
I felt I was part of a group in the near end location only		2	4.76%
	Average	2.98	N/A
	Total selections	42	N/A
	Total Responses	29	

55 Did the video conference meet your expectations?		Count	Ratio
Yes		18	62.07%
Partly (descibe why)		11	37.93%
	Average	1.38	N/A
	Total selections	29	N/A
	Total Responses	29	

56 Would you use video conferencing as a means of communicating again?		Count	Ratio
Yes		24	85.71%
No		1	3.57%
Only if improvements were made		3	10.71%
	Average	1.25	N/A
	Total selections	28	N/A
	Total Responses	28	

57	Would you change anything the next time you are involved in a video conference (if any)?		Count	Ratio
Yes (describe)			15	55.56%
No			12	44.44%
		Average	1.44	N/A
		Total selections	27	N/A
		Total Responses	27	

Appendix 8 Questionnaire 1 Lingnan case study (Final)

Single response: Video conference Lingnan University and Swinburne University of Technology

Survey input field	Respondent's answer
Country:	Hong Kong
What is your name :	Zig

1. Which group do you belong to:
1. I am a student
2. **I am a teacher/lecturer**
3. I am an administrator
7. Female
8. **Male**
10. Age 17 - 25
11. Age 25 - 35
12. Age 35 - 45
13. Age 45 - 55
14. Age 55 - over

2. Have you ever been involved in any kind of teleconference before?
1. **Audio conference**
2. Audio-Graphics conference
3. **Video Conference (ISDN)**
4. **Video Conference (IP)**
5. Other (describe):
6. None

3. When did you have this previous teleconference experience?
1. **1999 - 2003**
2. 1995 - 1998
3. before 1995
4. None

4. How difficult was installing the hardware and software? (If you were not involved proceed to Question 8)
1. Easy
2. Hard
3. **I was not involved (proceed to question 8)**

5. Did you receive assistance in installing the hardware and software?
1. From Audio-Visual department
2. From IT department
3. From other
4. None

6. Describe the assistance you received:
1. Installation hardware
2. Installation software
3. Firewall
4. Addresses
5. Other, (Describe):
6. None

7. Did you notice any resistance from anyone in trying to set up video conferences over IP?

1. Yes, from Academics/Teachers
2. Yes, from IT staff
3. Yes, from AV staff
4. No, I did not notice resistance from anyone
5. n/a

8. Did you receive any training using the current video conference facilities?

1. **Yes**
2. No

9. If YES (you did receive any training) was the training sufficient to get you started?

1. **Yes, I could get started**
2. No, I could not easily get started
3. I did not receive any training

10. Was there a coordinator who cleared issues between both sites, BEFORE, the video conference?

1. **Yes**
2. No

11. Please describe the desktop video system you were using:

1. Desktop
2. Group system
3. **I do not know**

12. How did you get involved in this video conference?

1. Voluntarily
2. **Part of study program**
3. Directed by others

13. What kind of link did you use?

1. LAN
2. DSL
3. Broadband Cable network
4. **I do not know**
5. Other

14. At what data rate did you link up?

1. 128 Kbps
2. 256 Kbps
3. 384 Kbps (or more)
4. **I do not know**

15. How would you rate the video conference (technicical quality)?

1. **Good quality**
2. Acceptable quality
3. Bad quality

16. If you did have technical problems during the link, how did you overcome these?

1. **Did not have difficulties**
2. I did have difficulties (Describe)
3. n/a

17. If the technology failed, which part of the technology failed?

1. Video (describe)
2. Audio (describe)
3. Other (describe)
4. **n/a**

18. Was any use made of a data application sharing facility?

1. Yes, through a separate computer e.g. a webconference, etc
2. **Yes, through the video conference system**
3. No

19. What data applications did you use?

1. Word document
2. **Powerpoint**
3. Drawing/Graphics
4. Other, (Please describe):
5. n/a

20. Did the data sharing facility work to your satisfaction?

1. **Yes**
2. No
3. I do not know
4. n/a

21. Was the audio of good quality?

1. **Yes**
2. No
3. I do not know

22. Did the far end pictures you observed provide enough detail? (Wide shot, close up)

1. **Yes**
2. No
3. I do not know

23. Could you interact and raise questions easily?

1. Yes, but only locally
2. **Yes on both the Hong Kong and Melbourne sites**
3. No
4. I do not know

24. Was the video conference effective as a learning medium?

1. **Yes**
2. No
3. I do not know

25. Did you feel the need for extra tools e.g. more cameras, document viewing or other software etc?

1. Yes (describe)
2. **No**

26. Where were you in relation to the screen:

1. In the middle
2. Off centre
3. **To the side**

27. Did you feel you had good eye contact with participants at the far end?

1. Yes
2. **No**
3. I do not know

28. Did you feel you were part of one group?

1. Yes
2. **No**
3. I do not know

29. Was the video conference distracting you from your learning, compared to attending a normal class session?

1. Yes
2. **No**
3. I do not know

30. How do you feel about the use of this technology in education?

1. **I am confident with technology**
2. I am not confident using technology
3. I worry about me being seen on the screen
4. I find it hard to concentrate on the session using the technology
5. **I find it not a problem concentrating on the session using the technology**
6. I felt I was part of a group in both locations (far end and near end)
7. **I felt I was part of a group in the near end location only**
8. I do not know

31. If you had a choice, would you use video conferencing as a means of learning and communicating again?

1. **Yes**
2. No
3. Only if improvements were made

32. If you had a choice, would you change anything the next time you are involved in a video conference (if any)?

1. Yes (describe)
2. **No (describe)**

Appendix 9 Information documents/ handouts

Systems
For comparison I have also included other video conference systems. They can be divided into 4 groups:

Internet Video conferencing

Cu-SeeMe Pro
Winnov Videum Conference Pro

Analog Video conferencing H.324 (POTS)

Aiptek HyperVphone 2000T
Aiptek HyperVphone 2000S
Aiptek HyperVphone 2000C
C-Phone C-Station
C-Phone Home
Panasonic Victpro KXC-AP150
TeleEye TV
TeleEye TM
TeleEye SV
TeleEye AE

Lan/Wan/H.323 Video conferencing

Cu-SeeMe
Intel Teamstation v5.0 384k
Intel Teamstation v5.0 128k
Intel Proshare
PictureTel Live 550
PictureTel Live 550
Polycom ViewStation SP
Polycom ViewStation 128
Polycom ViewStation 512
Polycom ViewStation MP
Polycom ViewStation V.35
Polycom ViewStation FX
Polycom ViewStation VS4000

ISDN Video conferencing

Aethra Maia-384 and 128 H.320 Video Telephones
C-Phone C-Station
C-Phone Sentinel
Intel Teamstation v5.0 384k
Intel Teamstation v5.0 128k
Intel Proshare
Panasonic Vision Pro 7800

PictureTel Live 550
PictureTel Swiftsite I
Polycom ViewStation SP
Polycom ViewStation 128
Polycom ViewStation 512
Polycom ViewStation MP
Polycom ViewStation V.35
Polycom ViewStation FX
Polycom ViewStation VS4000
Sony Contact 1500
Sony Contact 1500 U
Sony Contact 1500 ME
UIC VC Pro STB-128
VTEL

Another example of a video conference system

The Dwyco Video Conferencing System (CDC32) is an advanced program for Windows95/98/NT4 that allows you to send and receive video, audio, and chat (for further interaction or in case video/audio drops out) in real-time across the Internet. It is very flexible, and works well as a video chat tool or a video broadcast server. It can be used like an Internet phone, a chat board, a security cam, etc. Or you can use just the audio and chat, or just the video, and so on.

Version 2.0, CDC32 includes an advanced Zap Message system that allows you to send and receive quick messages that contain Audio and Video as well as text. This is particularly handy as a fall back option. Often the internet (being packet switched) is so congested packets are slow to arrive or even get lost. This results in video and or audio freezes. This does not mean the connection is broken though. The message system (Chat) will still allow end users to send typed messages hence and forth.

These are some of the main functions:

- A flexible video quality adjustment feature works with the lowest modem speeds to the fastest network connection.
- Call screening using optional password.
- Flexible call management allows you to decide how many calls to accept at a time.
- Allows video and audio adjustments without having to disconnect from remote users.
- Supports both half-duplex and full-duplex audio hardware.
- Easy to install and set up.
- No-risk installation. Unlike other systems, Dwyco video conferencing software does not overwrite any Windows95/98/NT4 system files.
- Works with virtually any video hardware supported by Windows95/98/NT4 that supports a raw RGB or YUV capture format.
- Works with virtually any audio hardware that supports 8000Hz, 16-bit sampling.
- Complete automatic and flexible data rate adjustments allows you to avoid overloading your network link.

Cu-Seeme

CU-SeeMe Pro for Windows 95, Windows 98, and Windows NT provides a complete conferencing solution for the Internet and corporate Intranet. Powerful features let you communicate with full colour video and audio, collaborate on virtually any Windows-based application, exchange information on an electronic whiteboard, transfer files, and much more. You can use it to hold face-to-face video conferences with friends and family and business associates around the world.
A new "Favourites List" feature, makes it not necessary for the end-user to know the IP address of the person you want to contact as an e-mail address will suffice. You can drag-and-drop names from the ILS directory into your Favourites List. The Favorites List feature can find users of CU-SeeMe, as well as users of Microsoft® NetMeeting™ 2.1. And, because CU-SeeMe Pro is fully H.323 compatible, you can make point-to-point calls to users of Microsoft® NetMeeting™, Intel® ProShare® or other H.323 clients.

TeleEye TV
TeleEye H.324 TV plugs straight into the TV cable, POTS telephone line, and the phone set. It visually connects to anyone in the world with another H.324 International Standard Videophone system. The operation of TeleEye 324TV is easy and intuitive. It is as straightforward as making a telephone call and switching on the monitor function.

Winnov Videum Conference Pro
The Videum Conference Pro (PCI-NTSC) package combines the Videum AV (PCI) board with the Winnov Colour Video Camera. Video conferencing is its most popular application, and because the video conferencing software included on the Videum Software CD makes it a complete video conferencing solution. Of course, it's also good for many other applications.

The above are just a few examples of what is available on the market today. There is no doubt there will be many others still in the next few years ahead. When broadband connections become commonplace across the globe, further standards will be applied to regulate the streaming video application software and hardware.

Appendix 10 Sample document for CRC project:

Improving communications for the CRC project team members

As members of the CRC team are mostly geographically dispersed,it is worth our while to examine possibilities to reduce travel as well as improve communications.

Background

Technology allows the use of telephone, point to point as well as multipoint. This is a quick and useful communication aid, however, communication can benefit greatly if an adequate visual link was present as well.
Video conferencing immediately comes to mind but traditionally ISDN links are being used, often with high call costs attached. A further consequence of video conferencing over ISDN is the need to travel to a dedicated room designed for these kinds of facilities. This often is a deterrent to use such facilities.

Alternative

A development that is increasingly being considered worldwide is video conferencing over IP. Video conferencing over IP allows users to link to other locations from the desktop or from group systems. Benefits are as follows:

- Easy access room any networked PC
- No booking of facilities required
- No call costs
- Connection speeds up to 384 Kbps
- Easy set up
- Powerful diagnostics.

A system well tried at Swinburne University of Technology is the Polycom system.
Its desktop system, ViaVideo, (figure 1) plugs into an available USB port of a networked computer. The desktop system can link to group systems and vice versa, all over IP.

Figure 1 ViaVideo

Software is included and latest versions are freely available from the web.
It allows for video conferencing on the desktop with a viewing area close to 2/3 size of the PC screen in most cases. (See figure 2). It is easy to operate and allows users to set up its own address book. ViaVideo also offers the option to log onto a worldwide ILS server, mainly frequented by Business, Education and Businesses.

ViaVideo also has the following features:

- File transfer
- Chat
- Desktop application sharing
- Snapshot via browser

Figure 2 Desktop ViaVideo

A limitation of using a Viavideo system is that it has a small camera with a fixed lens. This makes it suitable for “fitting-in” a max. of 2-3 people.

For larger groups you can use the Polycom ViewStation, see Figure 3. This is a small unit that can be placed on top of an existing TV or Monitor. It plugs straight into an existing free network point. Its camera is auto-focus and has a wide zoom lens. This makes it suitable for larger groups. Its camera can be controlled by all Polycom equipment locally or at the far end connection. Connection speeds are up to 512 Kbps.


Figure 3 ViewStation 512

Video conferencing over IP will work well if all the minimum standards are adhered to (see enclosed standard requirements).

It is of the utmost importance that your IT department is involved in the setting up of the firewall port for your system. A fixed IP address is an absolute necessity. Your IT department needs to open a specific port to allow incoming video conference calls. This is a straightforward procedure.

Proposal

To improve communication methods in the CRC project, I recommend that the team members take steps to set up a small network between themselves. This will ensure that IP video conferencing will become an integral part of the CRC project.

The following steps need to be undertaken:

- Acquire information to check if minimum standards are present in their respective organiations and that their IT departments are cooperative with the firewall and fixed IP issues.
- Purchase the relevant equipment
- Install the equipment
- Obtain a fixed IP address
- Open the specific firewall port
- Test the links.

Assistance

Assistance at all levels will be provided by Paul Meulenberg.
Diagnostics and data will need to be gathered by users at each video conference. This is an easy procedure and will be explained to you.
A questionnaire will need to be completed at some stage during the project.

Paul Meulenberg
Manager, Educational Production & Services, Learning & Teaching Support.
Swinburne University of Technology
Ph: (03_ –9214 8458
Mobile: 0410 569317
Video: 136.186.85.185 (ViewStation 512)
Video: 136.186. (Desktop)

Minimum standards

Minimum PC Hardware Requirements:

•USB Port
•350 MHz processor, Pentium® II compatible MMX
•64 MB RAM
•4 MB video memory
•120 MB available hard disk space (may be less, if required software already installed)
•SVGA monitor (800 x 600)
•16 bit color or higher
•Broadband IP network access (32 KB and above)
•Desktop PC with headphones, headset or external speakers *OR*
•Laptop PC with headphones, headset or internal speakers.

PC operating standard:

•PC Operating system compatibility with Windows 98, Windows ME, Windows 2000, Windows XP.

Connectivity (network) standard:

Network connection minimum: ***Ethernet, Token Ring, DSL, LAN, FDDI, FRAME, T-1, ATM or Cable networks and connection to ISPs with at least a minimum of broadband access to the Internet, capable of at least 128 Mbps upload and 128 Mbps download (preferably not shared).***

IT Technician stuff: For Network connections see:
http://www.polycom.com/products/video/viavideo/NetConnect/

Video conference equipment:

When the PC hardware, network and ISP connection minimum standards have been met, then conditions are right for using Polycom products over IP.

We recommend:

- a Polycom ViaVideo desktop system for person to person calls (approximately AU$1140)

or

- a Polycom ViewStation 512 for group calls (approximatelyAU$11,500)

Appendix 11 Present video conferencing in Universities (Aus)

University of Adelaide
Australian Catholic University
Australian National University
Ballarat University
Bond University
University of Canberra
University of Central Queensland
Charles Sturt University
Curtin University
Deakin University
Edith Cowan University
Flinders University of SA
Griffith University
James Cook University
La Trobe University
Macquarie University
Melbourne University
Monash University
Murdoch University
New England University
University of NSW
University of Newcastle
Northern Territory University
University of Queensland
Queensland University of Technology
RMIT
University of SA
University of Southern Queensland
Swinburne University of Technology
University of Sydney
University Of Tasmania
University of Technology, Sydney
Victoria University of Technology
University of Western Australia
University of Western Sydney
University of Wollongong

Appendix 12 References

The bibliography/references have been divided in the following categories:

- Main
- Miscellaneous (site visits, interviews, etc).

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Commonwealth of Pennsylvania University Centre for Distance education.

http://www.global-leap.com.
A directory listing of schools interested in PictureTel's world-wide video conference network.

http://www.wiredcolleges.com
Shows the full survey results of the most wired colleges and universities in the USA.

http://www.pde.rpi.edu/academics/video
Video streaming at Rensselaer. USA.

http://myhome.hananet.net/%7Esoonjp/vidconf.html.
Shows the extent of video conference systems and software available across the globe.
http://www.vrvs.org/
Virtual Rooms Video conferencing Systems

http://www.wired.com/news/technology/0,1282,53387,00.html
A new twist on light, Fibre Optic

http://www.crcwood.unimelb.edu.au/
CRC project CRC Wood Innovations

http://www.polycom.com/products/video/viavideo/NetConnect/
IT Technician stuff: For Network connections for Polycom

http://www.video conferencing.co.uk/
Various papers and case studies on video conferencing issues.

http://www..com/
Various papers and case studies on video conferencing issues.

Http://www.iana.org/numbers.html

Internet Assigned Number Authority (IANA).

RFC 1700
Protocol numbers and assignments for IANA port numbers

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Speed comparisons DSL

www.ivision.com.au
Latitude webconferencing

www.electroboard.com.au
Smart Brigit webconferencing

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listing of webconferencing software and hardware.

http://www.itu.int/ITU-T/
Description and a listing of ITU-T standards

http://myhome.hananet.net/%7Esoonjp/vidconf.html
Desktop Video conference software for the Internet

http://www.packetizer.com/iptel/h323/whatsnew_v5.html
H.323 Information Site

Http://www.wvn.ja.net/vc.htm
Research into room decoration

http://www.capemaytech.net/ettc/links/distancelearning.htm
Summary of video conference etiquettes and associated issues.

http://www.mega-net.net/megaconference
Megaconference information (global video conferences)

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Video conference information

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Appendix 13 List of referenced Publications

- Publication One: Meulenberg, P. (2002). Case study of IP video conferences with Professional Doctorate in Design students, Taiwan. In S. McNamara and E. Stacey (Eds), *Untangling the Web: Establishing Learning Links.* Proceedings ASET Conference 2002. Melbourne, 7-10 July. http://www.aset.org.au/confs/2002/meulenberg.html
- Publication Two: Meulenberg, P and Rees, M (2004). An exploratory study on the operation videoconferencing in bi-national tutorials. Published November 2004 at ANZMAC 2004, New Zealand.

Publication One: Case study of IP video conferences with Professional Doctorate in Design students, Taiwan

Paul Meulenberg
Swinburne University

Abstract
This paper reports on an investigation of the effectiveness (educationally and technically) of digital video conferencing over IP across two geographically separate locations, Melbourne and various sites in Taiwan. The study looks at the processes required to set up effective communications with students using digital video conference media. It identifies the hurdles that needed to be overcome and looks at the educational values of such link-ups. It also addresses some of the technical problems as related to IP video conferences. The study is part of a PhD investigation of the use of digital video as applied to Education.

Focus
Flexible provision of higher education may be afforded through the employment of various strategies, including the use of learning and teaching techniques and technologies such as CD-ROM, online materials, online communications, print materials, face-to-face tuition, distributed face-to-face sessions, video-on-demand, videotape/audiotape, video conferencing, teleconferencing, TV and radio (Ling, Arger, Meulenberg 2002). The mainstream of video conferencing technologies has been focusing largely on linking up via ISDN and, to some extent, ATM. Now, however, there is a growing trend to use IP as a main transport vehicle for such video conferences. It initially took one year to develop the first version of H.323 standard for duplex video over IP. It took another year to get the new standard approved.
Now, some 5 years later, H.323 is still being improved. Version 4.0 of the H.323 protocol has just been produced by RADVISION. The industry continues to push large organizations to send video, audio as well as data over IP. Educational Institutions are also jumping in all over the globe. Swinburne University of Technology is pushing the boundaries a little further by insisting that their overseas Professional Doctorate in Design (DDes) students use it to link up with their supervisors.

Background DDes (International students)
The Professional Doctorate in Design is an innovative program of advanced study designed to meet the professional needs of experienced designers in industry and education. Its focus is upon the new emergent electronics media and their creative application within the fields of design. These have wide application across the entire range of Design professions, and are equally relevant to professionals working in, for example, Industrial Design, and Interior and Exhibition Design. Its project-based structure allows the designer to pursue a research goal appropriate to his/her discipline, while using technology to better achieve that goal.

Research approach and methodology

Research genre
The research applied was practical. As each video conference project is different, a more individual approach was taken here. It followed a structure set by similar projects in video conference research, in particular the 'Information Technology Enhancement Program, Desktop Video conferencing' (Thompson 1997). The Professional Doctorate in Design commenced with eight weeks of intensive study at the Prahran Campus, Melbourne. Part-time students then returned to their respective countries to continue to study.

Case study methodology
Fifteen students were involved in the project. The study follows their experiences with video conferencing from concept to realization. The first students commencing the program were from Taiwan. Of the 15 students, 12 decided to study part-time, and 3 full-time. All of the students are currently employed as lecturers in educational institutions in Taiwan. The Taiwanese government has made a requirement for these lecturers to obtain a PhD. If not, their prospects for promotion are very limited. The part-time students are required to have regular meetings with their supervisors (once per month). The strong visual aspect of their research required visual sighting of their work, hence video conferencing was considered.

ISDN or IP?

Video over ISDN
Initially, we looked at standard video conferencing over ISDN (Latchem et al, 1994).

Positives and negatives
On the positive side we could expect good quality video and audio and trust we were applying a reasonably reliable medium using conventional technology. On the negative side, there would be significant call cost incurred. The average duration of each meeting was estimated to take one hour, a total of 13 hours for all students. The total costs for these regular video calls were considered to be prohibitive. A further problem was the logistics of booking video conference facilities at the Prahran Campus, as the facility is heavily booked, thus making regular meetings, and indeed spontaneous meetings, difficult to organize. Additionally, students at Taiwan did not all have access to ISDN video conference facilities nearby. The 64% average reliability factor of ISDN connections was also not acceptable (Henkel, 2002).

Video over IP

Positives and negatives

On the positive side, we would have no call costs for parties involved. Calls could be made from various locations, provided that high-speed Internet facilities were available, for example, at the office or from home (Aber, 1997), (Taylor, 1997). Additionally, no facilities needed to be booked, either at Prahran Campus or in Taiwan. On the negatives side, students needed access to a desktop video conference facility either at work or at home. This was possibly not available to each student. Video and audio quality was likely to suffer in low bandwidth situations and, as such, the reliability factor of using IP video conferencing across ISPs was unknown. The decision to accept IP video conferencing was made by comparing all the pros and cons, with the main deciding factors being accessibility of the systems to each individual as well as the relatively low cost of IP video conferencing as compared with ISDN.

Equipment

Research was conducted to determine the most appropriate video conference equipment. Many systems were considered, such as: Tandberg, PictureTel, RadVision, Sony, Polycom, Aethra Vega2.

In the investigation a whole range of other IP softwares and systems are also available now, or on trial (http://myhome.hananet.net/%7Esoonjp/vidconf.html). Some were investigated and a few were tested.
The final choice of equipment was based on ease of use, quality and reliability of the product, keeping in mind that the project's main aim was not to test particular equipment, but rather to look at the educational and technical outcomes of using the media over IP. We opted to accept the IP video conference using Polycom ViaVideo products, as this was offering QOS and it was affordable as a desktop unit.

First orientation for participating students

In order to inform students about the video conference requirements and to make them familiar with the technology, an initial presentation was given to the group of 13 students in their first weeks at the Prahran Campus. The reasons and benefits of remaining in contact using desktop video conference facilities over IP were explained. In brief the benefits were:

- Access to powerful visual media would aid their visual presentations.
- For very little financial outlay, cost-free video conferencing could occur.
- Supervisors/students could be called upon any time whilst in their office (on demand).
- Video conferencing facilities did not need to be pre-booked.

In the orientation, a demonstration was given of the Polycom ViaVideo desktop video conference system. Links were established to other ViaVideo systems within the University as well as to external locations in Australia, as well as the USA. Additionally, a link to a Polycom ViewStation was established, which allowed for remote operation of the far end camera (zoom, pan, tilt). Furthermore, it was shown that powerful diagnostics were within easy reach.

It was stressed that by linking two Polycom systems, excellent video and audio links would result, making this a uniquely suitable system for their purpose (provided that use could be made of Ethernet, Token Ring, DSL, LAN, FDDI, FRAME, T-1, ATM or Cable networks, networks and/or ISP's with at least a minimum of broadband access to the Internet, capable of at least 128 Mbps upload and 128 Mbps download (preferably It was also pointed out that their respective places of employment (Colleges, Universities) could fund the purchase of such a system at around AU$1100. Students were asked if this would pose a problem to any of them. No noticeable objections were made.

To reinforce the importance of establishing a video conference link with their supervisors, a second presentation took place a few weeks before the students returned to Taiwan. Identical information was repeated and reinforced. Also the following documentation was handed out:

- A handout covering the reasons for the video conference links, minimal technical specifications of PCs that should be used, procedures and a contact IP address.
- Reason for the research.
- A letter explaining confidentiality of the data and identities involved.
- A letter of agreement that students would need to sign.
- A letter setting out procedures on how to lodge an official complaint if necessary.
- A data sheet that students needed to complete with student contact details.
- An information sheet explaining procedures on how to access required diagnostic data from the Polycom systems in operation.

Some students raised the possibility that their networks and/or ISPs might not be fast enough; however, by enquiring about their network specifications all said they had access to broadband Internet. These fall within the minimum specs and were acceptable to the research project. No student raised any other possible issues; however, a slight uneasiness was sensed. We were unable to ascertain why this uneasiness existed.

Hurdles

Up to this point everything had gone reasonably smoothly; however, some difficulties arose. Students were uncertain about their workplaces purchasing a Polycom system. Additionally, upon return to Taiwan, communication with students proved difficult, even via Email. We experienced severe technical problems such as firewall and Bandwidth issues.

<u>Students were uncertain about their workplaces purchasing a Polycom system</u>
A subsequent meeting with two students and the supervisor followed after a few days. In this meeting it became clear that there were issues to be worked out further. Possibly the purchase of Polycom systems was seen as problematic, as their workplaces were not likely to purchase these.

Third Orientation

In this meeting, SUT invited a representative of the International Student Unit with a Taiwanese background whom also could speak Mandarin. She was also familiar with the local culture. After addressing the group it soon became clear that the following factors needed to be taken into consideration:

- It was unlikely that their respective places of employment would support the purchase of equipment valued at around $1100.
- It was unlikely that individual students could afford a Polycom system.
- It seemed that other (low end) IP video conferencing systems were much more within reach as indeed some already existed at their workplace or at home.

Alternative options

As we, at this stage, could not expect the students to outlay the required funding themselves for the required equipment, we suggested the following alternatives:

1. Students could divide themselves into groups that were within acceptable distance of a central point in Taiwan. Each group could obtain access to one Polycom system that could be shared by the individuals making up that group.
2. Students could try to obtain access to a conventional video conference system within each of their areas.
3. Use could be made of existing (low end) IP video conference units that already existed at their workplace or at home. If linking up with these units was not satisfactory to the supervisors involved, students would need to upgrade to a Polycom system after all, either as a group or as individuals.

Option 1 would be inconvenient to the students, as most of them would have to travel to the location of the shared desktop facility. Option 2 was considered, but large group systems were not easily at hand. Also, significant call costs for each video conference call would be incurred either to the students or to the University. These were likely to be twice the cost of a timed telephone call. Furthermore, the logistics of arranging both video conference facilities at simultaneously suitable times was seen as prohibitive. Option 3 would diminish the video and audio quality of the medium. It was expected that the Taiwanese end would receive a good picture from the Swinburne University; however, Swinburne University would receive poor quality images from Taiwan because of the low-end desktop technologies used there. Significant packet loss of audio as well as video was to be expected resulting in broken audio and video freeze.

Findings

Much discussion ensued to flesh out possible choices. Students then made up their minds as follows:
Total students enrolled in Doctorate of Design 13
Total students studying full-time in Australia 2
Total students studying part-time in Taiwan 11 (needing access to VC facilities)

Students	System proposed
5	Group A (sharing Polycom)
1	Small camera via IVisit
1	Buys new camera, perhaps Polycom
1	Small IP camera from home
1	Large VC system work, will also try small IP camera at work
2	Small IP camera from school

Upon return to Taiwan, communication with students proved difficult, even via Email TrialsStudents went home and appeared to hope that it would all go away. But it didn't. A week in October (2001) was set aside in which students were expected to establish contact with a test unit at SUT. All students were issued with two IP numbers, one to a ViaVideo unit and another to a ViewStation. According to their choices, a total of six calls were expected - five calls from individuals using smaller cameras, one call from group A using a ViaVideo. None came. After reminding all students via email, a new date was set. No calls came in again; some students emailed that they were busy doing other things. A new date was set again, now a total of two weeks later. In that week, three calls from individuals were received as video calls with mixed results. Two students rang in using smaller cameras running it from their homes via NetMeeting on an ADSL network. One student rang in with a small camera using software on a Macintosh computer.

<u>Video conference trials were not what was desired</u>

The first two calls delivered poor quality video with lots of visual freezes. Audio was sporadic and almost non-existent. These calls were made during daytime hours in Taiwan. Students reported that ADSL networks are usually very congested at this time. It was suggested to shift the calls to early morning Taiwan time 8am (10am Melbourne time). This provided some improvement. Video and audio contact was established. Packet loss still occurred. Only two students ringing in with the small camera, via Netmeeting, made calls that came through best. Packet loss was least both in audio and video.

The video frame rate was as follows for all calls at 8 am:

	Tx fps (from SUT)	Rx fps (from Taiwan)
Student 1	18-20	8-10
Student 2	12 –15	5 - 9
Student 3	12 - 24	8-14
Student 4	Not received	
Student 5	Not received	
Group A	Not received	

One student suggested to use Ivisit software since this also worked with Macs; however, when tested the systems were not compatible as Polycom works with the H.323 standard and Ivisit uses H.263.

First Polycom link-up
As these initial tests were only partly successful, and none had made use of a Polycom system, we decided to send one ViaVideo system to an IT literate student. This would at least provide us with the possibility of testing the Polycom system. It would also provide the basis for the argument to either urge the other students to purchase a Polycom system OR it would prove a fruitless exercise if the quality was not improved. The ViaVideo was set up and suitable times for linking were arranged, early in the morning Taiwan time to avoid Internet congestion. The student was asked to wait for our call but a connection could not be made. Communication was difficult. A lot of email (non-synchronous) communication went backwards and forward, often missing each other. Several attempts were made until time ran out and other commitments needed attention.

Firewall issues

New appointments were made with similar outcomes; however, the student could make local (intranet) calls and SUT could make other (internet) calls successfully. Soon it was realised that outgoing calls (external to the University) could be made but not received (external). The writer checked with the University ITS department who informed him that a new firewall had recently been installed. They just had not informed us. This explained why incoming calls were not coming through. A request was made to set up individual access permissions for all Polycom systems in the project. It was now needed to specify each IP address at SUT that expected incoming video conference calls. This would allow the researcher to open individual ports for each of those locations to allow traffic to flow in. The firewall in question is a Cisco pix firewall running IOS 6.1.1. Whilst that was being worked on contact with the Taiwan-based Polycom system was finally made. The result was acceptable.

	Tx fps (from SUT)	Rx (From Taiwan)
Student 4	25-30	15 -24

Bandwidth

First supervisor links

The first supervisor link was established before the successful Polycom test occurred. Although a Polycom system was not used, the connection was successful; however, the picture appeared intermittent but was adequate. The sound was acceptable, although not without the occasional break-up problem. Three supervising staff were involved. Although conditions were not ideal, supervisors felt it worked well enough and certainly achieved its purpose in having a sense of direct contact with the student. As the Polycom test had proved successful, we now needed definite information on the bandwidth availability at each Taiwanese location. It was known that SUT had a 34 Mbps ISP pipeline, which was exceptionally suitable for video over IP to anywhere in the world. Other places would most probably have significantly less. Students were asked to provide simple feedback on their Internet pipelines. The results were as follows:

Swinburne University	34 Mbps
Student 1	T2 for school, T1 for proxy server
Student 2	ADSL 512 kbps downlink, 56 kbps uplink (HOME)
Student 3	ADSL 512 kbps downlink, 56 kbps uplink (HOME)
Student 4	36 Kbps uplink
Student 5	Not received
Group A	Not received

Subsequent link-ups with students 1, 2 and 3 showed that the T1 access was acceptable but that the ADSL access was very unreliable. Early morning link-ups to avoid 'traffic' on the networks made some, but insignificant, difference.

Cultural and Language Issues

In Western culture we take for granted a communication style that basically consists of relatively straightforward question and answer. In most cases questions that are raised, either formally or in casual conversation, will be answered directly. We may, at times, not like the answers to our questions, but as a rule this is accepted. As this is the Western way of communicating, we may assume that this is the case elsewhere. In other cultures, however, this may not always be the case. In some cultures it may be better to answer a question differently if the answer might put a person in an embarrassing situation (culturally). For example, asking for road directions in some countries, to a person unfamiliar with the neighbourhood, will still attract a happy explanation of how to get there, as it is more polite to answer the question positively than to answer it with a negative reply. In some cultures it may be better not to answer an email when the answer might be negative or unknown, as this could possibly save face. On other occasions a culture might place family commitments first.

According to Whitley (1991), 'In Chinese society, commitment to one's family overrides all other loyalties, and individual prestige is based on family standing rather than being organisational or occupational'. As our Taiwanese students were combining full-time work with part-time study as well as family life, a few were complaining about "having not enough time" for the project. Additionally, English is not always fully understood, even though students may appear to. This may also stem from the belief that it is better not to disappoint. When not aware of such customs and behaviour, frustration (in our culture) could (and did) occur.

Some of these issues might have played a part in our communications with the students.

Educational values

The investigations for the report "Video conferencing in Higher Education in Australia" (Mitchell et al 1992) informs us that the aspects of video conferencing lecturers like best are as follows:

- Video conferencing is easier to prepare for than other distance delivery modes.
- Distant students like seeing their lecturer.
- The medium enables a lecturer to offer stronger support to their students.

- The medium provides opportunities for real time action.
- The medium provides students with opportunities to interact with peers from other sites.
- The visual medium, used appropriately, is very effective.

The Taiwanese video conferences certainly created the feeling of visual contact at the meetings. Body language was clear enough to be useful. Visually, participants needed to be reminded of proper camera placement in order to obtain better eye lines. Visuals were useful in as much that design work could be displayed with relative ease, even though technical problems were part of most link-ups. The Taiwanese video conferences attracted the following comments from staff involved:

- You are 'aware of the technology', for example, you are aware of its shortcomings when the frame rate is low and the audio drops out. This is not good!
- You are never certain that a connection can be made as there are so many technical issues seemingly standing in the way. This resulted in either connections not being able to be made, or at least connections being too poor and thus unsatisfactory.
- One supervisor commented that the picture was too small and could not be enlarged (a problem with NT).
- It was hard to concentrate on the conversation as too many technical issues were occurring.

Recommendations Summary

The following recommendations for process and do's and don'ts are provided as a guideline. They are based on linking up with participants from non-English speaking countries, but can be applied to other mainstream video conferences as well.

Process summary:

- Test and select the appropriate Video conference equipment for your situation.
- Train students and staff in all facets of video conferencing.
- Ensure students obtain access to identical video conference equipment.
- Ensure language barriers are cleared before the video conferences commence.
- Beware of cultural differences before commencing projects and find a way to work with it.
- Adhere to a rigid timetable, preferably at less busy network times.
- Use MSN Messenger, or similar, for synchronous backup communication.
- Ensure your IT department is aware of your program.
- Ensure firewall issues are cleared, preferably on both the far and local end.

Main problems encountered:

- Obtaining the same video conference equipment.
- Poor communication with students, once overseas.
- Time restraints of students overseas (Part-Time).
- Firewall issues.
- Bandwidth issues.
- Cultural and language differences.

What to do:

- Insist on using the same standard VC equipment; this will make problem-solving easier.
- Obtain bandwidth information at all locations from IT staff, **before** commencing the program.
- Keep close contact with key IT staff in your organization.
- Keep the first video meetings short, increasing duration once expertise has developed.

What not to do:

- Do not assume **performance** specs as supplied by equipment suppliers are 100 % accurate.
- Do not assume your English is understood.
- Do not assume participating students will respond to your email requests.
- Do not assume email alone is a good way of communicating.
- Do not assume students are ok with the technology, even after instruction and training sessions.

Other issues:

- Ensure to check appropriate equipment is set up and camera alignment (eye lines, eye level).
- Audio takes priority over vision (microphone close to source, away from speakers).
- Use an additional camera or zoom lens for detailed or large visual displays.
- Use a reasonably lit room.
- Do not have bright objects in frame.
- Seek neutral background settings, with no backlight.
- A bright screen takes longer to transmit than a normal lit screen.
- Be aware of technical limitations.
- Be aware of human limitations.
- Be aware of educational limitations.

Conclusion

Although we expected the focus of this program to be on Education and Technology, the outcomes have clearly indicated that the psychology and behaviour of the participants have been major factors in the program thus far. Although the supervisors' meetings have been somewhat disrupted by this process, the results are encouraging enough to persist only with the few links that conform to the required technical standards.

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Biographical Information

Paul Meulenberg is Assistant Director, Learning and Teaching Support, Swinburne University of Technology (SUT). Ph. (03) 9214 8458.
Qualifications include: Cert Teacher Training (Hawthorn Institute of Education), M.T.S. Architecture (Zaanstreek), B.A. Film and Television, (SUT), Commenced Masters, progressing towards PhD by research (SUT). He is experienced in the application and design of Video conferencing systems across Educational institutions.

Publication Two: An exploratory study on the operation videoconferencing in bi-national tutorials

Paul Meulenberg
Murray Rees

Abstract

Research in the area of using newer technologies such as videoconferencing via the Internet in tutorials is limited with even less covering the issue of effectiveness as a learning device. This technology enables expansion of the international marketing tutorial to include other countries/cultures. This study uses a case study methodology to investigate the conduct of bi-national tutorials to see if videoconferencing adds value to the learning experience of students. Two tutorials were conducted between students in two universities in Australia and Hong Kong. The students involved were positive with regards to interaction, engagement, motivation, interest in learning and felt comfortable with videoconferencing their tutorials. Issues involved with this project included: time differences (project length, semester timing, timetabling), role of champions, and common curricula. The authors derive human and pedagogical recommendations for running bi-national tutorials using videoconferencing.

Research in videoconferencing

With the considerable progress made in Internet provided technologies, more educational providers are moving to use desktop and small group videoconference systems to link to classes and/or students over the Internet. There is little research on the actual implementation of videoconferencing in educational institutions, specifically as related to the operation of joint tutorials. Sumner and Hostetler (2000), conclude that according to most available research, desktop versus face – to – face communication produce similar learning outcomes. This is also supported by Owen and Aworuwa (2003), analysis of how distributed education compares to traditional classroom teaching. Forster and Washington (2000) offer a positive, yet realistic, model of organization for videoconference courses. Amerian (2002) argues that educators should use videoconferencing interactively, not passively like the 'six o'clock news'. Videoconferencing, "should be used for tutorial support to maximise the benefits of small group interaction, and not primarily for content delivery, which can often be more effective using books, videos and multimedia CD packages", (Hearnshaw, 2000 p. 222).

The existing research answers a number of questions and provides a number of important conclusions, for example Greenberg (2004) states:

- Videoconferencing is neither more nor less effective than a traditional class.
- Videoconferencing supports far greater interaction than is otherwise possible from many asynchronous technologies, and effective videoconferencing based instruction must be designed to take advantage of this capability.
- Other, related instructional strategies have been identified to maximize the success of videoconferencing based learning situations.
- When used appropriately, videoconferencing is a cost effective way for educational institutions to deliver successful educational experiences to an expanded population.

This paper explores whether the use of videoconferencing enhances a student's experience in a tutorial where cross-national/cultural issues are being explored in the context of international marketing. What are the benefits and challenges to marketing educators in conducting bi-national tutorials?

Methodology

This study uses case study technique, 'which involves an empirical investigation of a particular contemporary phenomenon in its real life context using multiple sources of evidence, (Robson, 1993, p. 52). In this instance, evidence will be provided through observation of observers, facilitators and students evaluation of the tutorials. By using a number of sources of evidence this in part overcomes the possibility of bias by either or all parties.

The universities that were involved were Lingnan University Hong Kong & Swinburne University of Technology, Australia. Lingnan group comprised approximately 30 3rd year business students in a management class and Swinburne students comprised 12 2nd year marketing and international business students mainly in 2nd/3rd year. There were two tutorials conducted in September and October 2003, 6.30-7.30 pm AEST in labs specially constructed for videoconferencing. The first tutorial was run by Lingnan and had 6 groups of three to four students present findings for an ethics case study on Scaffolding. The follow-up tutorial was conducted by Swinburne two weeks later with a small group of 2 students presenting a case by Trimarchi (2003). In addition to the students there were a number of observers in both countries as well as lecturers, tutors and technicians.

The first tutorial

Both classes linked up without incident. The first noticeable difference between the two videoconference sites was the use of the microphones. Lingnan used a handheld microphone, as the group of students was quite large. This resulted in the presentation looking a little like a television show. Students could only talk (and be heard) when the microphone was handed to them. This appeared to slow things down on the first observation. At Swinburne, two microphones were strategically placed among the group of twenty students. This resulted in student being able to speak freely at the time of their choice.

Lingnan was to present in this videoconference class and thus they formally started the class session. When the class started Swinburne students were not acknowledged immediately, rather the class just started whilst it appeared the lecturer addressed the local (Hong Kong) students. Only after the first student had made his presentation, and asked for comments and questions, was Swinburne acknowledged. At first people appeared to be uncertain when the student asked for questions. Most Swinburne students appeared a little camera shy, however questions were raised and dialogue between students at both ends began. The local camera at both end points looked for a single shot or close-up on students that were talking, wherever possible. This initially resulted in some laughter as other students, oblivious to the fact they were blocking such camera shots were gently pushed out of the way by others.

This appeared to be due to the fact that students were looking at the far end picture and not necessary the local picture. It did not take long however for students to ascertain what was going on and to move out of the way when the camera was focusing on some one in their vicinity.

Another observation was that, when someone in a large group was asking a question you really had to search for that person to see where he/she was. Students at both ends appeared to have difficulties understanding each other. This was not because of poor audio rather it appeared to be language oriented. People appeared to be camera shy initially but this became less so during the second half of the conference. Additionally, when questions were asked nobody appeared eager to answer. A considerable amount of coaching by lecturers, and tutors took place to encourage students to answer. As is often the case in groups some students tended to talk more than others. It was no different in these groups.

Furthermore it was observed that the Lingnan students introduced themselves, before addressing the group whilst Swinburne students did not. The Lingnan students presented their conclusions regarding the case in an orderly fashion, eliciting questions of the Swinburne students. This was very confronting to the Swinburne students as it was quite formal and somewhat ‘put them on the spot’. This could be that Lingnan students might have been exposed to more videoconferences than the Swinburne students or this is a cross-cultural difference in terms of class engagement. Humor was used to good effect during the conference at both ends. The videoconference seemed somewhat stilted at the start but appeared to flow more naturally toward the conclusion. It was clear students were concentrating on the incoming picture, whilst also having to get used to seeing themselves on the near picture, this took some getting used to.

When the videoconference class ended initial reactions from students were gauged in interviews. Students mentioned that it took one hour to cover a standard half hour tutorial exercise, but that it was more engaging doing it in a videoconference. All students liked seeing the far end students and commented they liked the camera focus in on people. Some students wanted it to be more like a tutorial for example; the tutor should be more in charge and speak more. Swinburne students suspected that Lingnan students were worried about their English. In the first half hour of the videoconference the international students based at Swinburne asked questions however, in the second half the Australian students were more dominant. All Swinburne students said they did not like the roving microphone at the Lingnan end.

The second tutorial

There was a noticeable difference in this conference and the first. This time, Swinburne students were presenting, and Lingnan students were providing the questions. A separate monitor (also called a confidence monitor) was set up for the Swinburne presenters. This monitor permitted the presenters to view the remote site as well as the images that were being transmitted. It also allowed the presenters to address the local class simultaneously without turning their back to any participating site. This was similar to the experiences of Price and Spence, (2002). Students appeared to be more at ease with the medium and were more eager to participate. Conversations were more plentiful and playful.

The web-conference provided useful visuals (PowerPoint), which all participants could see on a separate screen. Interaction flowed more easily than previously. Some comments were made immediately after the video- conference one of which stood out: “you see every cringe, especially as it is larger than life on the screen”.

Both tutorials

Students commented that although the teachers may have been well trained and prepared to use the videoconference technologies, the students were not and, in many cases, were overwhelmed by the initial videoconference. Some students wished that they were told in advance what to expect. They also wished that they too should have been trained or prepared and suggested there ought to be a prepared write up to supplement some of the language barriers that appeared to be present. The language (accent) barrier was clearly identified by most students to as being of significance and one that was slowing down the class significantly. Indeed some students said they covered in one hour what they would usually cover in half that time. For some students the tutorials where too structured and they would have liked to see a format that was less formal.

One student felt that “We should know each other more first, so we can talk more freely”, whilst another thought it “Critical that participants are told beforehand what will happen, what is expected of them and what they can expect from the other end”. All in all most students enjoyed it but thought the sessions were “very intense”. Approximately 70 participants from both universities were invited to complete a short survey, see Table 1

Table 1 key survey findings (n=43)

Dimension (questions truncated)	Disagree	Neither	Agree
Interaction with students from other University by videoconferencing (vc) helped me learn more	0	26%	74%
VC tutorials using case study were engaging, motivating	2%	14%	84%
VC technology enhanced my interest in learning	5%	30%	65%
Questions raised in discussions were critical to issues raised	14%	26%	60%
I accepted ideas put forward by students from other Uni	14%	14%	72%
My learning responsibilities have been appro. allocated	5%	40%	55%
I felt comfortable with tutorials delivered by vc	12%	14%	74%

* full details will be revealed at the conference.

Common Issues

The two-hour time difference between the locations in this instance was generally not seen as a problem. The main dilemma was that the Academic years were vastly different at both Universities, this meant that to find a window where both classes could discuss the cases meaningfully could only take place after some weeks had transpired in respective subjects. Additional to this were the difficulties with timetabling the classes to enable use of the laboratory setting. Most, if not all class sessions are setup and confirmed well before the start of the semester, so planning to incorporate these tutorials was made several months before they were conducted. Another challenge was the issue of tutorial time allocation, at Swinburne, the tutorial is 1 hour long, where at Lingnan was 1.5 hours.

This project was initiated via two educational facilitators at the respective universities. Their personal vision of the process was the driving force behind the instigation of this project. Recruitment to the project were technical specialists to conduct the videoconference hookup and subject academics to enable a common learning environment. In this project the Lingnan side had two groups of subject academics who were introduced to the concept during the life of this project and in the first instance did not go ahead with it due to: lost contact, semester breaks and the outbreak of SARS closing the Lingnan campus for a few weeks. Their discontinuance is not known however it could be that they had lost interest or did not have a relevant class in the subsequent semester in which to apply this concept to. This meant more time taken to recruit new academics to the project and agreement to content etc.

The eventual running of the two tutorials meant an alignment of curriculum which requires significant planning. In this case the Swinburne tutorial was on International Marketing and Lingnan on International Management. In addition the Swinburne students were a mixture of second and third year students whereas the Lingnan students were all third year. The first issue was finding a topic common to both subject cohorts, and exercises relevant to the course level of the students. It was agreed to use an ethics case study for the first tutorial to see what differences there were between the east/west cohorts. A confounding factor for the ethics case was the impurity of culture with Swinburne students with at least eight different cultures represented with twelve students. The second tutorial it was decided to use a case about Hong Kong and an Australian company's market entry strategy to enter this market (Trimarchi, 2002). In this instance the case study was presented by Australia students who were in some respects reality testing their strategy with the Hong Kong students. The difficulty with this approach is that the Lingnan students were not fully conversant with the theories surrounding market entry and therefore their feedback was somewhat shallow.

Recommendations

The following are additional recommendations that could well aid tutors:
- Train students and staff thoroughly in all facets of videoconferencing before classes,
- Ensure language barriers where possible are cleared before the videoconference,
- Beware of cultural differences before commencing projects and find a way to work with it,

• Ensure a coordinator is appointed during the implementation process who can oversee and deal with all common issues between connecting parties,
• Maintain someone in the room during every videoconference. Both a local facilitator and a technical support person (close by) are mandatory (Greenberg and Colbert, 2003),
• Ensure introductions are made all round to ensure that students and tutors alike know who their counterparts are,
• Limit the number of observers or outsiders to reduce the artificiality of the session,
• Adhere to a rigid timetable, start on time, finish on time,
• Keep the first video meetings short, increasing duration once expertise has developed,
• Do not assume your English (accent) is understood during foreign link-ups,
• Be aware of technical, human and educational limitations,
• Use 'people and content' where possible to aid communication,
• Use continuous presence to ensure all parties can be seen at all times,
• Use hand signals to attract attention when raising questions. (ensure you understand the cross cultural significance of same too) This is specially important when class sizes are larger,
• Encourage interaction by involving participants by asking them for feedback and addressing them directly, although this could be problematic in high context cultures,
• De-brief after classes where possible to obtain useful feedback,
• Ensure co-ordination of curriculum and learning outcomes between parties before commencing the project
• Aim where possible to conduct these tutorials in a "regular" room rather than a studio to reduce the degree of artificiality of the surroundings.

Future research could be conducted in a number of ways including: Cross cultural experiences, valid measurement of bi-national tutorial effectiveness, common/joint assessment, and international collaboration activities.

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