Project Number: CXD-AUS4

Using the Access Grid at Global Project Sites

An Interactive Qualifying Project Report
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the
Degree of Bachelor of Science
by

_____

Vincent Amendolare

_____

Ryan LeBlanc

_____

Julian Race-Moore

on

May 3, 2005

Approved:

Professor Chrysanthe Demetry, Co-Advisor

Professor Edward A. Clancy, Co-Advisor

Abstract

The Access Grid is an emerging videoconferencing technology that is experiencing a slow diffusion among new users at WPI. This project evaluated the usefulness of the Access Grid in the Global Perspective Program to determine ways to increase its usage. The project goals were accomplished through direct experimentation with the technology, correspondence with program participants, and analysis of Access Grid documentation. Finally, this project recommends feasible communication scenarios for Access Grid use.

Acknowledgements

We would like to thank those people who provided us with valuable support and assistance throughout our project. First, we would like to sincerely thank our sponsor, Dr. Julia Mullen. Our thanks go out to our advisors, Professor Edward A. Clancy and Chrysanthe Demetry for their guidance throughout the project. Also, we could not have completed our project proposal without the wisdom of Professor Thomas Estabrook. We are deeply grateful to Nelsie Fernandes and the staff at the Victorian Partnership for Advanced Computing (VPAC) in Melbourne for their advice, support, and generosity. Finally, we owe a great deal to those who provided us with valuable input, including Professor Jonathan Barnett, Professor Holly Ault, Professor Richard Vaz, Professor Paul Davis, Thomas Lynch of the WPI Information Technology Division, Jim Miller of inSORS, Joseph Kalinowski of the WPI Academic Technology Center, Jennifer Teig von Hoffman of Boston University and the Access Grid Documentation Project (AGDP), Natalie Mello and staff of the Interdisciplinary and Global Studies Division at WPI, and of course all those who participated in our surveys and interviews.

Table of Authorship

Section #	Section Title	Primary Author(s)	Primary Editor(s)
	Abstract	Julian	All
	Executive Summary	All	Julian
1.	Introduction	All	Vince
2.	Background Research	Vince	All
2.1	Understanding Communication Technologies	Vince	All
2.2	Videoconferencing Technologies	Ryan	Julian
2.3	The Access Grid	Julian	Ryan
2.4	Uptake of New Technologies	Ryan	All
2.5	The Global Perspective Program	Ryan	Vince
3.	Methodology	Vince	All
3.1	Research Questions	Ryan	Julian
3.2	Idea Generation	All	All
3.3	Assessment of Communication Needs…	Ryan	All
3.4	Pilot Tests	Julian	Vince
3.5	Analysis of Feasibility	Vince	All
3.6	Access Grid Guidebook	Vince	Julian
4.	Results and Analysis	Ryan	Julian
4.1	Understanding the Practicality…	All	All
4.2	Analysis of Usage Scenarios	Vince	Ryan
5.	Conclusions and Recommendations	Vince	Ryan
5.1	Applications of Videoconferencing Technology…	Ryan, Vince	Julian
5.2	Suggestions for a Videoconferencing Solution…	All	Ryan
5.3	Access Grid Guidebook	Vince	Julian
5.4	Recommendations for the Future	All	All
	References	All	All
Appendix A	Mission of Agency	Julian	All
Appendix B	What is an IQP?	Vince	All
Appendix C	Interviews	All	Vince
Appendix D	Web-brochure	Julian	Julian
Appendix E	PowerPoint Presentation	Julian	All
Appendix F	Site Director Focus Group Questions	Ryan	Vince
Appendix G	Project Advisor Survey Questions	Ryan	Vince
Appendix H	Student Survey Questions	Julian	Vince
Appendix I	Project Sponsor Interview Questions	Vince	Ryan
Appendix J	Access Grid Participant Survey	Julian	All
Appendix K	WPI Global Project Sites	Ryan, Julian	Ryan
Appendix L	Pilot Test Results	Vince	Ryan
Appendix M	Focus Group Minutes	Julian	Vince
Appendix N	Key Correspondence	Vince	Ryan
Appendix O	Sponsor Interviews: Summary	Vince	Julian
Appendix P	Student Survey Results Summary	Vince	Julian
Appendix Q	Access Grid Guidebook	All	All

Table of Contents

List of Tables

List of Figures

Executive Summary

This project focused on assessing the feasibility of new applications for the Access Grid at Worcester Polytechnic Institute (WPI). The Access Grid is an advanced videoconferencing tool that supports group-to-group interaction and collaboration. Currently, WPI has an Access Grid facility that is utilized for large meetings, seminars, conferences, workshops, and occasionally as a virtual classroom. Although these applications represent several practical uses for the technology, the WPI Information Technology (IT) Division recognized that there were unexplored opportunities that could stimulate the deployment of the Access Grid into other areas of campus activity. This project's sponsor and member of the IT staff, Dr. Julia Mullen, indicated that one such avenue would be to incorporate Access Grid use into WPI's Global Perspective Program, where students complete academic projects during a two-month residency at sites around the globe.

The goal of this project was to determine if there are practical and effective uses for the Access Grid within WPI's Global Perspective Program. While addressing issues that are mostly unique to WPI, the results of this project may be applicable in other organizations that utilize global communications or conduct remote project activities. Research questions were posed to help guide the project's focus. These questions addressed topics such as identifying the communications needs for remote project sites regarding the various projects in the Global Perspective Program, and for which types of projects remote communication is necessary or beneficial. Also, differences between the types of Access Grid connections, or "nodes," (room-sized nodes and personal computer-based nodes) were investigated to determine if these differences would affect usage of the technology. Furthermore, issues were considered that would present obstacles to using the Access Grid in proposed communication scenarios. Finally, similar technologies were investigated, the most significant being the inSORS Grid solution, a commercialized version of the Access Grid, produced by inSORS Integrated Communications, Inc. While maintaining focus on the Access Grid, the research considered the impact other technologies could have on proposed communication scenarios.

Based upon background research and personal interviews with stakeholders of the Global Perspective Program, a list of possible communication scenarios was generated to help identify areas where the Access Grid might be useful in the Global Perspective Program. Next, a plan was developed to educate key groups about the Access Grid. This plan included the design of a web-based Access Grid brochure, an informational PowerPoint presentation, and personal consultations with key groups so that they could make informed decisions about the value of the technology. These groups included students, project site directors, advisors, and sponsors. Individuals within these key groups were contacted to gain more information on the perceived

benefits and drawbacks of the technology as well as effectiveness of the Access Grid in the possible communication scenarios through the use of surveys, interviews, and a focus group.

Several scenarios were identified where use of the Access Grid could be practical and beneficial to participants, including project presentations, remote advising, consecutive term projects, and counseling meetings. These scenarios were identified as functional because the technology was able to meet the user needs without presenting significant barriers to the interaction. The determination of practicality and feasibility for each scenario was made by identifying the needs each scenario presented, the benefits offered by the technology, and the issues the use of the technology raised. Important factors that led to each conclusion included the travel distance to room nodes, the network required to allow the technology to operate (availability of a high bandwidth connection without firewall restrictions), and the necessary level of user competence with the technology for each scenario.

Information gathered from the various methods indicated that project presentations represented a feasible use of the Access Grid in the Global Perspective Program. A survey provided data to suggest that the majority of students are willing to try this technology, and most respondents were particularly interested in the Access Grid's shared PowerPoint presentation feature. Also, project site directors expressed interest in the possibly of project presentations so that they could observe students at their project site when not physically present at that site.

Introducing the concept of "remote advising" to participants elicited positive feedback. When advisors and their students are physically separated, the need to communicate effectively is crucial. Stakeholders in the advising process were interviewed, and the results showed that advisors were interested in using the Access Grid to facilitate communication with their advisees, especially in situations where technical matters would be discussed. In particular, the ability to share ideas via a whiteboard, the face-to-face nature of the exchange, and the data sharing capabilities all contributed to the success of this scenario.

WPI's global project sites occasionally host projects that are related to one another but are performed in consecutive academic terms. These types of projects represent another potential use of the Access Grid. Students who were involved in these types of projects were consulted, and the consensus was that Access Grid technology could significantly improve the communication between project groups.

Finally, the possibility of conducting student counseling meetings via the Access Grid was received favorably by participants. Students indicated that easy access to aid, in the form of counseling, would be helpful during off-campus projects, and representatives from the student counseling center at WPI expressed interest in the idea. In particular, the face-to-face nature of the technology interested participants because it would become possible to identify unspoken signals such as body language and gestures. While participants expressed concerns about privacy, they noted that overall they were interested in the technology for future use.

Each of these meeting types is restricted by logistical issues involved with connecting to the Access Grid, such as the availability of a nearby Access Grid room node and the technical considerations of setting up a personal Access Grid node, as well as issues such as network connectivity, time zone differences, and technical know-how. However, some usage scenarios were burdened with barriers to feasibility that did not outweigh the potential benefits. Using the Access Grid for off-campus judicial hearings was one such scenario. Stakeholders expressed interest in the idea, but drawbacks such as time constraints (off-campus hearings must occur within forty-eight hours of the incident) and coordination of required participants proved too difficult to overcome. Also, the use of the Access Grid to facilitate communication with project sponsors during a project's preparation phase was identified as a potential use that presented more drawbacks than benefits. While students seemed interested in the idea, project sponsors indicated that current communication techniques were effective, and the costs and inconvenience associated with setting up this new technology would be unjustifiable.

We recommend that stakeholders in the Global Perspective Program consider the Access Grid as a viable option for enhancing communication. Also, other technologies, specifically the inSORS software, should be considered when evaluating the usefulness of videoconferencing technology. In order to make the decision of whether or not to use the technology, participants should understand their communication needs and the information they hope to convey. In general, this understanding relates to how effectively the features of the technology can improve current communication methods.

Information is provided in the form of an easily accessible, comprehensive guidebook that will help educate potential participants. In this guidebook, participants can follow a "decision tree" that allows them to quickly assess the practicality of conducting their meeting over the Access Grid. This decision tree guides the user through the issues involved with Access Grid use, such as meeting size, network connectivity, technical knowledge, and node availability. The tree helps the user identify if their communication needs can be met by the Access Grid, and if so, how they should proceed. From this determination, the guidebook then outlines the steps necessary to arrange their meeting, suggesting references to seek out or individuals to contact who can aid them in this process. It is our recommendation that this guidebook should be made available and/or distributed by the IT Division at WPI, and can be found in Appendix Q of this report. In particular, stakeholders of the Interdisciplinary Global Studies Division of WPI, such as project site directors, advisors, and students, should be made aware of the existence of the Access Grid and of the possibilities that this new technology could present to them.

1. Introduction

As barriers to human interaction are broken down, society has expanded to include not only one's local community, but the larger global community. Now, more than ever, people want and need to communicate across the globe easily and effectively. The field of communication is no exception to the perpetual evolution of technology. People are regularly looking for new and improved methods of communication.

The Access Grid, a product of the U.S. Department of Energy's Argonne National Laboratory, is a videoconferencing tool that facilitates group-to-group interactions within the global community. Unlike traditional videoconferencing, which focuses on one-on-one meetings, the Access Grid is designed for small group (three to six people) meetings between several geographically disperse locations. The Access Grid is capable of streaming several channels of audio and video amongst many meeting sites, making it practical for a range of communication scenarios. However, the Access Grid is an emerging technology, and is experiencing a slow diffusion amongst new users. Presently, it is mostly used by its developers, researchers at or above the graduate level, and other technically proficient users.

Within the past few years, more and more Access Grid facilities have been added to this ever-growing community of users. One such facility is located at Worcester Polytechnic Institute (WPI), a university of science and technology in Massachusetts, USA. WPI undertook the investment of creating this multi-use facility, and pays for personnel time and effort to keep the room fully operational. With help from its Information Technology (IT) Division, WPI prides itself on employing of some of the newest technologies on the market to supplement traditional forms of communication and educational enhancement. The IT Division's mission is to "partner with students, faculty, and staff in the quest for knowledge, applying the power of technology to unite people and content anytime, anyplace" (WPI, "Information Technology", 2005). The WPI contact for Access Grid involvement on campus is Dr. Julia Mullen, an employee of the IT Division. She is responsible for facilitating interactive and collaborative events over the Access Grid.

Currently, WPI's Access Grid room node is utilized for large meetings, seminars, conferences, workshops, and even as a virtual classroom. Although these applications represent several practical uses for this technology, the IT Division recognized that there were unexplored opportunities that could stimulate the deployment of the Access Grid into other areas of campus activity. One topic noted by Dr. Mullen was that Access Grid events on campus significantly lacked representation by the undergraduate student population. Realistically, students have little need for Access Grid technology during their normal coursework, and unless WPI develops or alters current courses to incorporate this technology, the level of Access Grid use at WPI will not

be significantly increased. However, Dr. Mullen realized that this technology may be valuable for improving communication to parties that are situated off-campus.

WPI undergraduates participate in a number of off-campus programs and projects, the majority of which are supported by the Global Perspective Program. This program encourages students to gain a global outlook during their undergraduate education. The Global Perspective Program entails WPI undergraduates traveling to remote project sites around the globe in order to complete various projects, typically during a seven week on-site residency. These projects are usually sponsored by governmental, non-profit, or commercial organizations in the host cities. The students spend two months preparing for the on-site activities and need to correspond with their sponsors while still in Worcester. While participants normally use telephone and email to meet these communication needs, the program could possibly be enhanced by implementing the Access Grid in select areas of project work. The Global Perspective Program's unique requirements for distance communication were perceived to be a good fit for the benefits of Access Grid technology.

The goal of this project was to determine if there are practical and effective uses for the Access Grid in the Global Perspective Program. We sought situations where using the Access Grid could be beneficial to those involved and investigated them to determine their degree of feasibility. In order to develop these scenarios of Access Grid use, an understanding of the communication needs and views of stakeholders in the Program was essential. We sought the opinions of stakeholders in the program, such as students, project site directors, advisors, and sponsors. The opinions of the stakeholders were important to our investigation of the use of the technology in various "communication scenarios." While our research was concentrated on Access Grid use in WPI's Global Perspective Program, much of our work is applicable to the entire Access Grid community. As a byproduct of this project, an educational guidebook containing protocols to instruct new Access Grid users was developed. The guidebook is beneficial not only to users at WPI, but to all new users of the Access Grid. Also, other institutions that have global programs may be able to apply our research on the Access Grid's use in the Global Perspective Program to their own programs.

It is also important to note that we completed this project in Melbourne, Australia as participants in the Global Perspective Program. We worked at the Victorian Partnership for Advanced Computing (VPAC) for the duration of our project using their Access Grid facility and high speed internet connection as essential tools allowing us to conduct our tests and hold meetings with our sponsor back in Worcester, MA.

2. Background Research

First, an understanding of communication in general and the manner in which human beings interact is presented. Next, an overview of the various videoconferencing technologies currently available allows the reader to understand the capabilities and drawbacks of the Access Grid when compared to other technologies. Furthermore, an examination of the Access Grid, including its capabilities and requirements, illustrates what benefits this technology has to offer. Also, by examining how people adopt new technologies, one can better understand how to facilitate the uptake of Access Grid use. Finally, research into the Global Perspective Program sheds light onto the communication needs of projects away from the WPI campus.

2.1. Understanding Communication Technologies

It is important to recognize the broad importance of communication. The history of communication techniques, the evolution of communication technology, and the current state of the art in videoconferencing are presented to allow the reader to understand the development of communication technology over the years. With this knowledge, a better understanding of how our project can implement technology in various communication scenarios is achieved.

2.1.1. History of Communication Technology

Communication is defined as "a process by which information is exchanged between individuals." Though it may be possible for a *person* to survive without communication, it is absolutely vital to the function of a *society*. A society is an association of people for mutual benefit and people need to convey information to one another in order to have such a relationship. It is for this reason that communication developed. (Merriam Webster Online, 2005) Communication itself predates recorded history and has no well-defined beginning. After all, the recording of history itself is a form of communication. Animals have been communicating with each other for millennia, through body language and even primitive vocal techniques. Most scientists believe that human conversation evolved from apes using these sorts of communication techniques. (Hewes, 2005)

In ancient times, societies functioned much more locally than they do now, with little need for long-distance communication. Most, if not all, communication needs could be met by conversation alone. As larger societies formed, consisting of geographically dispersed people, distance began to pose a problem for communication. The solution to the distance problem was technology.

From the earliest forms of writing to the invention of the printing press, communication evolved with technology. Advances in communication helped humans to collaborate like never before and previously insurmountable barriers to communication were overcome. For example, in 1876 Alexander Graham Bell invented the telephone and achieved a breakthrough in

communication technology. From that day forward, people could actually speak to each other over large distances. Although it took many years for the phone system to be implemented on a large scale, society embraced the technology and eventually a phone could found in nearly every home in America.

The development of computers in the latter half of the twentieth century marked the beginning of the information age. In 1994, a major milestone was reached when the United States government released control of the Internet to the general public, thus beginning an era of communication revolution. People now had access to large amounts of information, from sources all over the world. Furthermore, the advent of e-mail made sending messages to people fast and easy. (About.com, 2005)

2.1.2. Human Factors in Communication

Despite the plethora of communication methods between humans, there are really only five ways a human can observe their surroundings and take in information: the senses of sound, sight, smell, taste, and touch. Thus, all methods of communication between two humans must use at least one of these senses to convey information. (Brennan, 1963, p. 74)

Sound is an extremely important sense for humans, although only ten percent of what we perceive comes from sound. Humans interpret sounds in hundreds of different ways (Brennan, 1963, p. 75). However, the main way that sound is used for human interaction is through speech. Speech, or language in general, has developed over thousands of years to be able to convey most information humans desire to share. There are a few major limitations to this form of communication, physical distance being a typical example. Humans can only speak to each other when in close proximity, unless using a device like a telephone. Another limitation is the language barrier. Not all people on Earth speak the same language, and it can be very difficult to communicate to someone who does not speak your language. A third limitation to speech is the lack of a visual element. It is possible to paint a picture in someone's mind using words; however in many instances this is impractical or impossible. (Brennan, 1963, p. 155-159)

Sight is the most important sense, as eighty-five percent of what humans perceive is visual (Brennan, 1963, p. 74). Language is an important form of communication for sight as well, in the form of writing. Writing is another effective means for conveying information, with some relatively subtle differences from speech. Writing still represents the information in words, so it is the same as speech in that sense. However, sometimes the tone of a writer can be unclear since the reader can not hear the words spoken. One advantage of writing is that it is usually permanent, and easy to refer back to later. Also, writing is usually more thoughtfully composed, so it can be a more concise method of communication. Vision can also be used to examine at pictures, diagrams, tables, videos and many other forms of communication. (University of Westminster, 2005)

The other human senses are used relatively seldom for communication, however they are still extremely important. They can provide information that is unavailable to the eyes and ears and also data from these other three senses can be used to cross-reference data obtained from sight and sound. While we can focus on certain senses at certain times, information is coming in from all senses at all times. It is up to the central nervous system, both consciously and unconsciously, to interpret all of this information (Brennan, 1963, p. 75).

Communication is encoded with agreed representations of gestures and words, however sometimes these meanings have different interpretations to different people. One source of communication problems comes from cultural differences. What has a specific meaning to someone of one culture can mean something quite different to someone of another culture. This cultural difference can be a challenging obstacle to overcome. In order to overcome this barrier, a person must be willing to make an effort to understand the person with whom he or she is communicating and also to seek out any information that may be necessary to understand that person's cultural differences (Nulph, 2002).

Another communication limitation is associated with disabled individuals. Humans can suffer from a multitude of physical disabilities, and many of these can impede communication effectiveness. Fortunately, there are solutions that reduce the impact of these limitations. For example, sign language is a means of communicating with the hearing impaired as a substitution for speech. Similarly, the Braille writing system is used to enable blind people to read and symbolic languages are also used for people with communication disabilities. These languages usually consist of symbols that represent different words. There have been cases of people mastering thousands of these symbols and being able to communicate almost any idea in this manner. (ARCH, 2003)

According to Joeseph Kalinowski, the Assistant Director of the Academic Technology Center at WPI, when considering a means of communication, it is important to think about the needs that one is trying to meet. For many information exchanges (such as brief question and answer sessions and basic correspondence) all that is necessary is audio, so the telephone would be a sufficient communication medium. There may, however, be instances where a visual component is necessary, specifically in certain group collaboration environments. While it is possible that a visual component to communication could be undesirable (e.g., personal uses where privacy is preferred), in business or education it usually advantageous to have this visual element. For example, it would be overzealous to utilize videoconferencing to simply confirm a meeting time or reply to a simple question such as "how are you?" or "can you meet tomorrow at noon?" However, when discussing technical topics among a group of people, videoconferencing is a much more attractive tool as it enables communication to more closely approximate a face-to-face meeting. Since videoconferencing uses audio and video, as well as other information, it is a very appropriate technology for many communication scenarios. Before assuming it is the best

communication choice for a certain application, one must take into account the cost and other issues associated with videoconferencing. (Internet2, 2003, p. 12-13)

2.2. Videoconferencing Technologies

With the advent of more reliable, compact, and inexpensive communication technologies, especially those utilizing telephone and computer equipment, there has been a tremendous global expansion of information and ideas. The flood of information that can now be accessed at the push of a button is unlike anything that this world has ever experienced.

Two technologies have greatly helped to connect people together over long distances: teleconferencing and its successor, videoconferencing. These types of technologies are best understood by exploring their background. This section provides an explanation of networking, several videoconferencing solutions that are currently available on the market, and the user requirements and "human factors" associated with personal interactions using these communication technologies.

2.2.1. A Brief Explanation of Teleconferencing and Videoconferencing

Over the years, telephone technology has advanced beyond a simple one-on-one device, and now multiple callers can participate in the same conversation, giving rise to the concept of teleconferencing. Teleconferencing is defined as audio communication between two or more individuals employing devices that render the meeting different than that of a normal two-way discussion (Davis, 2003). Teleconferencing is typically accomplished with the use of a speakerphone, which creates a group atmosphere as opposed to the individual atmosphere created by a regular telephone. Teleconferencing is the simplest way to facilitate instant, two-way communication between geographically remote groups. Videoconferencing was the next logical step to promote a group atmosphere with a visual component.

Videoconferencing incorporates the use of video capture equipment in order to allow participants to experience anything from still images to streaming video in addition to a real-time audio component ("Videoconference - a Whatis.com definition", 2003). Unfortunately, this video component requires large quantities of data to be sent between the locations involved. For example, for a videoconferencing session, bandwidth must be available or the experience can be poor for participants in the meeting. Typical videoconferencing sessions require between 300 Kbps to 400 Kbps[1] for each stream (a video feed plus its associated audio data) in order to be effective (Perey, 2001). Newer technologies can use even more bandwidth (up to 1 Mbps per stream), and require even better internet connections. These limitations place constraints on the

[1] Data **bits** are the building blocks of computer information. A **byte** consists of 8 bits. A typical CD-ROM is capable of storing over 5 billion bits. **Kbps** refers to the transfer of one thousand bits per second. Similarly, **Mbps** and **Gbps** mean 1 million and 1 billion bits transferred per second, respectively.

quality of the video displayed at the desired remote locations depending on the type of connection used. The main deciding factor in terms of the quality of the communication is the network providing the signal.

One benefit of videoconferencing is that it simulates a face-to-face meeting and delivers a perceived sense of a close proximity of participants. This proximity yields a setting where both verbal and non-verbal interactions among the group can greatly impact the quality of the meeting. If these natural interactions are misunderstood or suppressed in some way, the meeting can be unsuccessful (Hull, 2005). The issue associated with utilizing videoconferencing technologies is that when the technologies either have errors or fail, the effectiveness of the meeting is severely reduced. In order to prevent disastrous meetings from occurring and participants from becoming frustrated, there are two facets of videoconferencing meetings that must be considered. So, Daw (2002, p. 31) defines "user requirements" as the necessity of a seamless interaction between the participant and the technology. In this sense, the technology should become virtually transparent to those involved in the meeting. The second is defined as "human factors." This term is used to explain how users adapt their behaviors as a reaction to the videoconferencing technology being used. "Good distributed meetings can be achieved by helping humans to get the best from the…technology through training, preparation and some forethought to the wider issues such as culture, language and the meeting's purpose and aims beforehand" (Daw, 2002, p. 31). Both topics are further developed in later sections after an explanation of some of the more technical aspects of these technologies.

2.2.2. Networking and Bandwidth Requirements

A key facet in videoconferencing technology is the ability to transmit all the data required to connect devices together. As the technologies have grown, so have the bandwidth requirements. Internet connectivity has experienced a revolution in the past decade or so. We have seen connection speeds transition from analog modems capable of transmitting mere bits per second (bps) to digital fiber-optic networks able to transmit entire volumes of data in moments. High bandwidth is the key feature desired in videoconferencing. Bandwidth refers to the amount of data that can flow through the connection. Unfortunately, bandwidth can come at a high cost (typically charged as monthly access fees). This cost sometimes needs to be accepted, especially when certain bandwidth intensive applications require it. Even using special compression techniques, it is difficult to reduce the amount of data required for a videoconferencing session. Fortunately, there are groups, both academic and industrial, that are involved in researching ways to make data transmissions faster, cheaper and more reliable.

The current state of the art in telecommunications is the use of multi-gigabit backbone networks, such as the Internet2. In the United States, there is a major collaborative effort involving over 200 American universities, leaders of industry, and a variety of government

agencies to develop the next generation networking applications, infrastructures, and technologies. Currently, this research is being conducted using an advanced network architecture which is able to provide bandwidth resources for the testing of experimental technologies. This network, named “the Internet2,” is a test-bed for innovation in areas such as videoconferencing. The Internet2 is comprised of high-speed internet backbones, operating in excess of 10 Gbps. For comparison, a typical home Digital Subscriber Line (DSL) or Cable internet connection operates at an average bandwidth of between 500 Kbps and 1.5 Mbps, and thus would only be able to support one or two videoconferencing data streams. While the Internet2 is the project being developed in the United States, similar initiatives are maturing around the world, including the GrangeNet and AARNet3 in Australia. Regardless of the infrastructure providing it, videoconferencing relies on the availability of high speed connectivity and the interoperability of those connections.

2.2.3. Currently Employed Videoconferencing Solutions

Several videoconferencing technologies, such as H.323, Virtual Room Videoconferencing System, Microsoft Conference XP, and Access Grid utilize the high bandwidth allotted by Internet2. Although there are more stable forms of each technology available in a commercial package, the versions being tested by the collaborative efforts of those involved in Internet2 are the forerunners of what will eventually be a set of interoperable and essential technologies for research, educational, commercial, and governmental groups (ITU-T, 2004). Some of the differences among these systems, such as bandwidth requirements, hardware requirements, available collaborative software, and associated costs, are summarized in Table 1.

H.323, and its predecessor **H.320**, are standards for digital video transmission developed by the International Telecommunications Union - Telecommunication Standardization Sector (ITU-T). While “non-binding, these [standards] are generally complied with due to their high quality and because they guarantee the interconnectivity of networks and enable telecommunication services to be provided on a worldwide scale” (ITU-T, 2004). While not a videoconferencing solution itself, H.320 and H.323 are standards utilized in stand-alone videoconferencing equipment. H.320 and H.323 (collectively called H.32x) “set-top-boxes” can be found in board rooms and development labs around the world; these hardware-based “turn-key” products predicated the software based solutions that are becoming popular today.

Virtual Room Videoconferencing System (VRVS) is a videoconferencing program that uses the H.323 standard and software known as Mbone (**M**ulti-cast Back**bone**) tools. VRVS allows users who have access to an IP network and web browsing software to connect to the central VRVS web server. From there, a user may reserve a location called a “virtual venue.”

VRVS permits users to purchase equipment that is within their budgets, since there are no minimum hardware requirements. Further flexibility of VRVS is shown by its ability to use either H.323 for voice-switched video or Mbone tools for a thumbnail grid of video feeds[2], allowing users to select participants they wish to see in larger windows. A downside to VRVS is that the compression algorithms can make video appear choppy and on large displays images become pixilated. VRVS does not include many software options other than a Java-based chat, but Virtual Network Computing (VNC), a remote desktop sharing software, can be used to share other applications. (Daw, 2002; VRVS v3.4) Finally, VRVS is designed around multicast networks[3], which not all network infrastructures support.

Microsoft ConferenceXP is a system for videoconferencing based on the efforts of Microsoft Research in conjunction with Argonne National Laboratory's Access Grid Project. ConferenceXP uses standard features of both Windows XP and Tablet PC, such as Windows media, for a videoconferencing experience that supports the audio, video, and optional software applications used in windows machines. Additionally, ConferenceXP supports the use of 802.11b (WiFi) wireless connections. An archive service can also be purchased, giving users the ability to have entire sessions recorded for later review. Other useful features include support for multiple video cameras on an individual computer and very low quality video support to enhance the experience for low bandwidth users. ConferenceXP also supports standard plug-and-play hardware devices. This system supports several software applications. *Classroom Presenter* allows shared PowerPoint presentations where presenters can add real-time "ink" using a Tablet PC. *ReMarkable Texts* allows participants to make annotations using "ink," hyperlinks, "sticky notes," and audio to enhance classroom notes, presentations, or other documents submitted during the meeting. *Inkboard* is a "network-sharing Tablet PC sketching application" (Beavers, 2004). ConferenceXP is currently freely available for research purposes and while promising, this technology is being developed by Microsoft, and as such the final version will only be supported on Windows-based computers and will most likely have a high associated cost of acquisition.

inSORS Grid (IG) is a videoconferencing solution available from inSORS Integrated Communications that has been commercially available since 2000 and features similar functionality to ConferenceXP. The inSORS software is loosely based on the Access Grid framework but has been built from the ground up to incorporate a variety of tools in a single,

[2] Voice-switched video activates a video stream display based on which party is speaking, usually only showing one feed at a time. A thumbnail grid allows the user to see all video feeds at once, and actively select which streams to enlarge or hide.

[3] A **multicast** enabled network lets a computer send out a single stream of data and allows multiple sites to grab that stream from the network without placing more demands on the individual connection.

easy-to-use package. inSORS Grid allows the sharing of PowerPoint presentations and data through desktop sharing and file posting, group whiteboard use, and camera control for remote sites. Other features include integrated back-channel chat, the ability to record meeting video and audio feeds, and an encryption tool to limit user access. Another useful feature is IG Meeting, which allows a user to create dynamic, "on-the-fly" meetings with other users online and also contains a meeting scheduler to aid in arranging meeting times and forwarding reminders to participants. This software is currently available for Windows 2000 and Windows XP operating systems, but is expected to extend to Mac and Linux platforms within the next year. Multiple universal serial bus (USB) video cameras can be connected at once, and developers are working to reduce the video feed bandwidth in future versions of the software. A key difference between the inSORS Grid and the Access Grid is that inSORS is built to accommodate slower connection speeds and allows users to select bandwidth levels for the transfer of video and audio streams to support lower bandwidth internet connections. Video streams can be set as low as 100 Kbps, and audio can be set from 64 to 128 Kbps. It also has the ability to connect through firewalls[4], which is sometimes a barrier to data transfer in situations involving other videoconferencing technologies.

All of these features are available in the software and a single client license can be purchased at the educational price of 2,400 USD. When purchased in bulk, the cost decreases significantly (e.g. 800 USD per license for 10 or more) and arrangements can be made to allow license rollover for new users in an academic setting where different groups need access from time to time.

[4] A **firewall** is a piece of software or hardware that prevents the flow of malicious network traffic. However, sometimes these solutions can also block legitimate content.

Table 1 - Comparison of Videoconferencing Technologies

	H.320/H.323 Solutions	VRVS	ConferenceXP	inSORS Grid	Access Grid
Backing Institution	ITU-T[5]	High Energy and Nuclear Physics communities	Microsoft	inSORS Integrated Communications Inc.	Argonne National Laboratory
Bandwidth Requirements	ISDN[6]	Internet2	Cable Modem, Leased Lines[7]	Cable Modem or better	Internet2
Popularity (relative)	High	Medium	Low	Low	Low - Medium
Overall Cost (relative)	High	Medium	Low – Medium	Low-Medium	Low - Medium
Standard Shared Applications	None	Synchronized Web Browsing, VNC[8]	Whiteboard, PowerPoint	Shared PowerPoint, VNC, shared browsers, images, movies, Whiteboard, and meeting recorder	Shared PowerPoint, VNC, shared browsers, images, and movies
Customizable Shared Applications	None	VNC	Microsoft .NET Framework	VNC	Open Source, VNC
Number of Separate Sites that can Connect per Session	2	Many	Many	Many	Many
Native OS Support	None (standalone)	All	Windows	Windows (Linux & Mac pending)	Windows, Linux, UNIX

(Data compiled from: Olson, “Access Grid Hardware”, 2003; VRVS, 2005; Futures Laboratory, “Node Requirements” 2005; Pahud, “Conference XP Research”, 2005

[5] **ITU-T**: International Telecommunications Union – Telecommunication Standardization Sector
[6] **ISDN**: Integrated Services Digital Network
[7] **Leased lines**: dedicated, high-performance internet connections carrying voice, data, and internet traffic, which is rented from an telecommunications provider (e.g. T1 and OC-3)
[8] **VNC**: Virtual Network Computing

2.2.4. User Requirements

Considerations should also be made when designing the videoconferencing facility itself. The best design for a room consists of adequate acoustical insulation surrounding an uncluttered, spacious, well-lit layout with a modular table system and stacking chairs that can be set up according to user preference (Daw, 2002, p. 31). Walls and curtains should be light slate-blue in color, which provides sufficient contrast. A mirror can also be useful, letting users check their appearance before they appear on camera. Room lighting should be soft and dimmable. It should fully illuminate the face eliminating facial shadows without blinding the user. All other light pollution should be eliminated through the use of blinds or curtains (Daw, 2002, p. 31, 34). Further, videoconferencing rooms should be equipped with large individual video displays or an integrated display wall consisting of multiple projectors that form a large, seamless display. Also, the room equipment should include audio hardware that provides echo cancellation and full duplex capability. This equipment prevents extraneous noise and allows audio data to be sent simultaneously in both directions, simulating normal discussion.

It is important to familiarize the participants with the technology and facility they will be using prior to the official meeting. The “user requirements” of a technology are intended to develop the user’s level of comfort with that technology. There are several different aspects concerning the room and technology and its uses that must be taken into account.

Initially, users may have a range of competency concerning videoconferencing technology. In all cases, it is still important to provide them with a detailed introduction to the facilities and peripheral equipment so as to prevent unnecessary confusion during the operation of a meeting. In this case, the best means to educate potential users is to provide them a list of tips and suggestions to consider before the day of their meeting. These tips may include simple explanations of the equipment that will be available for their use and options for room configurations.

With respect to peripheral equipment, it should all be clearly labeled with the function it will perform. Location and sensitivity of microphones must also be considered. Users should be able to speak normally into microphones as if they were sitting right next to the person with whom they are conversing. The meeting facilitator’s microphone should be placed so that any whispering or keystrokes made cannot be heard by others. (Futures Laboratory, 2003, p. 7)

To minimize problems with the transmission of video data, it is beneficial for participating sites to not only have sufficient bandwidth but also to use compatible video hardware and standards. Dedicated videoconferencing cameras – optimally positioned to simulate eye contact showing viewers close-ups of various members while offering white and light balancing – will greatly enhance video quality (Daw, 2002, p. 33). Other camera subjects that may enhance the viewer’s visual experience are the shared display, the audience, and two

angles for close-up shots on participants (Futures Laboratory, 2003, p. 7). Anti-glare monitors will aid in reducing reflections from room lighting and/or windows resulting in a clearer image on the screen (Daw, 2002, p. 33). If larger, composite screen displays are used, they should be aligned and connected to form a "single, seamless display" instead of three separate displays, which may be distracting to viewers (Futures Laboratory, 2003, p. 7).

2.2.5. Human Factors in Videoconferencing

In addition to user requirements, the "human factors" involved must also be considered to ensure the success of a videoconferencing meeting. These human factors cover areas such as general etiquette and facilitation techniques to which users should adhere. Both of these areas can easily be addressed if an effective, skilled chairperson, with experience of videoconferencing technology, facilitates the meeting.

At the outset of the meeting, the chairperson is the participant who greets each site as it enters the venue and acknowledges their exit with a parting salutation. The chairperson then should introduce members present at his or her site followed by individuals participating at remote sites. Greetings and introductions should be done for all late arrivals as they enter the venue. In some cases each participating site may have its own chairperson. These pre-meeting activities require communication and organization in order to coordinate and designate a hierarchy among the participants. The chairperson should also draw up an agenda with a general timeline for key points of the meeting. An agenda ensures that the meeting does not stall on less significant issues and that the meeting stays on track. Another useful document is a contact list containing basic information about individuals participating in the meeting, which can save valuable time during introductions. An off-line secretary should also be employed and can be used in conjunction with recording hardware or software, thereby recording valuable information discussed in the meeting without requiring active participants to devote time to note-taking. Time can also be an important consideration with regards to scheduling meetings. Time zones are the most obvious difficulty users encounter, but early morning or late-day meetings should be avoided because some people may be less attuned to the meeting if they have either just arrived or are waiting to leave work. (Daw, 2002, p. 36-37)

Other facilitation techniques that a chairperson could follow are similar to those used in normal face-to-face meetings. Each meeting will require a specific technique depending on the formality and size of the meeting. For smaller, informal meetings participants should find that it is easiest to hold a normal discussion relying on perceived, sometimes subtle, intentions that hint which person is trying to talk next. These visual and audible cues can be discerned, yet depending on the video quality some can also be easily missed. (Teig von Hoffman, 2003, p. 6)

Another fairly informal technique, raising hands, can be used for medium-sized meetings. The hand-raising technique is "quite intuitive." People are generally trained to use this method in

their schooling from a young age and naturally resort to it when they wish to politely attract the attention of a speaker. If used as a facilitation technique, participants should be explicitly told that questions will be handled this way during the meeting. (Teig von Hoffman, 2003, p. 6) Raising hands is a structured way of recognizing and addressing individual questions of participants. This technique requires a facilitator to acknowledge the raised hands of those who wish to add some insight into the discussion. This method is effective because it is a silent means of addressing questions and can notify the facilitator as to the level of importance of the question depending on how long the individual's hand stays in the air. At the same time, individuals can retract their question by lowering their hand before either having their hand acknowledged or being called on by the facilitator. Hand-raising can also act as a method of queuing individuals thereby giving everyone a fair chance to speak.

Passing the floor is a technique that is reserved for large groups where many sites are participating. These events are generally formally structured and should not be overly interactive. This technique requires that one site be referred to as the "main" site and other sites being referred to as "remote." Each site is required to have a Master of Ceremonies (MC or chairperson) who conducts his/her site and acts as the representative in the venue. The rule is that only one site has "the floor" at a given time. In this way, the MC for that site is able to internally manage activities by following some strategy for individual participation in the discussion. After a given time, or after discussion decreases at that particular site, "the floor" is then passed on to the main MC who then directs "the floor" over to another remote site. (Teig von Hoffman, 2003, p. 7)

Discussion by meeting technicians, or "node operators," over a MOO[9] is the final type of communication of which the chairperson should be aware. The MOO is a text-based back channel that can be employed by technicians for unobtrusive staff communications during the event. This communication gives technicians the ability to solve problems and share other relevant information without disrupting the event. This chat tool allows node operators to locate files for shared presentations or to discretely alert specific sites about pertinent information regarding the meeting. (Teig von Hoffman, 2003, p. 6)

User etiquette is also an important consideration for participants. As in any meeting, clear, concise phrasing and enunciation is important. Yet, due to the possibility of audio loss or delay during videoconferencing sessions, etiquette becomes even more important. As a result, users must speak at a normal pace while avoiding mumbling and shouting. Posture and body motions are also important elements to be discussed. Users must remember to maintain eye contact with the camera while talking and listening in the same way one would do in a face-to-face meeting. They must not rely on the fact that they are able to duck out of view of the camera.

[9] **MOO**: MUD, object-oriented. A MUD (Multiple user dimension) is a computer program which users can log into, explore, and use to communicate with other users.

Camera views that show the whole upper torso allow viewers to better read a user's body language. Slouching, fidgeting, and even multi-tasking can be considered rude to other participants. Essentially, as in a face-to-face meeting, users must constantly be aware of how they may sound and appear to viewers. (Daw, 2002, p. 38)

2.3. The Access Grid

The Access Grid is the culmination of a variety of communication technologies. As various telecommunication tools have evolved, so have peoples' perceptions about what could be achieved with these new technologies. Previously, videoconferencing had been limited to person-to-person interactions in virtual environments, and group-to-group or person-to-group exchanges were constrained to the physical world. The Access Grid is removing these limitations, and people are just beginning to realize the full impact this model can have on communication.

What the Access Grid seeks to accomplish is "wide-area, real-time, computer-mediated communications" (Stevens, 2003, p. 51). The Argonne National Laboratory's Futures Lab built the Access Grid around the central concept of multi-user workspaces with integrated audio and video where participants could move about freely, interact naturally, and join and exit conversations at will (Stevens, 2003, p. 53). In essence, the Access Grid "attempts to provide a sense of presence that approaches that experienced in face-to-face meetings" (Daw, 2002, p. 40). Relevant topics to be discussed in this section will include a description of the two Access Grid node types and the various hardware requirements for each, applications of Access Grid technology in both academic and business settings, and scheduling issues that must be considered as well as ways to address these issues.

2.3.1. Establishing an Access Grid Node

Before one can join the Access Grid community, an Access Grid "node" must be established. There are two types of nodes: room nodes and personal interfaces to the Access Grid (PIG) nodes. A room node, shown in Figure 1, consists of a conference room that is outfitted with cameras, microphones, displays, and computers. These facilities are usually designed to accommodate three to six individuals, but can be designed for much larger groups (twenty to thirty people).

Figure 1 - Access Grid Room Node
(The room includes seating for many participants. A display wall at the front integrates three separate displays to form a continuous image. Cameras above the display wall capture multiple angles of participants, and desk microphones (not visible) collect audio from all participants.)

There are no requirements or set standards for room configuration; however the typical "user requirements" are usually followed when setting up an Access Grid node. A PIG node, shown in Figure 2, is comprised of a personal computer with a single camera, microphone, and speakers or headset attached.

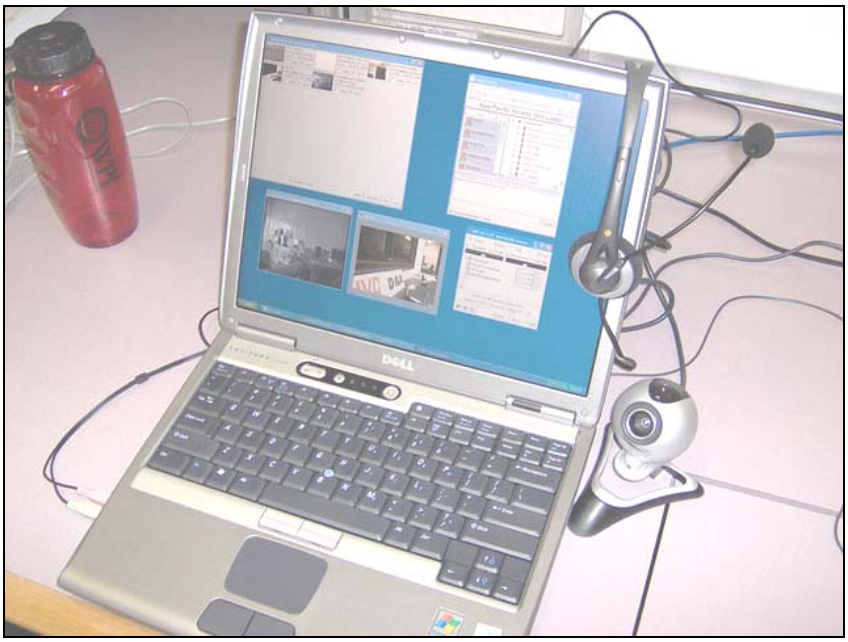


Figure 2 - PIG Node
(Standard windows-based laptop with USB web-cam and standard headset/microphone combination.)

Each type of node has its advantages and limitations. While the room node is much larger and can enable group-to-group meetings, it can be costly to set up and should have technical support staff on hand at all times. A room node is designed to handle a greater amount of network traffic due to the larger quantity of video feeds being processed and transmitted. Accounting for these factors, the costs of equipment increase quickly. A 2003 cost analysis of the equipment required for a room node provides a figure ranging from 42,000 USD for a smaller room node up to 47,000 USD for a larger room node (Olson, 2003, p. 1-11). These prices are high due to the fact that a room node typically requires four powerful computers to handle the tasks associated with Access Grid meetings: display, video capture, audio capture, and control. Other necessary equipment includes echo cancellation hardware, video cameras, audio devices, display screens, and projection equipment. In comparison, the PIG node is much cheaper to set up and operate, requiring only a personal computer running Microsoft Windows 2000 or XP, a headset with a microphone, and a web camera. The PIG equipment can be purchased for as little as 1,500 USD and the bulk of this cost is associated with the purchase of the personal computer. The drawback is that only a very small number of individuals (typically one to three) can participate from that node. And although a PIG node requires significantly less hardware, the network requirements are similar to that of a room node. While the PIG node only requires a single upload stream, is it still capable of displaying all of the incoming video streams, and thus still requires a large amount of bandwidth.

2.3.2. Scheduling

Before a meeting can take place over the Access Grid, the time and place must be scheduled and participants must be informed; these tasks are performed using the AGSchedule tool. Once a user has registered and logged in to the AGSchedule, they can find and schedule meetings, determine available virtual venues for those meetings, and even upload files that may be of use during the meetings.

Since meetings may take place at any node in the world, the issue of time conflicts becomes important. When logged into AGSchedule, meeting times are displayed in the user's local time zone. Therefore, if a meeting is going to take place in Boston at 4 PM EDT[10], then a user in California viewing the AGSchedule would see that meeting as 1 PM local time (PDT[11]).

2.3.3. Academic and Business Uses

According to the UK e-Science Programme, the Access Grid is ideally suited for meetings of 3-6 participants at 2-12 sites. (Daw, 2002, p. 44) Although the Access Grid was

[10] Eastern Daylight Time
[11] Pacific Daylight Time

developed for use in any environment, one of the areas that could benefit the most from this technology is academia. The group-to-group nature of the Access Grid is perfectly suited for academic collaboration. For example, the Access Grid can be used as a "virtual classroom" where students could attend a lecture or interactive class session being taught many miles away. Similarly, professors at WPI could teach a group of students at WPI, as well as Access Grid participants at distant locations. Furthermore, the Access Grid supports data sharing and visualization, features that are well suited for engineering research, and could aid colleagues working together from remote locations to collaborate on research and development.

The Access Grid offers significant benefits to business as well. Just as academic research relies heavily on collaboration, the success of a business is contingent upon support from their surrounding community of associates. Although the cost to set up an Access Grid node is substantially higher for business (most suppliers allocate substantial discounts to educational customers), the benefits can result in savings that would justify those costs. By facilitating face-to-face meetings over the internet, the Access Grid can reduce travel expenditures that would previously have been necessary. Similarly, because the Access Grid is designed for group interaction, many people from a variety of locations can meet without having to physically travel to a central location. Eliminating travel can be very beneficial in situations where the cost, "red tape", or political issues involved would be major obstacles.

2.4. Uptake of New Technologies

Despite the benefits that may be presented by new technologies, society does not generally accept their immediate adoption. Here, adoption refers to the psychological rationalization an individual makes to either accept or reject a certain idea or product (Bass, 1986). This choice is based on a conscious and subconscious evaluation of the costs of change that would be due if one were to embrace the technology. Many times this evaluation is characterized by an inherent uncertainty in the individual which stems from a lack of exposure to and therefore a limited understanding of how the technology functions and what those functions can do to alter the current opinion of the individual. For many individuals, the issue of adoption is not a definitive "yes" or "no" answer. "The choice being made is not a choice between adopting and not adopting but a choice between adopting now or deferring the decision until later" (Bronwyn, 2003, p. 1). It is this idea that defines the rate of diffusion of a technology in society. Diffusion refers specifically to the processes that lead to the acceptance or adoption of technologies by society. There are at least four different models of adoption, which attempt to explain diffusion. These models include the "Two-Step" hypothesis, the "Trickle-Down" theory, Everett Rogers' "Diffusion of Innovations" theory, and the "Crossing the Chasm" model proposed by Geoffrey A. Moore.

The first two of these models are fairly simple and deal with only two major populations. Generated by Paul Lazarsfeld and Elihu Katz, the Two-Step hypothesis focuses on a transfer of

understanding and acceptance from “opinion leaders” to those who hold them in high regard (Katz, 1973, p. 175-193). The opinion leader is the agent who is an active media user and who interprets the meaning of media messages or content for lower-end media users (Underwood, 2003). The general population essentially looks to a knowledgeable, trustworthy source for guidance on adoption and unquestionably follows the advice given to them. The Trickle-Down theory is a more generalized acknowledgement of a process that occurs with products and services in an economically driven society. This theory recognizes that frequently innovation is coupled with high cost. These costs are due to expenses that must be paid to meet requirements governing competency of personnel, setup of product, and maintenance resulting from imperfections in the design. Initially, these costs limit the customer base to only the upper class, but over time the product slowly becomes more readily available to the middle and lower classes. Time allows for further development of the product in terms of simplicity of operation, user-friendliness, and stability. (Bronwyn, 2003, p. 4-8)

The next model is also very similar in nature. Developed by Everett Rogers, the Diffusion of Innovations theory divides society into five adopter categories: technology enthusiasts, visionaries, pragmatists, conservatives, and skeptics. This theory, illustrated in Figure 3, uses a Bell curve broken into sub-populations to represent these five categories. Each population shares specific characteristics that determine its willingness and ability to adopt new technologies. Technology enthusiasts, or “innovators,” comprise only 2.5% of the total population and are characterized by venturesome, educated individuals. Visionaries, or “early adopters,” constitute 13.5% of the population and are generally social leaders, popular, and educated people. Pragmatists and conservatives, respectively referred to as “early majority” and “late majority,” each make up 34% of the population and represent the largest groups. The difference between the two lies in the theory that pragmatists are open to moderate change, whereas conservatives are more hesitant to accept forward progress with innovation. The last group, the skeptics, comprises the final 16% of the population. Also know as “laggards,” this group usually has little desire for emerging technologies, and they will resist their incorporation into the rest of society. (Orr, 2003; Beshears, “The Technology Adoption Life-cycle”)

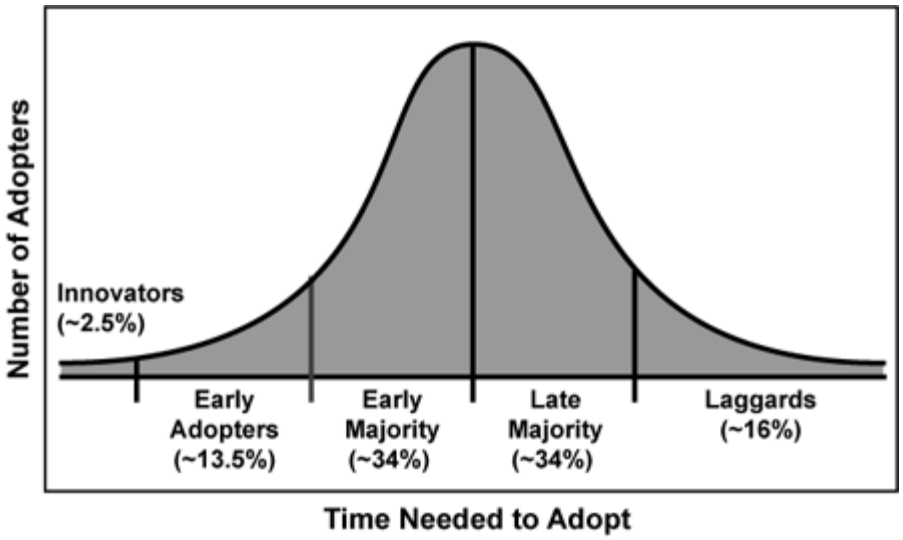


Figure 3 - The Technology Adoption Life Cycle.
(ARSC 2000, courtesy of Ada Leung)

Based on the model in Figure 3, Rogers was able to understand the individuals and processes that impact the rate of diffusion of new technologies. He noted that adopter populations are targeted by a "change agency," or a group/institution desiring the acceptance of the innovation by the majority of the population. Typically, the change agency is unable to directly initiate adoption and therefore requires help from a "change agent," whose function is to facilitate the diffusion process. "The change agent's role is to provide support to the participants, guide them to the direction of adoption, and provide reassurance once the decision to adopt has been made" (Hoerup, 2001, p. 3-8). The change agents usually have different backgrounds and expertise than both the change agency and adopters but remain proficient and knowledgeable in areas relevant to the innovation. These differences facilitate communication between the two groups by bridging the gap that exists due to the different needs of each. They also are responsible for reducing and explaining massive quantities of generally technical information provided by the change agency and intended for the adopters. Without the change agent's interaction with the adopter groups, the diffusion process would be greatly inhibited and eventually terminated.

Rogers broke these interactions down into seven steps. These seven steps are briefly summarized in the list below and then elaborated upon.

The Steps of Change Agent Interaction with the Adopter Population:

1. Incite in the client a need to change some aspect of the client's current situation.
2. Develop a strong relationship with the client built on trust in the agent and confidence in the role that the agent has concerning the innovation they represent.
3. Delve into the current needs of the client and emphasize points where needs are not currently being met through existing means.

4. Stimulate intent to fix a specific problem.
5. Emphasize the benefits of the innovation and correlate these to a solution that meets client's needs.
6. Follow-up with the client by reinforcing their decision and providing technical support for any issues that may arise.
7. Enable the client to troubleshoot future issues associated with the innovation.

The first step is to incite a need in the adopters. This need can be accomplished by the change agent "pointing out new alternatives to existing problems, dramatizing the importance of these problems, and convincing the client that they are capable of confronting these problems" (Rogers, 1983, p. 315). The second is to develop an acceptance of the change agent and their role in the innovation. They must create a sense of "credibility, trustworthiness, and empathy with the client's needs" (Rogers, 1983, p. 316). The third is to examine the current status of the client and the means that they are using to meet their needs. The fourth is to "create the intent to change in the client" (Rogers, 1983, p. 316). The agent must focus on the client's perceptions of problems that exist and what needs to be done to improve the situation. The fifth is to "translate intent into action" (Rogers, 1983, p. 316). The agent now must present the innovation as a solution to their problem. The sixth is to "stabilize the adoption and prevent discontinuance" (Rogers, 1983, p. 316). Finally, the seventh step is to "achieve a terminal relationship with the client by developing the client's ability to be their own change agents" (Rogers, 1983, p. 316-17). This step gives the client the confidence required to troubleshoot their own future issues with the innovation thereby ensuring continuation of its use.

Knowing the importance of the change agent and how the interactions impact each population, Rogers determined that technology would be accepted by society slowly at first and would then increase for a period of time before leveling off once the market became saturated with the product. This acceptance is represented graphically by an S-curve and has been shown in studies such as the one in Figure 4, which illustrates the uptake of certain electronic products in the United States over the past century. (Moore, 1999)

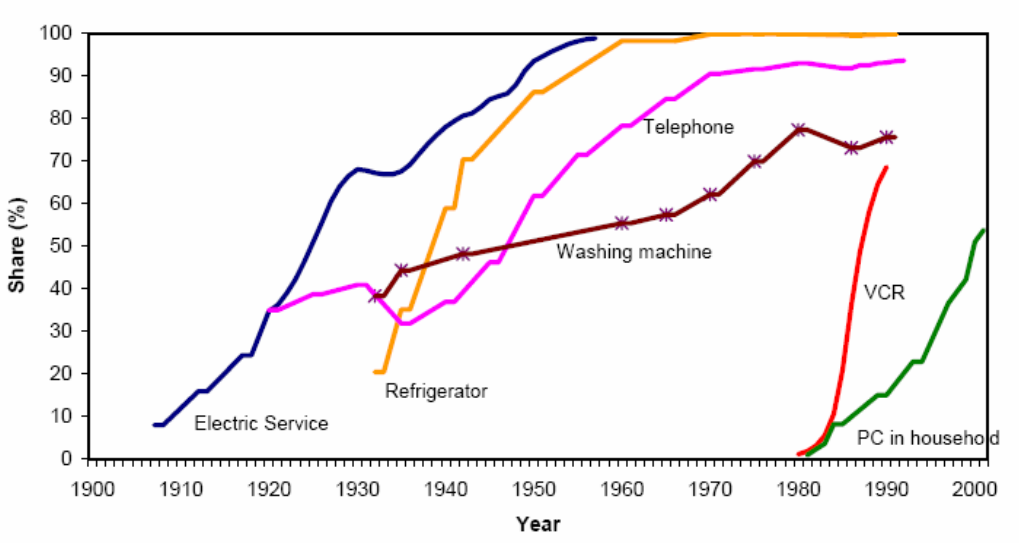


Figure 4 - Diffusion rates in the U.S. for selected consumer products.
(Bronwyn, 2003, p. 15)

Another model based on the work of Everett Rogers was proposed by Geoffrey A. Moore. In 1991, he wrote a book, entitled *Crossing the Chasm*, which uses the categories employed by Rogers. The difference between his and Rogers' model lies in a slight twist on the interpretation of how the adoption process flows from group-to-group. Moore believes that there is a "chasm," or barrier, that must be overcome in order for the technology to be successfully adopted by the majority of society. This chasm lies between the visionaries and the pragmatists as shown in Figure 5.

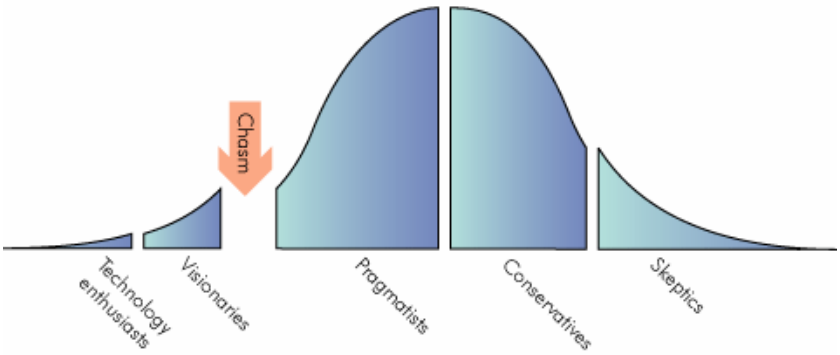


Figure 5 - The Technology Adoption Life Cycle according to Moore.
(Wikipedia, 2005, "Crossing the Chasm")

In order to cross the chasm, the promoter of the technology should focus on one group of customers at a time, using each group as a base for marketing to the next group (Moore, 1999). The first group includes the technology enthusiasts (innovators or "gatekeepers"). This group opens the door for the next group, the visionaries, by providing a sense of assurance that the innovation has met their expectations – that the product has potential and is unique. The visionaries adopt the technology and accept the fact that the innovation may only be 80%

complete. They look to gain an edge over competitors and are willing to fund experimental trials in adopting these innovations. The Chasm occurs after this group due to the nature of the pragmatists. These individuals want a full solution to their problems provided by a well-established and reputable business. They rely on the opinions of each other and will only invest in a new technology when the rest of the population surges toward it. In order to market to this group, a "Bowling Alley" strategy is required. The marketer must focus on specific target "pins," which consists of niche groups that must be "knocked down," meaning they have adopted the technology. Yet, in order to obtain the support of the first "pin," a "beachhead" is needed for the point of attack. The "beachhead" is a total solution that meets all of the needs of a niche group. Moore used the term "beachhead" to describe what is required to knock-down the first "pin" – as part of a metaphor relating to the D-Day attack by the Allies in World War II. Eventually, as more pins are taken down, the market expands and the product is eventually seen as an all-purpose solution and is therefore a viable option for adoption by the whole pragmatist group. (Moore, 1999)

2.5. The Global Perspective Program

At the outset of this project, the project sponsor indicated a niche where Access Grid technology could possibly be effectively implemented into the WPI community. This niche, WPI's Global Perspective Program, required investigation into the unique communication needs of the projects and individuals involved. WPI's Interdisciplinary and Global Studies Division (IGSD) is the organization that supports off-campus projects. The IGSD oversees a large number of off-campus projects every year. Off-campus sites include numerous locations in the United States, Latin America, Europe, Asia, and Africa. (A full list of project site locations and academic terms[12] in which they are conducted is located in Appendix K). Students travel to these sites to complete one of the projects that are central to a WPI education: the Sufficiency, IQP, or MQP.[13] The program began in 1974, and as the years progressed the level of student participation has dramatically increased. Recently, over 50% of WPI graduates have participated in off-campus projects, as can be seen in Figure 6 and Figure 7.

[12] A **term** refers to a seven week period of coursework. WPI has five terms (A, B, C, D, E) starting at the end of summer and running through the year until the middle of the following of summer.

[13] Each project is designed to achieve a specific goal. The **Sufficiency** strives to promote appreciation and understanding of the humanities and arts for students receiving a primarily technical education. The **Interactive Qualifying Project (IQP)** allows students in teams to tackle an issue that relates science and technology to society. Finally, the **Major Qualifying Project (MQP)** provides a "capstone" experience, where students apply what they have learned in their major field of study to define a problem and develop a novel and creative solution for that problem.

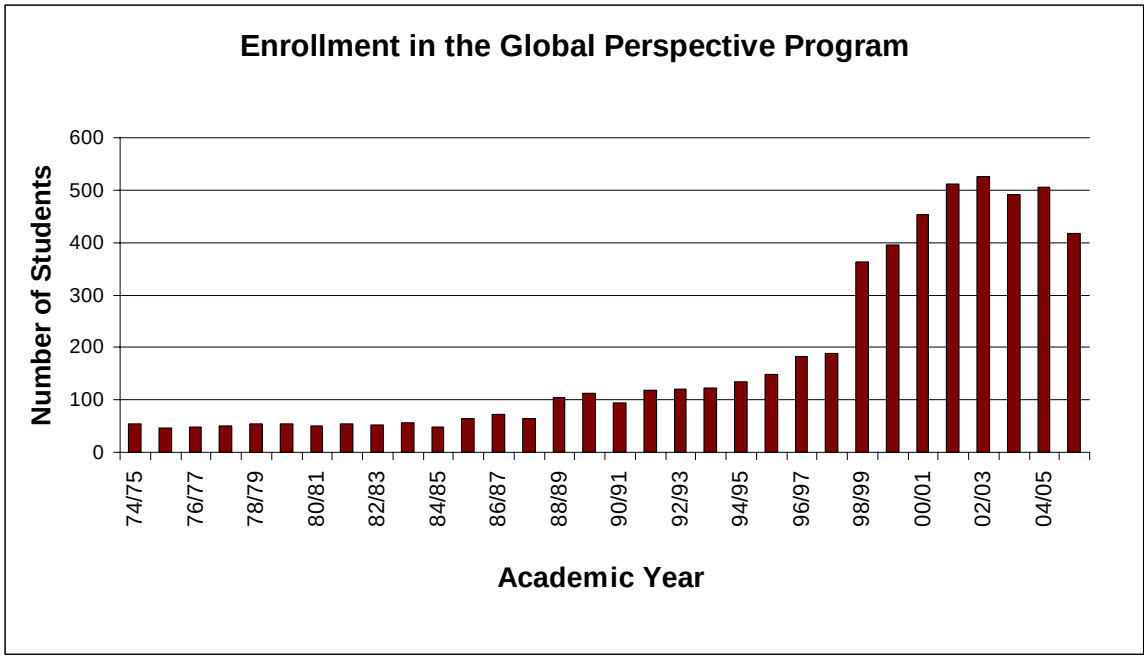


Figure 6 - Enrollment numbers for the Global Perspective Program since its inception. (WPI IGSD, Courtesy of Natalie Mello)

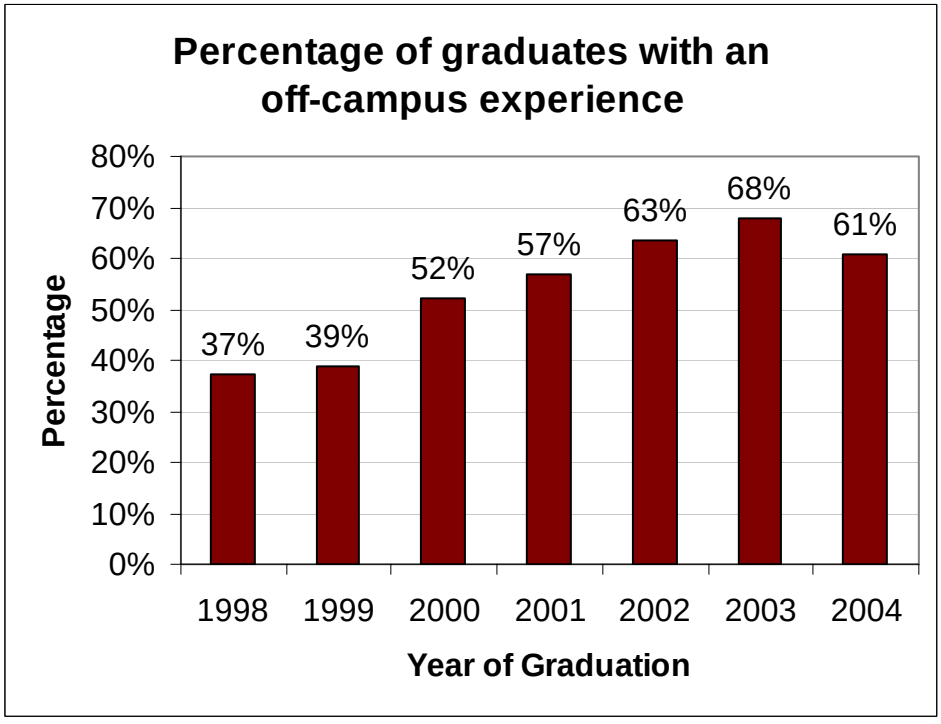


Figure 7 - Percentage of WPI graduates who have experienced off-campus project work in the Global Perspective Program (1998 - 2004). (WPI IGSD, Courtesy of Natalie Mello)

The mission of the Global Perspective Program is to help students "come to understand and appreciate other cultures and to see – firsthand – how their lives and work will play out on a

global stage" ("WPI Global Perspective Program", 2004). This experience gives students a unique opportunity to study abroad for a seven week period and employ their skills and efforts toward a problem that benefits others on a larger scale than they have ever experienced before. They are required to work intimately with others using a variety of communication technologies to facilitate their specific project communication needs. At the end of each project, students present their findings in a final project report and presentation that represents the capstone of the experience.

A number of individuals work together closely to ensure the success of the program. WPI professors take on the roles of both project site directors and project advisors. WPI endeavors to secure project sites for students and project sponsors to provide the project topics. Therefore, it is the responsibility of a project site director to set up appropriate projects through contact with sponsors, secure safe housing for students and faculty on-site, and generally coordinate WPI's efforts to send students to a particular site. The director also works with project advisors orienting them to the project site and introducing them to project sponsors. Site directors are usually involved in only one or two project sites, and remain dedicated to those sites for a number of years.

Project advisors have a somewhat different role. The advisors' responsibility is to ensure the success of their advisees' projects in a particular term. Further, advisors serve as an extension of the WPI campus while students are off-site; they act as counselors to troubled students, health services to sick individuals, and judicial officers in the event of misbehavior. Advisors typically reside locally with the students and provide guidance and support to the students although in some cases during smaller MQPs, advisors are unable to remain on-site with their advisees. Also, advisors are encouraged to travel to a variety of sites, and are allowed to apply to different project sites from year to year.

Project sponsors are typically external to the WPI community, and are usually associated with an organization or group that has a specific problem they wish the students to address. Students need to communicate with sponsors before they go abroad, and they need to get in touch with resource persons while away. During the project, students have nearly unlimited access to their sponsors, but while students are completing a pre-project period (PQP), in which they write a project proposal prior to departing for the project site, they have to rely on remote communication methods to contact their sponsor. Traditionally, this communication is accomplished via conference phone calls, email, and fax. While effective, some of these methods can be costly and frustrating. To organize conference calls, students currently have to arrange time to use a single "project phone" shared among a large amount of project groups. They also need to schedule a conferencing time that is convenient for their sponsor, taking time zone issues into account. Email is also effective, but can take a long time to receive a response due to its

asynchronous[14] nature and sometimes requires numerous back and forth communications to clarify an issue. Similarly, faxes can easily be lost or misplaced, are asynchronous, require access to a fax machine, and are a slower form of communication.

Additional communication needs can arise during off-campus projects. While project advisors act as counselors to students who need advice, many times students or advisors will seek the help of counseling staff at WPI for extra support. Also, if a student at an off-campus project site requires disciplinary action, the site advisors are empowered as WPI judicial officers and will hold an informal hearing to assess the issue and determine a punishment. Again, traditional forms of communication have been employed thus far, and these informal hearings are usually backed by communication with WPI officials via telephone or email. While the projects completed at all off-campus sites differ in nature, a common theme remains: the need to communicate with individuals and groups located at distant locations, whether on-campus at WPI or at other project sites.

[14] **Asynchronous**: referring to the time-delayed, back-and-forth nature of the communication.

3. Methodology

The goal of this project was to objectively assess practical and effective uses of the Access Grid in the Global Perspective Program at WPI. The methodology employed to investigate the uses of the Access Grid consisted of several steps. Based upon background research, we generated a list of possible communication scenarios where the Access Grid might be useful in the Global Perspective Program. Next, we developed a plan to educate key groups about the Access Grid using various techniques. These groups included project site directors and advisors, students, and project sponsors. Once educated, these groups could make more informed decisions about the value of the Access Grid. We contacted individuals within the key groups to gain more information on the perceived benefits and effectiveness of the possible communication scenarios through the use of surveys, interviews, and a focus group. These key groups were used as a means to determine the validity of the scenarios we had generated as well as to suggest ideas for further examination. They were chosen based on their experience with the Global Perspective Program and the reality that these individuals have a vested interest in communications impacting the projects program. We also verified the feasibility of the various scenarios by conducting "pilot tests" over the Access Grid during which we held and facilitated meetings of the type that we were investigating. Finally, we created an Access Grid guidebook that serves as a means for potential users to determine not only whether they should use the Access Grid but also how to do so.

3.1. Research Questions

Prior to data collection, we established what information our methods would gather. By performing a literature review and conducting several interviews, we generated a list of questions pertaining to a variety of topics that were important to the success of the project. Thus, the goal of our methodology would be to find appropriate answers to this set of questions:

1. What are the communications needs for remote project sites regarding the various projects in the Global Perspective Program, and for which types of projects is remote communication necessary or beneficial? What technologies are currently being used to satisfy these needs?
2. How many possible applications in the Global Perspective Program exist for the Access Grid? Would the Access Grid offer a significant benefit? Is its use feasible in each of these situations?
3. Would using the inSORS software for personal node use be superior to Access Grid? Would the required investment be worth these benefits?
4. What is the effectiveness of communication over the Access Grid for people with communication disabilities, and could the Access Grid improve communication?

5. What should new users (especially in the WPI community and those who interact with them) know before they attempt to use the Access Grid?
6. Are there issues with equipment compatibility, firewalls, connection strength/stability, bandwidth limitations for meetings between WPI and the global sites?

We conducted surveys and interviews to establish a basic understanding of communication needs in the Global Perspective Program. Furthermore, by analyzing documentation on the Access Grid, and contacting professionals in the videoconferencing field, we gained an understanding of how the Access Grid could fulfill these needs.

3.2. Idea Generation

In order to pursue the project goal, we needed to consider where the Access Grid could be applied successfully in the Global Perspective Program. Based upon our background research on the Access Grid's capabilities and limitations, and correspondence with various participants in the Global Perspective Program, such as site directors and advisors, we generated a list of ideas for possible uses. The following list identifies the ideas that were generated from this process. One of the main aspects of our methodology was to investigate each of these ideas to determine if they were beneficial and feasible.

1. **Sponsor meetings with students**
   During the PQP phase of projects, students need to be in contact with their sponsor(s) to agree on project goals. This communication can be difficult while the students are at WPI and the sponsors are at remote sites. It was proposed that the Access Grid could be used to facilitate meetings that are more effective than telephone or email conversations.

2. **Faculty meetings with graduate students**
   Many site directors and advisors have graduate students in their tutelage back at WPI. We conducted investigation into the feasibility of conducting faculty meetings with their students while away at a global site. A professor could communicate with these students via the Access Grid to have effective discussions of scientific/engineering work.

3. **Meeting with MQP students and Advisors**
   At many global MQP sites, project advisors are not present for the duration of the term. This separation can occur when the amount of students at the site is too small to warrant sending a faculty member to work with them full time. However, the advisors are still responsible for monitoring the students' progress and for grading the students. The Access Grid may have potential for facilitating communication during the period of time when the advisors are away from their students.

4. **Final project presentations**
   Many people at WPI have an interest in projects that are being completed at remote sites: project directors, students and advisors that are or will be attending that site, as well as other interested individuals in the community. By allowing final project presentations (normally presented to an audience on-site) to be broadcast over the Access Grid, people at WPI are given the chance to view the outcomes of the projects.

5. **Meetings with future project students**
   It could be beneficial to have students at a global site meet students over the Access Grid who will be traveling to that site the next year. Students could share information about the site, projects, living conditions, etc. This usage could be combined with project presentations over the Access Grid.

6. **Consecutive term projects**
   On occasion there exist global projects that are continuations of another, taking place in consecutive terms. This situation typically occurs at the London project center which hosts projects during multiple terms. By having regular meetings over the Access Grid, two project groups could work together more effectively and keep project goals consistent.

7. **Judiciary hearings with on-campus WPI faculty**
   In the event of an allegation involving a student at an off-campus project site requiring an impromptu judiciary hearing, the student “shall be accorded an informal on-site hearing before a WPI representative designated by the dean of Interdisciplinary and Global Studies Division” (XIII. Constitution of the WPI Campus Judicial System, Article VII). This process requires the WPI representative to communicate with the Dean of Interdisciplinary and Global Studies Division, the Dean of Students, and the Student Life Office. It also differs from the process experienced by a student on campus whereby he or she would receive a hearing in front of the Campus Hearing Board. It could be possible to hold these hearings over the Access Grid in order to include people back at WPI for a more comprehensive and just hearing.

8. **Team Consulting/Counseling Meetings**
   When student groups are abroad doing project work it is possible that problems could arise within the group. By meeting with a professional counselor back at WPI, these groups could potentially be benefited. The Access Grid could be a good means for this, since it would be a group communication.

These ideas were investigated using two major techniques: correspondence with stakeholders in the Global Perspective Program and "pilot testing" usage scenarios. For each idea we investigated, we contacted appropriate stakeholders in the Global Perspective Program to obtain their views on uses of the technology. We sought their opinions on whether the Access Grid had significant benefits to these communication scenarios and whether they would outweigh the costs associated in using this technology. These costs[15] were typically in the form of time and effort. Using these two methods of investigation, we drew our conclusions on which uses of the Access Grid in the Global Perspective Program were feasible and which were not.

3.3. Assessment of Communication Needs and Access Grid Potential

The actual participants in the Global Perspective Program represent the population most familiar with the needs and practices of the program. It was important to gain their opinions on Access Grid use within the program, but first they had to be introduced to the technology. Once indoctrinated, we then questioned the participants for their feedback on this technology in relation to the program.

3.3.1. Educating Stakeholders about the Access Grid

In order to obtain information from individuals regarding how they envision the implementation of the Access Grid in the Global Perspective Program, they needed to be provided with a basic understanding of the Access Grid. We utilized various techniques in order to accomplish this goal. While it was possible to involve some people in Access Grid meetings to demonstrate the technology, for others it was necessary to find alternate means. Thus, we created a brochure and a PowerPoint presentation illustrating the functionality of the Access Grid that could be shown to users who could not experience an Access Grid session firsthand.

Our first objective was to create a web-based educational brochure that would serve as an introduction to the Access Grid for new users. Most of the information that we conveyed through this document was intended for WPI off-campus project advisors, directors, students, and sponsors. Our goal was to author a document that showed them specifically what the Access Grid has to offer them. Through the brochure, our intent was to provide these groups with pertinent, fundamental information pertaining to the Access Grid by:

1. Generally explaining the Access Grid, its features, and its capabilities,

[15] There is little concern for financial costs when using the Access Grid due to the fact that the software is freely available, there is already an Access Grid room node at WPI, and equipment to set up PIG nodes is available to borrow by the ATC. The bandwidth consumed by the Access Grid could be a financial concern if one is paying by the amount transferred, however most providers charge a flat rate.

2. Listing potential benefits to be found for both students and faculty from their participation in the Access Grid,
3. Generating a list of basic equipment and connectivity requirements.

This brief brochure was intended to effectively communicate our information and allowed our audience to access it from anywhere with internet access and can be found in Appendix A.

Another important feature in our educational strategy was the creation of a PowerPoint presentation that would be employed to inform potential users of the Access Grid in more formal meetings. This presentation, located in Appendix E, contained pertinent information similar to that present in the brochure, and reused much of the brochure content. Also, the key groups we targeted were project directors and sponsors. Although these were the groups to which we intended to present this information, we also recognized that this presentation could easily be used in future occasions by our sponsor or others in the Access Grid community (with minimal adjustment). This presentation focused more on an in-depth explanation of the benefits associated with Access Grid and its uses in global projects as well as the capabilities that allow this technology to provide enhancements to the current state of communication. This presentation was then used to create a transition into discussions on further implementations of the Access Grid.

3.3.2. Gathering Feedback from Stakeholders

In order to determine the feasibility of the ideas for the use of the Access Grid in the Global Perspective Program, all types of participants were contacted: site directors, project advisors, project sponsors, and students. From these groups, we sought insights into how they thought the Access Grid could affect communication in the program. Information from these people was obtained using various means: a focus group, surveys, and interviews.

Information from Site Directors

A focus group was held to obtain the opinions of project site directors. We invited all of the project site directors, along with the high-level staff in the Global Perspective Program including the Dean of the Interdisciplinary and Global Studies Division (who is also a site director). The actual focus group consisted of five site directors, a site advisor, Dr. Mullen and ourselves. At the beginning of the focus group, we presented our PowerPoint demonstration to educate the participants and to get them to think about how the Access Grid could be used at their project site(s). We then initiated a focus group discussion in which we proposed ideas of Access Grid use at remote sites and their feasibility. We initiated conversation with the following questions in mind:

1. What are the communication needs of the project sites and what communication technology is currently being used?

2. Would the Access Grid be useful at a particular site?
3. Are there any other scenarios where Access Grid use would benefit the Global Perspective Program?

The focus group was mediated with the help of Dr. Mullen. Since participants were located both at the Access Grid room node at WPI and at the VPAC Access Grid facility in Melbourne, the meeting itself demonstrated the group-to-group meeting capability of the Access Grid. Questions were posed to the group, and the discussion was guided towards relevant topics. Afterwards, the participants were asked to express their opinions about the meeting itself and if the Access Grid proved to be an effective tool using our Access Grid event assessment survey. In particular, we asked how participants rated the event overall, how the technology performed in relation to their expectations, and any comments (positive or negative) on the experience. The questions we asked, as well as some key correspondences with participants can be found in Appendix N.

For those site directors that were unable to attend the demonstration and focus group, the focus group questions were sent as an email survey, as shown in Appendix F. Surveys were sent out via individual emails. Questions that only applied to certain people (for example, the London and MQP questions) were omitted from the other individual surveys. Also, this email contained a link to the web-based brochure to give the site directors a basic idea of the Access Grid and its capabilities.

Information from Project Advisors

Project advisors are also key participants in the Global Perspective Program. They work closely with students during the projects and thus have a unique perspective on the frustrations that students face during the course of their projects. We contacted all of the project advisors from the past year (22 advisors total) in order to obtain their views on the Access Grid. We sent an email survey to these advisors and asked them about the current communication needs at their project site and how these are met, any obstacles they must overcome in regards to communication, and their opinions on how these processes could be improved. See Appendix G for the project advisor survey questions.

Information from Project Students

Students were another important group to contact regarding Access Grid use during global projects. They complete the projects and are the stakeholders who would most directly benefit from improvements to the program. We focused on students who completed an IQP or MQP in the past year, as well as the IQP groups located in Melbourne with us. We obtained the contact information for all of these students and asked them to fill out a survey. Our primary objective with this survey was to determine if students involved in off-campus projects felt there was a lack of communication during the project process. Also, we sought student opinions on the

Access Grid and how it could fill potential gaps in the communication needs. Finally, an open-ended response section allowed students to suggest ways to improve the current state of communication. The survey questions are located in Appendix H.

Unlike the previous two surveys, the student survey was conducted via an automated webpage. This method was chosen because it would allow us to better handle the large amount of data we expected (the survey was distributed to approximately 500 students). Also, WPI students tend to be disinclined to complete long surveys, and our online survey took very little time to complete.

Information from Project Sponsors

A significant group of participants in the Global Perspective Program are the project sponsors. While participants in the other information gathering methods were involved in a variety of WPI's global sites, our efforts focused on the sponsors at the Melbourne project site. We determined that limiting the scope of our contact to these project sponsors was appropriate. First, we concluded that we could not effectively communicate the possibilities of the Access Grid's use to sponsors scattered about the globe by using email or telephone. Second, in total there are a large number of project sponsors – more than we would be able to contact due to the time constraints of this project.

We traveled to five of the eight sponsors' facilities and showed them the Access Grid PowerPoint presentation that we developed. After each sponsor observed the presentation, we conducted an interview with a series of questions to determine their level of interest and obtain information that informed us of communication technologies and techniques they employ. The interview questions, located in Appendix I, solicited information about their current communication methods and satisfaction with these methods, amount of contact with their WPI project students prior to arrival on-site, and their opinions of how these processes could be improved.

3.4. Pilot Tests

During the course of the project, we conducted several pilot tests to assess the Access Grid's use in various situations. One method used to determine the effectiveness of each meeting was a participant survey, located in Appendix J. Also, based upon our observations (such as notes made about meeting duration, participant behaviors, technical issues, and meeting atmosphere) as well as participant opinions on each scenario, we determined whether or not certain Access Grid uses were feasible. We used pilot testing to investigate the Access Grid's use by the hearing impaired, and we also compared the effectiveness of using the inSORS software to Access Grid PIG nodes.

3.4.1. Sponsor Meetings

As our sponsor was located at WPI while we completed our project in Australia, it was necessary for us to correspond with her using remote access technology such as email, phone calls, and especially the Access Grid. To achieve a healthy level of communication with our sponsor, we met with her at least once a week, and many times two or three times each week. These Access Grid meetings allowed us to experience both formal and informal situations while using the technology. Since our sponsor was very comfortable with Access Grid use, we were able to try out the various features of the Access Grid and learn about their capabilities. We set up meetings with her using a room node, PIG node, and various combinations of each (e.g., PIG node from Australia to room node at WPI and vice versa). In addition to our standard Access Grid event evaluation techniques, at the end each meeting, we discussed its effectiveness with our sponsor and how the Access Grid could be used in similar meetings in the future.

3.4.2. Faculty Meeting with Graduate Students

A major issue faculty face when going abroad is disconnection from their research staff and graduate students. One of the advisors at the Melbourne project site faced such a dilemma. We arranged a meeting between the faculty member in Melbourne and his research students back at WPI. We facilitated the setup of the meeting, but allowed the participants to conduct their meeting. The event included technical discussion, so a video camera was aimed at a standard whiteboard so that the participants could share visual ideas. At the end of the event, we asked each participant to fill out a brief survey of the experience. Our data collection goals were simple, and we measured the effectiveness of the meeting, the utility of the Access Grid for their specific purpose, and the participants' reactions to the Access Grid in general.

3.4.3. Meeting Between Off-site Advisor and Project Students

We also facilitated a meeting between an IQP project advisor and his students. The advisor was in Australia using the Access Grid room node at VPAC while the students were back at the WPI facility. This meeting was held during the PQP phase of the students' project. The topic of the meeting concerned progress on the students' work that term. The setting of the meeting was fairly informal and was organized as an unstructured discussion. There were several aspects of this meeting which were of interest to us. We administered the Access Grid Participant Survey, located in Appendix J, to the individuals at the meeting to determine the perceived effectiveness of the meeting to those involved. We also asked for comments regarding the apparent worth of the meeting considering meeting time, content and information relayed during the meeting, and impressions of the technology.

3.4.4. Final Project Presentations

Another test we conducted was the presentation of final project findings for a selection of the project groups in Melbourne. Due to time constraints, we were unable to arrange for the actual final presentations to take place via the Access Grid. Therefore, we arranged for students to deliver practice presentations. A number of the groups were asked to present their project presentation over the Access Grid. In Worcester, the students who had recently been selected to attend the Melbourne project site next year were invited to our presentations, as well as various faculty and staff. Each group in Melbourne presented their practice presentation, using the distributed PowerPoint feature of the Access Grid. Once each group was finished, we acted as moderators, and allowed the audience at each location to ask questions of the students and make comments on the presentations. Finally, at end of the event we opened the floor to the prospective students in Worcester to ask general questions about the Melbourne experience.

3.4.5. Meeting with the Hearing Impaired

An important consideration during remote projects is that students need to be provided with a supportive environment and any aid necessary towards reaching project goals. In some cases, students with disabilities may find it difficult to communicate using the standard technologies currently being employed. Therefore, we sought to determine the feasibility of Access Grid use for an individual with hearing impairments. We arranged for a hearing impaired student at WPI to meet with us over the Access Grid. By adjusting factors such as lighting, camera angle and zoom level, and video screen size, we were able to test the most effective settings for a hearing impaired person while using the Access Grid. While many hearing impaired individuals use sign language to communicate, our subject was adept at lip reading, and thus we attempted to test “typical” communication scenarios that students would encounter during a project. Using a list of randomly generated sentences, we read phrases to our subject, and then had the student repeat them to determine how well the student understood us. Then, we changed settings, such as zoom level, and repeated the test with a different set of sentences to determine which settings produced the best results. Furthermore, we had the subject use a PIG node and repeated the same tests.

Also, we interviewed our subject to obtain the subject’s opinions on Access Grid use and its effectiveness as a communication tool. Specifically, we asked our subject to rank the Access Grid amongst current communications tools, how willing the participant would be to use it in the future, and if the participant felt it provided any benefit to individuals with hearing impairments.

3.4.6. Effectiveness of inSORS vs. Access Grid for Personal Node Use

The Access Grid is software designed for its developers, researchers, and others who are generally technically inclined. These audiences also are usually situated at universities and other institutions with a large amount of bandwidth. One must not assume that participants in the Global Perspective Program have significant technical knowledge or sufficient bandwidth. The inSORS software, as outlined in the background research, claims to be superior to the Access Grid in these areas. inSORS also claims to be more effective than the Access Grid at operating through firewalls. We ran a series of tests in order to see if our results coincided with these claims.

Test of inSORS vs. Access Grid Bandwidth Usage

We tested the software to verify the claim that inSORS reduces bandwidth usage. We tested the software in both situations that could occur in the Global Perspective Program: inSORS node to inSORS node, and inSORS node to Access Grid node. We tested the bandwidth usage of an inSORS personal node and compared it to that of an Access Grid PIG node.

Test of inSORS vs. Access Grid User-Friendliness

We also conducted a test in which we had two professors who were unfamiliar with the use of this type of technology attempt to connect to the Access Grid using inSORS. We then asked the subjects if they found software easy to use and whether they would feel comfortable using it by themselves at a remote site, and why they felt this way.

Test of inSORS vs. Access Grid Firewall Performance and Ease of Installation

A professor at the Melbourne project site had previously attempted to set up a personal Access Grid node at his place of work; however, he was frustrated by failure due to firewall issues. We used this opportunity to test whether or not inSORS would be able to succeed where the Access Grid failed by having this professor attempt to connect from the same place using inSORS. This professor also was in a position to testify as to the difficulty of installing these two software packages. While these tests are not comprehensive in nature, they serve their purpose as indicators as to whether inSORS product performance claims are substantial, and also whether inSORS is a more appropriate software choice for the use of personal nodes at remote project sites.

3.5. Analysis of Feasibility

We tested as many applications of the Access Grid as possible given the time constraints of our project and the availability of individuals in the key groups. Ideas that we were unable to test required further discussion with those groups who would have been involved in the situation

defined by the specific application. Many of these ideas were discussed in the site director focus group. The site director input has high bearing on whether the Access Grid would be used at their specific site. Other ideas required us to seek out other WPI faculty and/or staff for further information.

Our analysis of the data uses a variety of analytical techniques. Much of our data is qualitative in nature, having resulted from discussions and open-ended interview and survey questions. As such, a careful review of all data allowed us to draw conclusions by finding common themes among our results. Also, each communication scenario is considered in light of all data collected, not by the information gathered in that particular test or investigation. Our results also contain a significant amount of quantitative data, especially some of the results from the student surveys and background research. These data can be represented in aggregated forms, such as graphs and tables, which can more succinctly present our findings.

3.6. Access Grid Guidebook

After our data collection, the results were compiled into findings and recommendations, and are also be channeled into an educational guidebook that will serve as an aid to new users of the Access Grid. This guide is organized in such a manner as to be simple, effective and easy to understand. A word document and a PDF version of the document serve as the medium for this guide. It has been laid out to be printer-friendly and lends itself well to an “off-line” version.

The information in the guidebook is based upon our background research, existing Access Grid documentation, the input of regular Access Grid users, as well as our own experience and the information gained through the evaluation of each of our Access Grid application ideas. The guide is intended for a non-technical audience and addresses the need for a simple, effective introduction to the Access Grid. This guidebook is an additional deliverable attached to our report, located in Appendix Q. Also, the guidebook addresses a gap in the current documentation of the Access Grid. Specifically, there is little existing Access Grid documentation aimed at inexperienced users, and our guidebook seeks to bridge the gap between the extremely rudimentary documentation and the high level technical documentation.

4. Results and Analysis

By following the steps described in the methodology, information was obtained from the stakeholders in the Global Perspective Program and other data pertaining to technical aspects of Access Grid technology. This information, coupled with the team's personal experiences using the Access Grid in a variety of communication scenarios, was used to analyze the practicality of using the Access Grid in the Global Perspective Program. In this chapter, the general findings that impact the Access Grid's use in the Global Perspective Program are discussed and a step-by-step process is suggested to aid these key groups in determining the communication scenarios in which the Access Grid should be employed. Also, we discuss and analyze the results of each usage scenario pertaining to Access Grid use in the Global Perspective Program.

4.1. Understanding the Practicality of an Access Grid Meeting

Throughout the course of the investigation, information was gathered regarding the practicality of using the Access Grid in general. This information was sorted into four topics, each covering different considerations for participants. These topics are as follows:

1. The availability of a connection to the Access Grid
2. Overcoming bandwidth and firewall issues
3. A comparison of the benefits and costs of both the Access Grid and inSORS
4. Implications of videoconferencing applications for hearing impaired individuals

Each of these topics is relevant to the practicality of employing the Access Grid in various usage scenarios that exist within the Global Perspective Program. This practicality is based on the restrictions that exist for all Access Grid meetings.

4.1.1. Availability of an Access Grid Connection

When deciding whether Access Grid use at a remote project site is practical, the first consideration is the availability of an established Access Grid connection. Individuals who wish to set up an event or meeting must determine if an Access Grid room node exists that is in close proximity to the remote project site. The reason that a room node is suggested as the initial choice, as opposed to a personal node, is that the presence of trained technicians, or node operators, allows participants to focus on the meeting content instead of dealing with any troubleshooting issues that may arise. Most participants that were questioned throughout the course of this project indicated that the use of a room node was preferable to a personal node for this reason. A drawback of room nodes is that, depending on the organization that owns the node, there may be a fee associated with node use. The room node at WPI is free to use by WPI faculty, staff, and students for academic purposes, but this may not be typical of other organizations. A list of project sites that have Access Grid room nodes located within fifty miles

of the sites has been compiled, as shown in Table 2. At the time this report was written, the following sites did not have a nearby Access Grid room node: Budapest, Hungary; Wall Street, New York; Limerick, Ireland; Nancy, France; NASA Glenn Research Center; Copenhagen, Denmark; Venice, Italy; San Jose, Costa Rica; and Windhoek, Namibia.

Any of the room nodes in Table 2 could be used for meetings; however, the operators of those nodes must first be contacted in order to determine the availability of the facility and the potential existence of usage fees. These locations were obtained by comparing project locations gathered from the IGSD, shown in Appendix K, and the current Access Grid room node locations listed on the Access Grid website "Global AG Communities," <http://www.accessgrid.org/community/index.html>. These listings contain all major Access Grid room node locations around the world. Contact information for the Access Grid room nodes is also available at this website.

Table 2 - Project Sites and Nearest Room Nodes

Project Site	Nearest Node (within 50 mi)	City	Distance
E&J Gallo Wineries Modesto, CA	Sandia National Laboratories	Berkeley, CA	50 mi
Silicon Valley, CA	Sandia National Laboratories	Berkeley, CA	30 mi
Bangkok, Thailand	Kasetsart University (CPE)	Bangkok, Thailand	In City
	King Mongkut's Institute of Technology North Bangkok	Bangkok, Thailand	In City
Boston, MA	Boston University SCV	Boston, MA	In City
Hong Kong, PRC	E-Business Technology Institute, The University of Hong Kong	Hong Kong, PRC	In City
London, England	Centre for Computational Science, University College London	London, England	In City
	London e-Science Centre, Imperial College	London, England	In City
	United Kingdom Department of Trade and Industry	London, England	In City
	University College London	London, England	In City
	Wimbledon School of Art	London, England	In City
Melbourne, Australia	Victorian Partnership for Advanced Computing	Melbourne, Australia	In City
San Juan, Puerto Rico	University of Puerto Rico - High Performance Computing Facility	San Juan, Puerto Rico	In City
Washington, DC	University of Maryland	College Park, MD	9 mi

An alternative means of communicating via the Access Grid is through the use of a PIG node. In order to run a meeting using a PIG node, specific equipment requirements must be met. Participants must gain access to a computer, headset, and webcam, which for remote projects would not be difficult to obtain with minimal planning. Participants in remote projects are already provided access to a laptop for general project work, and according to the Assistant

Director of the Academic Technology Center[16] (ATC) at WPI, webcams could be distributed upon request. The only piece of equipment that could not be obtained from the ATC is headsets because these are considered "personal items" and are generally not transferred from one individual to another. Fortunately, the cost for a headset is relatively low (10-20 USD).

These items are the requirements for one person to use a single PIG for communication. In reality, it is feasible for several participants to use a single PIG with multiple headsets and a single camera, but this situation is not necessarily practical. We have tested this idea several times in meetings with our sponsor, and although communication during the meeting was successful, we found it difficult to fit three people within the small frame of the camera using an appropriate zoom level. In some cases, we had to use the computer's speakers for audio playback and to share a single headset's microphone for audio capture. This method was an awkward, yet viable, solution when multiple participants wish to join a meeting at a location where only the minimum required equipment is available.

Another issue to consider is differences in local times. These time differences associated with spanning multiple time zones can pose a significant barrier to communication. This obstacle must be taken into account regardless of the method of communication, be it telephone, videoconferencing, or another technology. Participants involved in global communications should be cognizant of limitations on interactions due to time zone differences. Meeting planners should be sensitive to the needs of others and attempt to schedule meetings at a reasonable time for all participants.

4.1.2. Technical Considerations for PIG nodes

If a PIG node is required, there are a number of technical details that must be addressed when considering use of the Access Grid. First, and foremost, bandwidth availability is extremely important. Issues can also arise when trying to connect to the Access Grid through a network that has a firewall implemented. Access Grid room nodes are built upon network infrastructures with enough bandwidth to support them and firewall issues are usually non-existent or resolved. When using a personal node however, the bandwidth available at the desired connection point might not be enough to support the communication. Therefore, the amount of bandwidth available at a desired site must be investigated to ensure a successful Access Grid connection. Also the cost of this connectivity must be considered. Further problems can stem from network firewalls; these issues can be difficult to remedy because they are often set up on networks over which the user has little control. Another issue unique to personal nodes is that it must be run by the user and therefore requires the user to be familiar with the software.

[16] The ATC works with the IT Division to deliver information technology services to the entire WPI community.

The actual amount of bandwidth used by the Access Grid can vary, largely due to the video compression used. On average, a single (upload or download) communication stream, including audio and video, uses a minimum of about 500 Kbps. Two-way videoconferencing is comprised of two (upload and download) streams, which therefore requires double the bandwidth. For example, a one-to-one communication would require at least 1 Mbps of bandwidth. Other data streams (shared PowerPoint, shared browsing, etc.) require extra bandwidth. However, these streams require far less bandwidth than the video/audio streams. A simple set of equations have been devised to aid in bandwidth estimations. Equations 1 and 2 provide the calculation of the maximum and average total bandwidth (upload and download) used at a given time in a meeting.

Equation 1 $MaximumBandwidth = 1\ \text{Mbps} * n$

Equation 2 $AverageBandwidth = 500\ \text{Kbps} * n$

where n is the number of streams (video/audio). The connection that is to be used must be capable of providing this amount of bandwidth (consistently).

In most cases, the location from which the Access Grid would be used has a pre-existing internet connection with a flat (usually monthly) cost. For this reason, running the Access Grid requires no additional cost, and although it is uncommon, some internet service providers charge by the amount of total data transferred (typically in cents per Megabyte) rather than a flat rate. For example, in Melbourne at our apartments, we paid 0.17 AUS per Megabyte downloaded. For these cases, the total session data transfer, and the associate costs can be estimated using Equations 3 and 4 respectively:

Equation 3 $DataTransfer = AverageBandwidth * SessionTime(s)$

Equation 4 $SessionCost = DataTransfer * CostPerKb$

This cost (if applicable) must be considered as one of the detriments of using the Access Grid, to be weighed against its potential benefits, when considering its use.

Network firewalls can also impose restrictions on the use of the Access Grid. Many organizations operate their local networks behind a firewall, which is intended to block nefarious internet activity but can also choke legitimate network traffic. In order to function properly the Access Grid needs to be able to initiate and use network connections (both incoming and outgoing) without restrictions. Firewalls can prevent this flow of network traffic, thus it must be determined if a firewall exists on the desired connection. A network administrator should be consulted to determine whether the Access Grid will work in these instances.

In the past, there have been instances where firewalls have interfered with potential communication over the Access Grid. In one example, the site director for the Melbourne IQP project site experienced continued failure in connecting to the Access Grid from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) in central Melbourne, which serves as his workplace and one of the project sponsor locations. MQP project sites, such as Silicon Valley and NASA/Goddard Space Center, have met the same barriers. Although each

of these sites meets the bandwidth requirements, site directors have been unsuccessful due to impassible firewalls.

Another limitation of using a PIG node is that the software must be run by the user. Our investigation has shown us that it would be quite problematic to conduct a meeting using the Access Grid without a basic knowledge of computers and a working knowledge of the Access Grid software. We reached this conclusion from our experience as new users of the Access Grid. Our project team consisted of individuals technically proficient with computers, yet we still required a fair amount of guidance from our sponsor when setting up and running the Access Grid at the start of the project.

The Access Grid is open-source software that is constantly undergoing development. The Access Grid is designed to be used by its developers and researchers, people who are vastly more experienced with both videoconferencing and computers than a general user at WPI. Due to the fact that the Access Grid is not a "turn-key" solution, users who are unfamiliar with the technology frequently experience significant difficulty when addressing issues that require troubleshooting. The lack of documentation intended for non-technical users available through the Access Grid Documentation Project is a contributing factor to this issue. In our interactions over the Access Grid throughout the fourteen week duration of this project, we have found that not only did we experience problems in connecting to the Access Grid (as fairly inexperienced users), but both our sponsor and liaison (very experienced users) found themselves in situations where they were unable to troubleshoot problems that arose. After experiencing these situations, we conclude that a student or faculty member who is unfamiliar with the technology would undoubtedly have difficulty trying to set up and use a personal node. Therefore, in order to ensure successful use of the Access Grid at WPI, adequate technical support needs to be made available, either in the form of simple documentation, email support, and live-phone or in-person troubleshooting aid.

In summary, we have discovered several potential limitations to using PIG nodes at global project sites: bandwidth, firewall issues, and technical knowledge of the user. As described in our background research however, there exists another software tool that claims to be an improvement on the Access Grid in these very areas.

4.1.3. Access Grid vs. inSORS

As discussed in the previous section, the Access Grid has some major limitations for use on personal nodes at remote sites. For this reason we also investigated the use of inSORS as a possible alternative for the Access Grid software in these situations. The inSORS software, as described in our background research chapter, is a commercial version of the Access Grid designed to have a more user-friendly interface. It allows the user to control the amount of bandwidth used and is designed to operate through most firewalls. The main disadvantage of

inSORS is the cost, as compared to the Access Grid, which is free software. We obtained a trial license of the inSORS software and used it to run a series of tests to determine if our observations supported these claims.

inSORS has a bandwidth limiting tool that can be used to set a maximum bandwidth limit to the outgoing video stream. Lowering the bandwidth usage causes the program to reduce the quality of the video to meet the specification. We tested this feature and found that the bandwidth could be reduced to as much as 100 Kbps before the video became unacceptable to us. The level of acceptable video quality is certainly a matter of opinion, however the test shows the degree to which bandwidth can be reduced compared to the average 500 Kbps for an Access Grid Stream. The bandwidth was reduced fivefold. Also, if the bandwidth is limited to a certain value, this enables the use of inSORS on connections with much lower bandwidth availability.

Our own experience with this software convinced us that inSORS was indeed easier both to install and to use. We sought a more objective opinion on this subject however, since we already were familiar with the operation of the Access Grid software. We had two WPI professors operate, but not attempt to install, this technology themselves. After, we asked them to provide us with their opinions on the ease of use of inSORS. We gave them some brief instructions on the software and then had the subjects enter a meeting themselves. They expressed that they thought inSORS was a relatively easy program to use with minor assistance, and that with some practice, they would feel comfortable taking it with them to a remote site and using it on their own.

A site director for the Melbourne project site recently attempted to set up a PIG at his place of work, CSIRO, in order to use the Access Grid. However, due to firewall issues, he was unable to establish a connection to the Access Grid. We tested inSORS in this situation to determine if it would have more success than the Access Grid. We guided the professor through the installation and use of inSORS over the telephone in order to carry out this test. The connection through the firewall proved successful, as established a link between his node and our own node at VPAC. The inSORS software worked simply and effectively. This evidence supports inSORS's claim that it is more effective at dealing with firewall issues than the Access Grid. The professor also stated that he found inSORS "trivial" to set up and use. He would be eager to use this software in the future although he would have to consider whether it was worth the financial investment.

4.1.4. Hearing Impaired Participants

For deaf or hard of hearing individuals, standard teleconferencing methods and other forms of verbal communication, which are currently available in the Global Perspective Program at WPI, are ineffective. Many hard of hearing individuals depend on some form of lip and gesture reading technique to help them understand what a speaking person is saying. For other

people, sign-language is a preferred method of communication. The visual component to the Access Grid could provide a medium for this type of communication over long distances. Slow frame rates and, at some times, a lack of synchronization between the video and audio feeds are currently the major issues that a hard of hearing individual might find discouraging. We investigated this matter to determine whether it was possible to accommodate the hearing impaired in Access Grid meetings.

We conducted a pilot test with a hearing impaired student as described in the Methodology chapter. The full results of this test are given in Appendix L. After a series of experiments, the student ultimately determined that the Access Grid was not a preferred method of communication for him. The student stated that with the camera sufficiently zoomed-in he could lip read well, without any problems due to frame rate or audio/video synchronization. The student was able to read lips and hear (using a hearing aid) reasonably well over the Access Grid. The experiment involved him communicating via a room node and a personal node, and he found the personal node to be clearer in terms of both video and audio. The closer screen and use of headphones associated with the PIG node aided in his understanding of verbal communication during the meeting. He said that communication was comparable to a face-to-face meeting and that face-to-face meetings in general are not an effective method of communication for him. Since the Access Grid's purpose is to come as close as possible to a face-to-face meeting, it seems that this technology could never meet this student's needs. The student's preferred method of remote communication is text messaging, as he feels it is the easiest medium to use. While there is an Access Grid captioning tool in development, it was not available at the time of our experiment. It is feasible that this student could use a combination of the Access Grid and text messaging; however, this type of communication may be better for one-on-one rather than group communication. Another note about this student is that he does not use sign language, so we were unable to test the degree to which sign language was successful over the Access Grid.

In contrast to the results of this test, discussion with John Paton, the chief executive officer of the Victorian Deaf Society in Melbourne, Australia in regards to the use of videoconferencing by the deaf and hearing impaired revealed the deaf community at large has positive feelings towards its use. He informed us that signing is the preferred method of communication in the deaf community. Sign language is widely used in the US via videoconferencing and has been found to be quite effective. He believes that adoption of the Access Grid by the deaf community could open up a big market. For the deaf, being able to see the person they are communicating with helps them feel less isolated, which is why Mr. Paton believes that the future of remote communication for the deaf community may very well lie in technologies such as the Access Grid.

Based upon the results of our investigation, we conclude that the Access Grid has significant potential to be used by the hearing impaired. Depending on the severity of the impairment different techniques may be in order. The constant development of the Access Grid

is promising for those with hearing impairments. High definition video, higher frame rates and even a captioning tool are in development. Based upon the specific abilities and needs of the hearing impaired person, the best method of communication over the Access Grid must be determined (signing, lip reading, etc.), since many hearing impaired conditions are unique.

4.2. Suggestions for a Videoconferencing Solution Based on Meeting Requirements

Based on our findings on the feasibility of using the Access Grid, we observed that there are many factors involved. When deciding whether or not the Access Grid is a logical communication solution to use, the decision making process may be difficult to understand for someone unfamiliar with videoconferencing technology. In order to aid participants in this decision, we have developed a "decision tree," shown in Figure 8, which guides the user through the restrictions and choices that contribute to the final determination of whether to use the Access Grid. Each section of the decision tree is discussed in detail, organized by the box numbers in the figure.

1. **Evaluating Potential Benefit:** First, the user should consider whether the features of the Access Grid offer a significant benefit gained by using the Access Grid over the current means of communication. Would there be a significant value added to having real-time audio/video communication in your meeting? Would traditional methods of communication be sufficient? Are there any other features of the Access Grid that could be advantageous, such as shared presentation, browser, image, and video? These questions should be considered before determining if the option of using the Access Grid should be explored.

2. **Node Type Preference:** The next decision the user should determine whether a room node or personal node is more desirable for the intended meeting. The user should weigh the benefits and costs of each against the other to determine which is desirable. Table 3 compares the features of room nodes to personal nodes to aid in this decision. The user making the decision should determine how much they value each of the advantages and disadvantages of each option and then decide which option is more desirable. Based upon this they should then examine the possibility they choose to determine if it is feasible by continuing to follow the decision tree. If still unsure which type of node is preferable, we recommend the user base their decision upon the number of participants at their site. We recommend that if the user has three users or less at their site, a personal node is advised. If more than three participants will be involved from a site, a room node is advised due to the number of cameras needed to capture all of the participants.

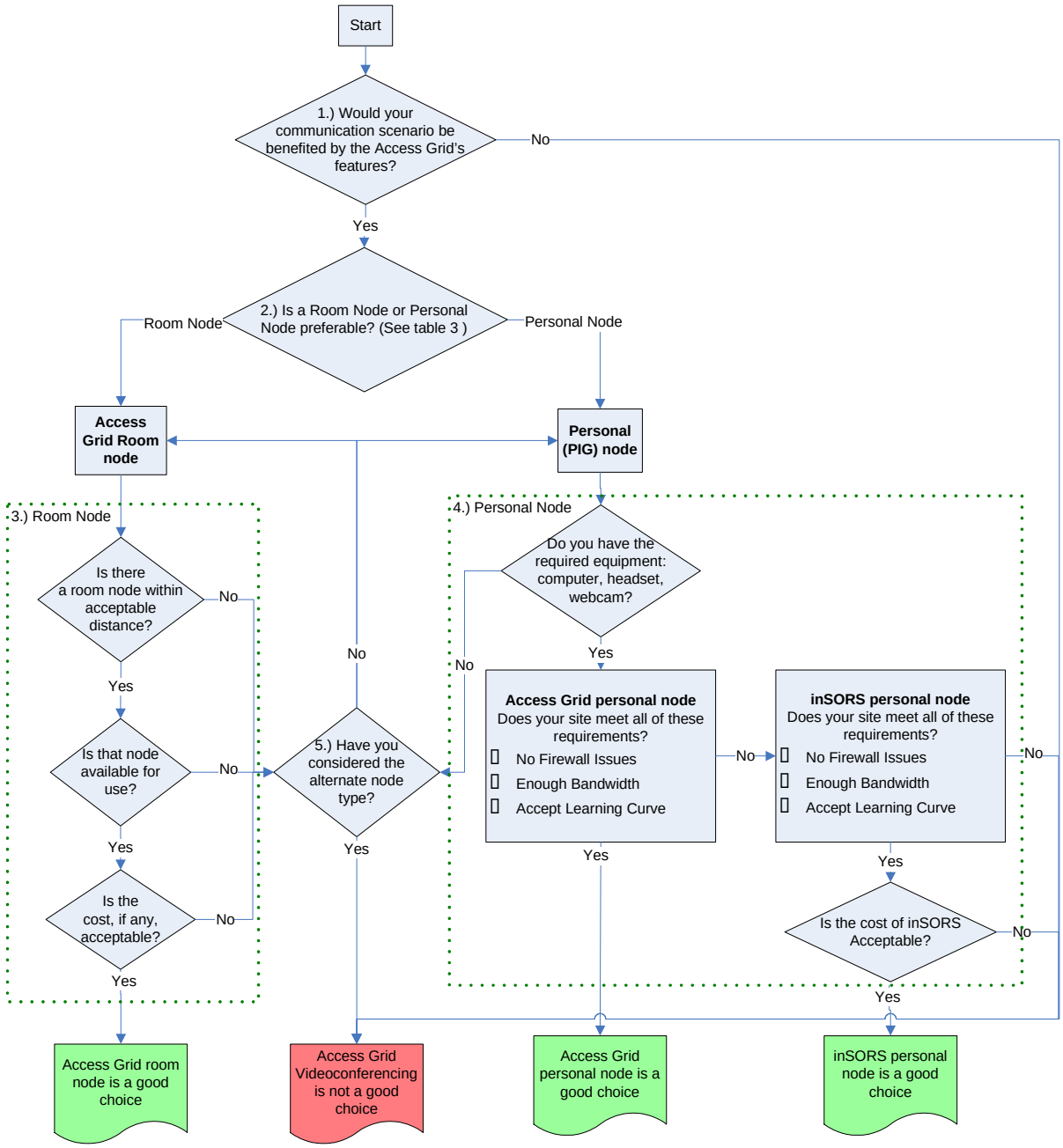


Figure 8 - Decision Tree
(See following explanation)

Table 3 - Room vs. PIG node

Node Type	Room	PIG
Meeting Size	Small to Large Groups	Individual to Small Groups
Equipment Cost	High	Low
Equipment Requirements	A room, multiple computers, video and audio capture equipment including echo canceller, larger displays or projector(s)	A personal computer, web camera, headset or omni-directional microphone with headphones
Bandwidth Requirements	Similar (minimum 256 Kbps/video stream, 64 Kbps/audio stream or text)	
Intended Operator	Experienced technician	Individual user
Number of Cameras at Local Site	Many	Usually 2 or Less
Display Size	Expandable	Limited
Advantages	Run by an experienced node operator. Many cameras and projectors. Can accommodate large groups at a site. At WPI one is located conveniently in Morgan Hall.	Can be set up anywhere with enough bandwidth. No need to schedule a room node.
Disadvantages	Not available in all locations, travel may be necessary. Needs to be scheduled.	Must be run by the user. Limited display size. Can only be used at locations with sufficient bandwidth. Best for meetings with a small number of participants.

3. **Room Node:** If examining the possibility of using an Access Grid room node, the user should determine if there is an Access Grid room within an acceptable travel distance. A list of room nodes nearby to each project site in the Global Perspective Program is in Table 2 (on p.39). A comprehensive list of Access Grid room nodes around the world is located at the following web address: <http://www.accessgrid.org/community/nodes/nodes.html>. If a room node is found within an acceptable travel distance, the staff at this node should be contacted to determine if it is available for use. This contact information

is also available at the link just mentioned. Since each room node is owned privately, the owner determines the terms for its use. Pricing policies vary from site to site. We recommend that project site directors conduct this investigation for Access Grid room nodes nearby their site and share this information with participants at their site whether it is a feasible option. If arrangements can be made, then the room node should be used as often as is warranted by the potential benefits of the meeting versus the costs (money, travel time, etc.)

4. **Personal Node:** When examining the possibility of using a personal Access Grid node, there are several issues one should address. One must be sure to have the necessary hardware: a computer, headset with microphone, and a webcam. Also necessary is an internet connection with sufficient bandwidth. The total bandwidth used is the sum the bandwidth used by each stream. The total bandwidth usage must be small enough for the connection to support it. This amount of bandwidth varies with each connection. Equation 1 aids in the calculation of the maximum bandwidth per second used at a given time in a meeting.

   Equation 1 $MaximumBandwidth = 1 \text{ Mbps} * NumberofStreams$

   where *n* is the number of streams (video or audio) and 1 Mbps is the bandwidth of each stream. One Access Grid stream (audio and video) can require up to 1 Mbps. Therefore a one-on-one conversation would require a maximum bandwidth of 1 Mbps. It must be investigated whether the internet connection to be used can handle this amount of bandwidth. This connection needs to be present at the desired meeting location. Network firewalls can also be an issue when attempting to connect with the Access Grid. A network administrator should be contacted to determine if a firewall is present and whether it can be adapted so that the Access Grid can operate through it. Also, since a personal node typically only uses one camera, personal nodes are less effective for large groups. Another issue to keep in mind is whether the participant operating the personal node feels comfortable using the software. This software may be difficult to use for users who are not quite proficient with computers, thus there is a considerable learning curve. The difficulties with the software must be considered when deciding whether or not to implement a personal node. Instructions educating users how to implement and use personal Access Grid nodes are contained in the Guidebook (located in Appendix Q). If it is decided that a personal node is desirable for use at a remote project site, then this decision should be made before leaving for the site to ensure one has the necessary equipment and that the node is fully functional before traveling.

   If an Access Grid Personal node is found to be unacceptable due to firewall issues, bandwidth, or the significant learning curve, then inSORS should be explored as an alternative. This software is has been shown to be superior to Access Grid in these

areas. It has been shown to work through most firewalls that Access Grid cannot. However, a network administrator should be contacted to determine whether inSORS will work on a desired network. The inSORS software also allows the user to adjust the bandwidth usage to as low as 100 Kbps (at the cost of video quality) to suit their bandwidth restrictions. This software is also designed to be more user friendly, and therefore the learning curve for this software is considerably easier than the Access Grid. While inSORS does have similar restrictions to the Access Grid (firewalls, bandwidth, learning curve) they are all significantly decreased, making inSORS the superior software for most situations. However, inSORS is commercial software, and its cost must be considered. The price of this software is approximately 2,400 USD for a single (one-camera) educational license. When bought in large quantities the price of licenses goes down; for example, ten academic licenses would cost approximately 800 USD per license.

5. If a determination is made that either a room or personal node is not acceptable, then the other alternative should be explored by returning to block 2 in the decision tree. From here, one should then follow the alternate path stemming from this box.

This decision tree will aid anyone trying to decide whether or not the Access Grid is a viable option for them. This tree and explanation is included in the Access Grid Guidebook and anyone who needs to make this decision can use that as a reference.

4.3. Analysis of Usage Scenarios

In order to determine whether each communication scenario we tested was practical, we analyzed the detriments and benefits of each. We first discuss the potential benefits of using the Access Grid in each communication scenario as compared to the current solutions. Next, we examine the detriments associated with using the Access Grid in each scenario and weigh them against these benefits. In our correspondence with participants of the Global Perspective Program, we presented these detriments and benefits and determined their opinions on whether the benefits outweighed the detriments. Our determinations are largely based on this correspondence. The practicality restrictions discussed throughout section 4.1 applies to all Access Grid meetings. Therefore, even if a usage scenario is deemed to be a beneficial idea – as determined in this section, the overall feasibility of the meeting is still subject to the practicality restrictions described previously.

In our conclusions, each scenario is assigned an overall rating based on the benefits afforded and the practicality of the meeting based on difficulty of setup and or willingness of key groups to participate in the meeting. Benefits are rated using “BENEFICIAL,” “SOMEWHAT BENEFICIAL,” and “NOT BENEFICIAL.” Practicality is rated in the same manner, using “PRACTICAL,” “SOMEWHAT PRACTICAL,” and “NOT PRACTICAL.” These “beneficial”

and "practicality" ratings are based on the aggregation of all available data and represent the overall opinions of the key stakeholders. All of these scenarios are subject to restrictions of Access Grid availability at each site.

4.3.1. Sponsor Meetings during PQP

One possible usage scenario for the use of the Access Grid in the Global Perspective Program that we investigated was student meetings with project sponsors in the pre-project, proposal-writing phase. This idea exhibited potential because it could enable students a means to contact their sponsors with a potentially more effective tool than email or the telephone, since the Access Grid provides for real-time video as well as audio communication. Our survey of all of the students who had completed a global project in the past year yielded 107 responses, about 20% of the total survey pool. All students used email to contact their sponsors during PQP, 63% used the telephone, and much smaller percentages used other techniques such as postal mail, instant messaging, and VoIP[17]. We inquired as to the level of difficulty students had when contacting their sponsors during PQP with these current methods of communication; the results are shown in Figure 9.

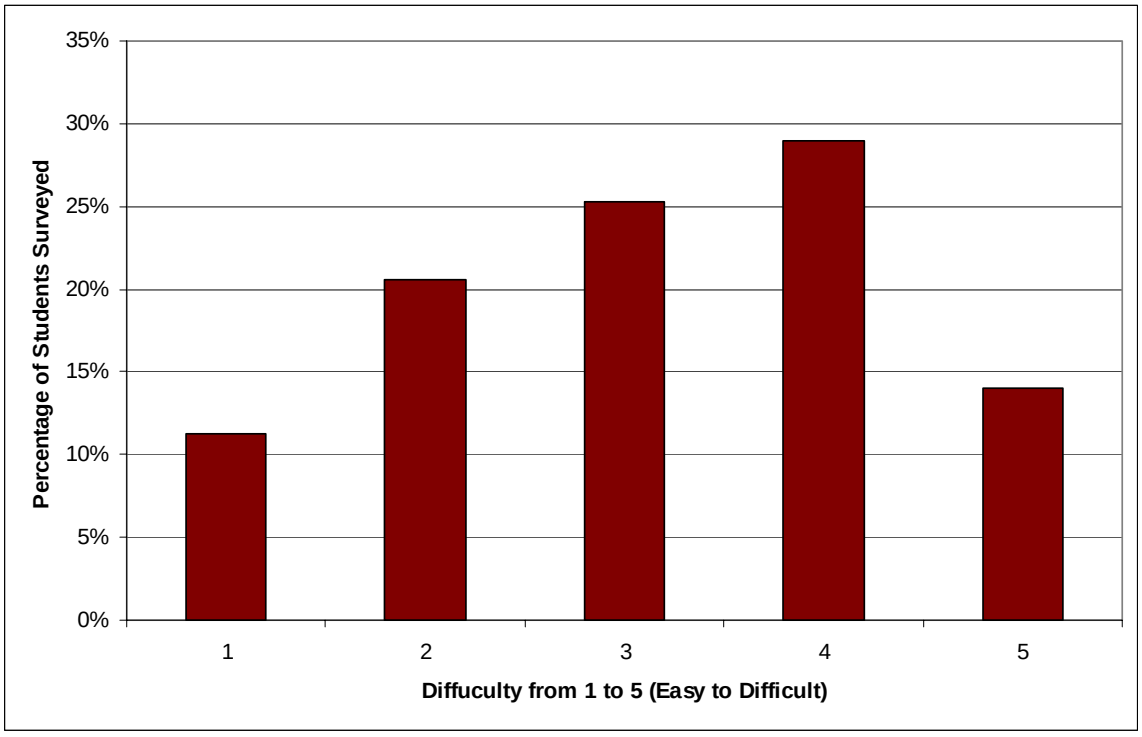


Figure 9 - Ease of Student Contact with Sponsor during PQP

[17] **VoIP**: Voice over IP; Internet telephony

It is clear from the results that many students perceived significant difficulty with communication during the pre-project phase. We also found that seventy-four percent (74%) of students contacted their sponsor less than once per week and eighty-five percent (85%) of students said that more communication with their sponsor would have improved their project work. Nonetheless, nearly seventy-four percent (74%) of students indicated that their project proposal met the sponsor's expectations when they arrived on-site. To improve communication, eighty-two percent (82%) of students indicated that they would be willing to use the Access Grid for their off-campus projects. The survey did not provide the specific reasons why the students felt this way, but open-end responses on the survey provided for extra student feedback. However, due to the large scale of this survey, it was not possible to correlate open-ended responses with the quantitative data.

We also interviewed five out of nine project sponsors at the Melbourne project site to determine their opinions on possibly using the Access Grid. As stated previously, for logistical reasons we only interviewed sponsors in Melbourne, Australia. These results are not necessarily representative of project sponsor responses for other locations around the world. The sponsors had very consistent views of the communication between them and students during the pre-project phase. They all stated that the current communication they use (mainly telephone and email) were sufficient, in that they were satisfied with it and that they have not had any major problems. While they were open to the idea of improving this communication, they felt that utilizing any method that required significant time and effort to use would be impractical. While the sponsors all seemed interested in the Access Grid, they all felt that unless there was a pressing need to use this type of communication for the project to be successful, then they would not be likely to use it. Most of them felt that both traveling to a nearby Access Grid room node (VPAC) and setting up their own personal Access Grid node would be more trouble than they were worth. There was one sponsor who explicitly stated that she would be willing to travel to the room node at VPAC to meet with the students. Sponsors are very busy people however, so allocating time to travel to and to meet with students over the Access Grid, when a teleconference could be done easily with the sponsors remaining at their office, did not seem practical. Most of the sponsors indicated that they would not spend this time unless they felt there was sufficient need for the video capabilities of the Access Grid to convey relevant information. Also, setting up a personal node would require significant setup time, as well as learning how to use the technology. Setting up a personal node in order to have a small number of meetings also seemed impractical to them.

4.3.2. Project Presentations

We investigated the possible Access Grid usage scenario of students giving presentations of their global projects to an audience back at WPI. Remote project presentations offer a chance

for students to present their work to people with whom they would normally be unable. This use of the Access Grid in the Global Perspective Program was piloted at the London Project Center in February of 2005. Final project presentations were given by three IQP teams to interested faculty and students at WPI. According to the London site director, the presentations conducted via the Access Grid ran successfully and positively demonstrated the many benefits of the technology. Some minor issues included technical problems with the shared PowerPoint presentation and inexperienced users moving out of the frame.

We discussed this usage scenario in the focus group that we held with project site directors, who identified that this scenario held a significant, potential benefit. Several directors indicated that many times they are not at the sites when projects are completed. Therefore, they would like the chance to see the completed projects at the remote site from back at WPI. Also, by inviting students who are going to the project site the following year to these presentations these students get a good impression of what to expect when they complete their projects the following year.

The site directors also discussed the possible limitation of this scenario. The first limitation was that if a director decided to use an Access Grid room node, then the sponsors may be inconvenienced if they had to travel in order to see the presentation. This limitation affects the number of sites that can utilize this scenario. It is conceivable for a PIG node to be employed to broadcast the presentations using a camera on the presenters and a shared PowerPoint presentation to share data. This method may be impractical when later attempting to include participants at WPI in the discussion at the end of each presentation. Another limitation identified was associated with time zone differences, which could possibly affect the time of day at which the presentations could occur. This issue can be problematic when arranging a meeting between two sites.

Similar to the London final presentations, we conducted our pilot test with practice presentations from Melbourne to WPI. By holding practice presentations instead of final presentations, only the students were required to attend at the remote site as opposed to interested faculty or local sponsors interested in the topic. This can potentially improve scheduling since project sponsors and advisors are not required to attend. We had three groups give their presentation to people back at WPI from the Access Grid room node at VPAC. After facilitating the three presentations to an audience of thirteen individuals at WPI including a Melbourne site director, a future advisor, and 11 students, we distributed the Access Grid Participant Survey to each of the project students involved in order to gather feedback regarding their experiences with the technology. In their responses they indicated that they felt the Access Grid was a “good” to “very good” method to effectively present the content they desired. They also stated that the event met their expectations. Students appreciated commentary on their presentations from outside sources and thought the interactions with the audience were benefited by the real-time video component. Unfortunately, the shared presentation feature did not work and the VNC

program experienced technical difficulties several times during the presentations. The VNC lag and failure at one point was mentioned many times in the students' responses. They attributed the difficulties to the Access Grid, and therefore some of their responses were biased concerning the dependability of the Access Grid. The students felt that the VNC lag interrupted the flow of their presentations. We also obtained feedback from the site director using the same survey given to students. Her responses indicated that her expectations were met and that her experience and the overall effectiveness of the meeting were very good. She commented that "it was a great opportunity for the future participants to be introduced to typical projects from the Melbourne project center. I was especially pleased that even at the end of term, about 1/3 of next year's students as well as one of the advisors were able to attend the presentations" (Ault, 2005, Appendix N). Also, both she and over half of the students indicated that they would be willing to use the Access Grid for future meetings

4.3.3. Remote Advising

The concept of "remote advising" extends to all cases where an advising professor would communicate with students when one party is located at a remote site. There are a few possible instances of remote advising. As discussed previously, some global MQP sites require the advisors return to WPI for much of the project duration, but during this time these advisors need to be in contact with the students to discuss progress. Another instance of remote advising occurs when professors travel to remote sites to participate in global projects as advisors or directors, yet they have students (typically graduate) back at WPI that they are advising on research with whom they need to communicate. This communication is currently done via telephone and email.

We investigated whether it would be beneficial to use the Access Grid to facilitate this communication. The advisor of the Ireland MQP site informed us that the Access Grid could benefit the communication he has with his students during the period he was away from them. He acknowledged how difficult it can be to have an engineering discussion over the phone and that the Access Grid's video and shared applications could provide a significant improvement for this communication. He maintained that he would be disinclined to use it if it required significant additional time (travel, set-up) to use.

We also conducted a test with one of the advisors at the Melbourne project site in communicating with his graduate students back at WPI. We held a pilot test during which this professor communicated with his students and evaluated the success of these meetings. We facilitated meetings which consisted of this professor meeting with three graduate students back at WPI. The professor spoke with each student individually, as they were working on separate projects. The discussion was focused on engineering research projects, and thus became quite technical at times. The professor spoke to his students while using a whiteboard to relay

graphical information (an engineering diagram). The configuration included a typical whiteboard with a video camera on it as a separate video feed.

The students expressed that they found this means of communication to be effective in this situation. The professor noted that the technological issues (at one point the display computer failed, momentarily interrupting the video feed), impeded the flow of the meeting. He also stated that the best feature of the meeting was being able to write on a whiteboard display that image to Worcester. The use of the whiteboard enabled dynamic visual data to be discussed in real-time, which is not possible via telephone and email. The professor also indicated that he would be willing to participate in Access Grid Meetings in the future. Since this pilot test involved a professor and students discussing technical work, we conclude that it also is a good reflection on how well many MQP discussions can be held over the Access Grid, since they also are technical in nature and may use similar techniques to share visual information.

Another test was held with an IQP advisor who was situated in Melbourne communicating to his students who were at WPI working during the pre-project period of their IQP. This meeting was held between two room nodes. This meeting was not very technical in nature and consisted more of qualitative discussion. The meeting went smoothly, without experiencing any failures in the technology.

The students were relatively unimpressed with the meeting because they believed it could have been conducted over the phone and saw no reason to go out of their way to use this technology. The professor, however, was quite pleased with his experience using the Access Grid. The aspect he found most useful was that he could tell who was speaking more often (out of the two students) and easily prompt the student who was less talkative to speak. He also stated he was willing to participate in more Access Grid meetings. While this situation of an IQP advisor being in a separate location from the students is rare, this test is a good reflection of how non-technical IQP discussions can be held over the Access Grid with significant benefit (compared to traditional methods of communication), in addition to the more technical MQP discussions.

4.3.4. Consecutive Term Projects

The London project center is unique in that it is the only site that hosts IQPs in two consecutive terms. As such, occasionally there are projects that are related to one another that are performed consecutively. The degree to which these projects are interconnected varies. We investigated whether or not using the Access Grid to facilitate communication between students performing their projects in London and students at WPI preparing to their projects in London could be beneficial and practical.

Having these meetings over the Access Grid would be very beneficial from the students' perspective. We contacted a consecutive term student group who was in this situation. This team

was present at the London final project presentations previously discussed. They observed the final presentation of first team and were able ask questions to clarify any outstanding issues. They told us they found this meeting "very beneficial" and that it "created the structure for the entirety of [their] Methodology." They also declared that they "would've loved to have a few meetings [with the other group] earlier and more often." (IQP Students, 2005, Appendix N.)

Nonetheless, there are logistical limitations to this possible usage scenario. We contacted the London project advisor that set up and facilitated the London final project presentations over the Access Grid. He informed us that there is very limited access to bandwidth at the site. He continued that the only location in London that had sufficient bandwidth for the Access Grid was at Imperial College: the Access Grid room node from where they gave the final presentations. He stated that the distance to this location was too far to warrant its use for regular meetings. "It would not be possible to have anything like weekly meetings at a node in London; it's just too far removed from the sponsors. It only makes sense to use the grid for final presentations, and/or perhaps one special meeting during the seven weeks." (London Site Advisor, 2005, Appendix N.) However, in our search of Access Grid room nodes around the world, we discovered that there are several others in London that could possibly be contacted.

4.3.5. Judiciary Hearings

Another possible usage scenario that we investigated for the Access Grid in the Global Perspective Program involved the enhancement of the judiciary hearings for students at remote project sites. Currently, when judiciary action is taken against a student at an off-campus project site, the advisors hold an informal hearing for the student. Prior to the hearing they also contact the judiciary staff at WPI. This contact is made to ensure the proper procedures are followed and the degree of judiciary repercussions is consistent with on-campus standards. We investigated whether the Access Grid could improve communication during these proceedings and thus enhance the entire judicial process. This potential benefit was that the Access Grid could be used to include people back at WPI in these hearings as well, or possibly even allowing a larger group of people to be involved in the process and thus bringing the on-campus judicial processes to the off-campus sites. This idea was discussed during the focus group with the project site directors and was received as a potentially beneficial idea.

The Dean of Students, Phillip Clay, was contacted about this scenario to obtain his feedback. He stated that using the Access Grid for off-campus judicial processes is not feasible. One of his major concerns was security, since these hearings need to be confidential. It is possible to have secure meetings via the Access Grid. Access Grid meetings can be made secure though the use of setting passwords to get into certain venues. Also it is possible for node operators to set up the meeting and then leave. The rooms themselves would need to be made secure (closing blinds, shutting doors, etc.). Thus, meeting venues can be configured to allow

only selected individuals to participate. So while the confidentiality issue could be addressed somewhat easily, Mr. Clay indicated that the use of the Access Grid at off-campus project sites is not feasible for other reasons as well.

Off-campus judicial hearings must occur within 48 hours of notification of charges. It may be difficult to try to arrange a meeting with the necessary participants in this short time period. Also, the fact that these events are unforeseen means that a PIG node could not be used unless it already happened to be at the site. Room nodes are not always present at remote sites, and at the sites that do have them it may not be possible to set up a meeting within 48 hours. Given the large number of participants that would be required for a full judicial hearing to be conducted (specifically, the Campus Hearing Board which consists of eight justices, alternate justices, a chief justice, and a case officer), it would be highly unlikely that an Access Grid session could be arranged in time and that all parties could coordinate their schedules to allow for it. Furthermore, all campus hearing board meetings take place at the end of the work day (approximately 5:30 pm EDT) and this time is not compatible with all of the project centers due to time zone differences. Mr. Clay stated that "these factors, when considered together with issues of confidentiality of the hearings," led him, "to believe that it does not make sense to pursue this option, and thus decline the pursuit of these ideas. We also agree that the results of our investigation lead us to conclude in the same manner" (Clay, 2005, Appendix N).

4.3.6. Consultation and Counseling Meetings

Another usage scenario of the Access Grid in the Global Perspective Program that we investigated involved group consultation and counseling meetings. We contacted Charles Morse, the Assistant Director of Student Development and Counseling at WPI, and found that consultations and counseling services are currently offered by trained staff at WPI that specialize in guiding both individuals and groups through problems or issues that may arise in their lives or in their interactions with others. The standard and preferred method of communication by the staff is a physical, face-to-face meeting between the counselor and counselees. These face-to-face interactions help a counselor to better evaluate non-verbal signals. According to Mr. Morse, "half [of counseling or consulting sessions] is the content, and the rest is process" (Morse, 2005, Appendix C). In this statement, he refers to the fact that not only is what a person saying relevant in showing how he or she feels, but – even more so – how the individual is presenting his- or herself can convey feelings that he or she may not state openly. Therefore, non-verbal content as simple as eye contact can allow a counselor to understand a situation much better than if these non-verbal communications were absent.

When dealing with subjects at remote sites, counselors are forced to use available communication technologies, such as telephone and email. Short of actually traveling to the site (which is usually extremely costly), these technologies are the only means by which a counselor

can make contact to remote sites thereby allowing them to evaluate and facilitate their interactions with those people seeking or requiring help. Unfortunately, none of the technologies provide the same level of non-verbal feedback that counselors are able to acquire in a face-to-face meeting. Therefore, faculty members identify problems at their site and contact counselors for advice. Any required discussion is easily and effectively done using email to schedule a later telephone conference. In these cases, the advisors are on location with the students, and they act as impromptu counselors working with advice from counseling staff back at WPI. According to Mr. Morse, the WPI Counseling Center does not receive many requests for assistance from remote project advisors. He informed us that these occurrences are not common, arising at most two to three times a school year, and that the advisors are generally capable of handling most situations on their own.

Mr. Morse also mentioned that confidentiality and privacy are necessary in varying degrees in either consultation or counseling meetings. In a consultation meeting, confidentiality between individuals and advisors is not imperative, but are still meant to be discrete. A consultation meeting starts with the counselor speaking to all group members individually in a private area. The counselor remains discrete with certain information at this point but will relay relevant information to advisors. Later, the counselor meets with the whole group in a private area and conducts an open, controlled discussion where individuals will be asked to express ideas touched upon in their previous discussion. Mr. Morse commented that private conference rooms would be appropriate for these types of meetings if used in conjunction with Access Grid technology.

With respect to counseling meetings over the Access Grid, Mr. Morse felt that not only are the levels of confidentiality and privacy too low for this type of meeting, but more importantly, he and other counselors would not be willing to assume the liability due to distance. Counseling sessions have a high likelihood of addressing issues that may be emotionally charged. He feels that it would be inappropriate, unsafe, and ineffective to discuss these issues if a counselor is not physically present with the individual. Unknown events may occur, potentially jeopardizing the health or safety of the counselee, which the counselor would not be able to control.

5. Conclusions and Recommendations

From our analysis and findings, we were able to draw some general conclusions regarding the use of the Access Grid in the Global Perspective Program as well as specific conclusions regarding each usage scenario. Each conclusion corresponds to an evaluation of the findings that influence the feasibility of specific applications of this technology in global projects at WPI. This evaluative process was explained in detail in the previous chapter and was outlined in Figure 8. In this chapter, each of these findings is briefly revisited. We then rated the corresponding communication scenarios based on their level of feasibility and ranked them with respect to each other and to their overall usefulness within the Global Perspective Program. Also, based on the benefits and complications associated with using either a room or PIG node, we recommended appropriate uses of these systems. Finally, we employed these suggestions to provide a basis for more far-reaching conclusions and recommendations concerning communications at WPI, in the Access Grid Community, and in other global projects.

5.1. Applications of Videoconferencing Technology in the Global Perspective Program

In order to effectively evaluate each application of the Access Grid in the Global Perspective Program, it was necessary to weigh the benefits against the potential drawbacks. Using feedback from participants in the Global Perspective Program about the Access Grid, determinations were made about the various uses of the Access Grid. The finding for each meeting scenario is summarized and a conclusion is stated followed by a set of recommendations for use. The degree of benefit and practicality for each scenario is summarized using the ranking scheme set forth in our analysis.

Sponsor Meetings – SOMEWHAT BENEFICIAL / NOT PRACTICAL

An investigation into the nature of student interactions with their project sponsors regarding the pre-project, proposal writing phase showed that a large percentage of students declared that they would be willing to use the Access Grid to facilitate these communications. Despite the potential benefits of and the students' willingness to use the Access Grid, most sponsors were not willing to go out of their way to use the technology unless either they or the students feel that standard communication technologies are unacceptable. Time is quite valuable in the business world, and any significant use of sponsor time must be justified. It is also possible that a nearby room node may charge a fee to facilitate a meeting, and this extra cost would further deter sponsors. At some sites, there is not a nearby room node available to the sponsors. In that case, a personal node would be the only option for communicating via the Access Grid. Based upon these findings, we conclude that sponsor meetings with students during

the pre-project period over the Access Grid would only be useful on a limited basis, when the sponsor felt the benefits of the meeting outweighed the costs.

Project Presentations – BENEFICIAL / SOMEWHAT PRACTICAL

The concept of shared PowerPoint presentations via the Access Grid was one in which site directors and students had expressed interest. In this scenario, the Access Grid gives viewers at WPI the option to observe remote project presentations, which is not possible through any other current means of communication. The feasibility of these presentations is usually dependent on the accessibility to and availability of a nearby Access Grid room node at the remote site, however it is possible – but not recommended – to use a personal node to broadcast a presentation. The success of these presentations also depends on whether time zone scheduling issues can be resolved. If so, Access Grid use for project presentations would be a beneficial and practical application, allowing the students and their projects to reach a potentially larger audience. If these issues were not addressed, a presentation might occur at inconvenient times for the different groups of participants. In some instances, this inconvenience may be unavoidable, and should be taken into account when planning this type of event.

In order to facilitate this use of the Access Grid, we recommend commencing the planning of final presentations well before the start of the project term. Time zone issues and a facility booking, including the presence of an experienced moderator or meeting facilitator, must be arranged. The nearest locations of Access Grid room nodes to each project site are listed in Table 2 (on p. 11) and in our Guidebook for easy reference. Another way to improve the practicality of the meeting is to limit the number of groups presenting, which reduces the overall length of the session thereby decreasing the time commitment required on the part of participants at WPI. Reduced presentations, both in terms of quantity and time, may be a suitable compromise, if final project presentations in full are not feasible.

“Remote Advising” – BENEFICIAL / PRACTICAL

While away and advising projects at remote sites, advisors recognize that they still have responsibilities to students and other work back at WPI and that they can have effective, constructive interactions with these individuals involving technical matters by using technology that incorporates a real-time visual component. We facilitated several meetings via the Access Grid, and participants found the technology was most effective for discussions involving charts, graphs, figures, and other data. As with any interpersonal communication, these videoconferencing participants found they were more attuned to visual cues such as gestures or body language that express feelings in ways that telephone or email conversations simply cannot convey.

There are certainly other instances where students and their advisors are separated by distance. Whenever this physical separation is an impediment to the exchange of certain types of

information or ideas, we recommend that the Access Grid be considered to facilitate communication. One use that we recommend is at MQP sites when the project advisor is not present on-site. Another example is when a professor is at a remote site but has students back at WPI that he or she is advising. We concluded that the success of the meeting we facilitated with the professor and his graduate students illustrates the effectiveness of technical discussions over the Access Grid. Similar discussions would take place during MQP advisor meetings. Based upon these conclusions and the significant need for communication when advisors leave the MQP sites, we recommend that the Access Grid be used in these situations, whenever possible. In the event that the advisor is away and needs to initiate conversation, he or she will most likely use a PIG node to contact individuals back at WPI. This use will require a consideration of the barriers associated with PIG node setup, bandwidth availability, firewall issues, and user training with the software.

Consecutive Term Projects – BENEFICIAL / SOMEWHAT PRACTICAL

The London project site is unique in that it hosts IQPs in consecutive terms. Occasionally, a project completed in one term is followed by a project completed the next term. Based on feedback from individuals involved in one of these consecutive term projects, it appears there is definite interest in collaboration between the groups during the latter group's project preparation phase. Students who were consulted in the latter group felt that the sharing of information during this time would have helped guide their efforts, resulting in a more seamless transition between the projects. The Access Grid has proven to be useful for this type of interaction.

For student groups that are involved in these projects, we recommend that the student groups initiate contact before the start of C-term, preferably prior to the first group's departure. An introduction before the groups are separated will aid in fostering communication between the groups. The groups should discuss the information they wish to share and decide if the Access Grid would be an appropriate technology to use. If deemed appropriate, they should arrange to have Access Grid meetings take place during their project work. Students should contact their site director or advisor(s) in order to arrange for an Access Grid room node at the project site. Given the group-to-group nature of these interactions, the use of a room node is nearly always preferable. Not only are room nodes better suited to group interaction, but a room node is typically run by an experienced node operator, and thus the students would be able to concentrate on the content of their meeting rather than the technical setup. If a room node is unavailable, students should obtain a PIG node and familiarize themselves with the technology before they depart. During the project phase, the number of meetings is up to the discretion of the students, but they may wish to set a regular schedule that will be easy to adhere to. It is possible that the students working on PQP may be more inclined to meet since they need information from the IQP group to do their project. Also, the group located at WPI would only need to travel to

Morgan Hall, whereas the group in London would be required to travel a considerable distance to a room node. There are other nodes in London, which should be investigated as alternate options.

Judiciary hearings – SOMEWHAT BENEFICIAL / NOT PRACTICAL

Based on feedback received from the focus group with site directors, there was a favorable outlook on future integration of videoconferencing technology in the judiciary processes currently set forth by WPI for remote projects. By adding this modification, a secure judicial hearing involving a student off-campus could be performed according to standard practices as if the student were physically present at an on-campus hearing. However, after weighing the benefits against the constraints this type of meeting presents, stakeholders indicated that given the current requirements for judiciary hearings, using the Access Grid to facilitate these interactions is not practical. Specifically, the short time frame allocated to off-campus judiciary actions (48 hours) and the large number of individuals required for a hearing board meeting represent insurmountable barriers to this idea. Also the security (both physical and virtual) of meetings was a concern.

While not practical at this time, this idea should not be completely dismissed. There was significant interest from faculty participants we corresponded with, and the limiting factor is not the technology, but rather the process. It is our recommendation that if WPI should consider a re-evaluation of remote project site judicial processes, they include the possibility of using this technology to enhance the judicial procedures.

Consultation/Counseling – SOMEWHAT BENEFICIAL / SOMEWHAT PRACTICAL

One communication scenario generated during the focus group involved employing the Access Grid to enable counselors at WPI to meet with individuals or groups at remote sites who require assistance. This assistance would be in the form of group consultation workshops or individual counseling sessions. Consultation meetings would serve to aid project students with issues associated with group dynamics. Counseling sessions would be geared toward individual student who are experiencing problems while away and whose needs cannot be satisfied by the onsite advisors. After further developing this idea with Charles Morse, the Associate Director of Student Development and Counseling at WPI, our discussions yielded two conclusions. First, the Access Grid is feasible and shows promise for enhancing consultation meetings for remote project groups. Second, the Access Grid is not feasible for counseling sessions and would be an unacceptable liability on behalf of the counseling staff at WPI.

The first conclusion is based on benefits described by Mr. Morse that are attributed to a face-to-face meeting. A physical meeting, or a meeting that closely emulates one, is very useful to counselors because it provides them with a way to assess the non-verbal communication that occurs among the members of a group. Non-verbal communications, such as eye-contact, seating preference, and displayed presence or actions, can inform the counselor as to what roles each

person assumes in the group. Understanding these non-verbal communications as observed via the Access Grid would greatly surpass current communication techniques due to the added video feature.

Based on this information, we recommend that consultation meetings be conducted using a room node to allow multiple views of the students involved by the counselor. A PIG node would severely limit a counselor's ability to view the many non-verbal communications occurring among students. Therefore, the practicality is somewhat diminished due to the fact that a room node would better serve this meeting type. The degree of adversity that the students are experiencing pertaining to their group dynamics would be the factor that determines whether or not a consultation meeting is necessary. Advisors could also make a suggestion to meet with a WPI counselor via the Access Grid if they deemed it necessary.

The second conclusion is based heavily on a shared belief, on behalf of the counseling staff at WPI, that if a situation involving a student's personal problems was severe enough to require professional intervention, the counselor should be physically present with the student. Counseling sessions can be emotionally charged for the student. If some event were to occur endangering the safety of the student that the remote counselor could not control, the result could be disastrous. Other important issues involve the confidentiality and privacy of the session. Although venues can be encrypted, the surrounding room may not be secure or private enough for these meeting types. In situations where a room node was employed, a node operator would have to be present to set up the meeting and be available to troubleshoot issues when they arise. These complications would interrupt serious discussion and represent factors that make this scenario inappropriate. Dues to these issues, we cannot recommend the Access Grid for use in remote counseling sessions.

5.2. Access Grid Guidebook

The goal of this project was not only to investigate possible uses of the Access Grid in the Global Perspective Program, but also to enable new users to feel comfortable with the technology by developing educational materials and protocols to facilitate their use of the Access Grid. For this reason, we created an educational guidebook for Access Grid use. This guidebook contains information to help potential Access Grid users to decide whether the Access Grid is a good choice for them, as well as to provide them instruction on how to use it. This guidebook is attached to this document as Appendix Q.

This guidebook contains pertinent information compiled from our own usage and investigation, and also from existing Access Grid documentation from the Access Grid Documentation Project. The shortcoming with existing Access Grid documentation is that it was written with experienced videoconferencing and computer users as its intended audience. For this reason, we decided to create this guidebook that educates Access Grid users with minimal assumed knowledge.

We recommend that this guidebook be read by anyone in the WPI community who has a communication need that may be met using the Access Grid. Specifically, we recommend that the WPI IT Division post a digital version of this guidebook to be accessible through either the IGSD's or IT Division's web sites. This guidebook explains to users the features and drawbacks of the Access Grid, information on the two types of nodes, how to determine if the Access Grid is a good choice for them, instructions for installation and use, as well as tips for running effective Access Grid meetings.

While this guidebook was initially written to be used by potential users at WPI, we also created another version of the guidebook that was not specific to WPI. This adaptation was made such that the guidebook could be applied to the entire Access Grid community. We recommend that this general version be considered for submittal into the Access Grid Documentation Project, so that it may benefit the entire Access Grid community.

5.3. Recommendations for the Future

Ultimately, our results have shown that a videoconferencing solution, such as the Access Grid, does indeed deserve consideration within the Global Perspective Program. By implementing its use in the ways described, the undergraduate utilization of the Access Grid at WPI can be increased on a limited basis. Further, communication in the program should improve and stakeholders should notice some level of improved satisfaction in communications throughout the program.

We also have researched and experimented with the inSORS software, and have concluded that it is superior to the Access Grid for use on personal nodes, especially when the users have issues with bandwidth, firewalls, and ease of use. Although a monetary investment must be made in order to use this software, we recommend that it be considered by WPI. We have found the inSORS software to be a more user friendly alternative to the Access Grid. It also incorporates other features that the Access Grid does not, such as its ability to operate in a firewalled network environment and to scale its bandwidth usage to a lower level. The drawback of inSORS is that it is a commercial product and licenses for its use require the allocation of funds. WPI would need to purchase licenses for this software in order for it to be used. The software and a single client license can be purchased at the educational price of 2,400 USD. When purchased in bulk, the license price decreases significantly (e.g. 800 USD per license for 10 or more) and arrangements can be made to allow license rollover for new users in an academic setting where different groups need access from time to time. We recommend that WPI consider purchasing this software, as it has great value to offer participants in the Global Perspective Program. WPI already has nearly all of the hardware in place to support an inSORS room node, and the laptops made available to off-campus users can easily be outfitted with the software and hardware necessary to use inSORS.

Also, we recommend that the Access Grid community further investigate deaf and hearing impaired accessibility to this technology, as the result of our investigation into use of the Access Grid by the hearing impaired was not extensive and somewhat inconclusive. Although WPI may only benefit from this knowledge in rare cases, the Access Grid community as a whole may reap much more from it. We found that the one hearing impaired subject we tested did not find the Access Grid to be particularly useful, however we also learned that videoconferencing is widely used by the deaf community quite successfully for signing. Based upon each person's individual condition, an assessment must be made as to whether the Access Grid is a viable communication option. The Access Grid may not be useful for all people with hearing disabilities, however we do recommend that it be considered when one of these people has a remote communication need.

Overall, we recognized that the Access Grid is a tool in development, and that it is difficult to make concrete decisions on such a dynamic technology. While nearly every person that was introduced to the technology was impressed with its capabilities, a large percentage of those people were also quick to recognize that this is a technology in its infancy, and that there is much work to be done before its full potential can be realized. We should also mention that our project scope was limited to practical uses of the Access Grid within the Global Perspective Program. As such, we only pursued those options that could benefit stakeholders in the program, and that many more potential uses for the Access Grid exist. With that in mind, a multitude of future possibilities should be considered for this technology. Humans are naturally somewhat resistant to changes that require some investment on their part, but once this technology has been proven as an effective supplement to current forms of communication, we expect that the general public will begin to accept it and will start finding new uses for videoconferencing technologies in their work and studies. As the Access Grid – and videoconferencing in general – becomes more prevalent as an accepted communication method, then its use in the Global Perspective Program will become much more feasible.

If WPI's Information Technology Division is determined to expand Access Grid use, they should consider the communication scenarios we have investigated and also actively pursue other situations where this type of technology may benefits members of the WPI community. Also, the Access Grid Community at large should recognize that this is a technology on the cusp of expansion, and with focused refinements towards user-friendliness and application capabilities, the technology can be made accessible to a wider audience and thus accelerate its expansion. Finally, if the Access Grid can achieve this expansion, then it may live up to its potential and significantly improve communications on a global scale.

References

Cited

About.com. *The History of Communication*. Retrieved Jan. 30, 2005, from http://inventors.about.com/library/inventors/bl_history_of_communication.htm

ARCH: A Legal Resource Centre for Persons with Disabilities. *Symbolic Languages.* (2003, October 17) Retrieved February 13, 2005, from http://www.archlegal clinic.ca/publications/law/A73_2003_000595/03_03_communicationDisabilities/x03_03_03_symbolicLanguages.asp

ARSC. 2000. *NASA regional workshops for state, local and tribal governments: Findings and implications*. Tucson, Ariz.: Arizona Remote Sensing Center, University of Arizona. Online: http://aria.arizona.edu/report.pdf (Accessed June 2003).

Bass, F. M. (1986). "The adoption of a marketing model: Comments and observations". In V. Mahajan & Y. Wind (Eds.), *Innovation Diffusion Models of New Product Acceptance*. Cambridge, Mass.: Ballinger.

Beavers, Jay, Chou, Tim, et. al. (2004, April). *The Learning Experience Project: Enabling Collaborative Learning with ConferenceXP*. Microsoft Research Microsoft Corporation.

Beshears, Fred M. *The Technology Adoption Life-cycle.* Retrieved February 20, 2005, from http://ist-socrates.berkeley.edu/~fmb/articles/lifecycle/

Brennan, Lawrence D. *Modern Communication Effectiveness*. Englewood Cliffs, NJ: Prentice-Hall Inc. 1963.

Bronwyn, Hall H. and Beethika Khan. (2003, April). *Adoption of New Technology*. Retrieved February 20, 2005, from http://repositories.cdlib.org/iber/econ/E03-330/

Davis, Paul H. (2003, Sept. 19). *Teleconference – a Whatis.com definition*. Retrieved January 31, 2005, from http://searchnetworking.techtarget.com/sDefinition /0,,sid7_gci213111,00.html

Daw, Michael, et al. (2002, October 23). *Multi-Site Videoconferencing for the UK e-Science Programme: A Roadmap for the Future of Videoconferencing within e-Science*. University of Manchester. Retrieved January 29, 2005, from http://www.nesc.ac.uk/technical_papers/UKeS-2002-04.html

Futures Laboratory, Mathematics and Computer Science Division, Argonne National Laboratory. (2003, July 11). *Access Grid Node Minimum Requirements*. Retrieved February 10, 2005, from http://www.accessgrid.org/agdp/guide/min-req.html

Hewes, Gordon W. *A History of the Study of Language Origins and the Gestural Primacy Hypothesis*. Massey University. Retrieved Jan. 30, 2005, from http://www.massey .ac.nz/~alock/hbook/hewes.htm

Hoerup, Sharon L. (2001, November 30). *Diffusion of an Innovation: Computer Technology Integration and the Role of Collaboration*. Virginia Polytechnic Institute and State University

Hull, Ray H. (2005) *The Art of Interpersonal Persuasion.* American Speech-Language-Hearing Association. Retrieved March 20, 2005, from http://www.asha.org/ about/publications/leader-online/archives/2003/q4/031007f.htm

Ideafinder. (2004, July). *Invention of the Printing Press*. (2004, July). Retrieved Jan. 30, 2005, from http://www.ideafinder.com/history/inventions/story039.htm

International Telecommunications Union – Telecommunication Standardization Sector (ITU-T). (2004, November 25). *About ITU-T > General Information on ITU-T*. Retrieved January 28, 2005, from http://www.itu.int/ITU-T/info/itu-t/info.html

Internet2. (2003). *Corporate Membership*. Retrieved February 11, 2005, from http://www.internet2.edu/pubs/200309-BR-CR.pdf

Katz, Elihu. (1973). *The two-step flow of communication: an up-to-date report of an hypothesis*. In Enis and Cox (eds.), "Marketing Classics", p. 175-193.

Kim, JongWon Ph.D. (2003, June 19). *Access Grid: Issues and Activities*. Korean Workshop, Kwang-Ju Institute of Science and Technology.

Merriam Webster Online. *Communication*. Retrieved Jan. 30, 2005, from http://m-w.com/

Merriam Webster Online. *Society*. Retrieved Jan. 30, 2005, from http://m-w.com/

MM Internet, Inc. (1999). *DSL Glossary*. Retrieved February 1, 2005, from http://www.mminternet.com/dsl/glossary.htm

Modem – a Whatis.com definition. (2003, April 11). Retrieved January 31, 2005, from http://searchmobilecomputing.techtarget.com/sDefinition/0,,sid40_gci213291,00.html

Moore, Geoffrey A. (1999, July 1). *Crossing the Chasm: Marketing and Selling High-Tech Products to Mainstream Customers*. New York: HarperBusiness.

Nulph, Sally. (2002). *Breaking Cultural Communication Barriers.* Retrieved February 13, 2005, from http://ga.essortment.com/culturalcommuni_raxq.htm

Olson, Robert. (2003, July 25). *Access Grid Hardware Specification*. Retrieved February 11, 2005, from http://www.accessgrid.org/agdp/guide/spec.html

Orr, Greg. (2003, March 18). *Diffusion of Innovations, by Everett Rogers (1995)*. Retrieved February 25, 2005, from http://www.stanford.edu/class/symbsys205/Diffusion%20of%20Innovations.htm

Pahud, Michel. *ConferenceXP Research Platform: Toward an Extensible Collaborative Environment.* Microsoft Research. 2005

Perey, Christine. *ABCs of Videoconfrencing*. Network World, October 29, 2001 Retrieved March 17, 2005 from http://www.nwfusion.com/research/2001/1029feat2.html

Rogers, Everett. (1983). *Diffusion of Innovations*. 3rd ed. New York: Free Press.

Seanet Corp. *ISDN Pricing*. Retrieved February 3, 2005, from http://www.seanet.com/services/isdn

Stevens, R.; Papka, M.E.; Disz, T. *Prototyping the Workspaces of the Future*. Internet Computing, IEEE, Volume: 7, Issue: 4, July-Aug. 2003 Pages: 51 – 58.

TeamSolutions (UK) Limited. (2005 Feb. 2). *Video Conferencing Standards & Terminology*. Retrieved February 2, 2005, from http://www.teamsolutions.co.uk/tsstds.html

Teig von Hoffman, Jennifer. (2003, July 11). *Beginner's Guide to Facilitating Interactive Communications on the Access Grid*. Retrieved February 10, 2005, from http://www.accessgrid.org/agdp/guide/facilitation.html

Underwood, Mick. (2003, June 21). *Katz and Lazarsfeld: Two-Step Flow*. Retrieved February 25, 2005, from http://www.cultsock.ndirect.co.uk/MUHome/cshtml/media/kl.html

Underwood, Mick. (2003, June 21). *The Shannon Weaver Model.* Retrieved February 20, 2005, from http://www.cultsock.ndirect.co.uk/MUHome/cshtml/introductory/sw.html

University of Westminster. (2005) *Speaking vs. Writing*. Retrieved February 20, 2005, from www2.wmin.ac.uk/eic/learning-skills/literacy/sp_vs_writ_dif.shtml

Videoconference – a Whatis.com definition. (2003, Sept. 19). Retrieved January 31, 2005, from http://searchmobilecomputing.techtarget.com/

VRVS v3.4. Retrieved January 31, 2005, from http://www.vrvs.org/

Wikipedia. (2005, February 6). *Crossing the Chasm*. Retrieved February 20, 2005, from http://en.wikipedia.org/wiki/Crossing_the_Chasm

WPI. *WPI Global Perspective Program*. Retrieved February 2, 2005, from http://www.wpi.edu/Academics/Depts/IGSD/about.html

WPI. Information Technology Division. Retrieved February 20, 2005, from http://www.wpi.edu/Admin/IT/About/vision.html

Consulted

Brainerd, Stuart. *ISDN Basics*. Synapse Networks. Retrieved February 2, 2005, from http://www.isdnshop.com/isdn-basics.htm

Penland, Patrick R. (1974.) *Communication Science and Technology: An Introduction*. New York: Marcel Dekker.

Appendix A Mission of Agency

Worcester Polytechnic Institute (WPI) is a private institution of higher learning located in Worcester, MA. A school of science and engineering, WPI educates students not only on the theoretical knowledge of their fields, but also in the practical and ethical use of that knowledge.

WPI's IT Division is composed of four departments: the Advanced Distance Learning Network (ADLN), the Academic Technology Center (ATC), the Computing and Communications Center (CCC), and the Gordon Library (see Figure A). Our sponsor, Dr. Julia Mullen is an employee of the CCC. The mission of the CCC is to "provide the communications, computing, and storage infrastructure, as well as the software utilities and applications [that] support the academic, research and administrative activities at WPI." ("WPI CCC", 2005) WPI views itself as a leader in technological education, and the CCC seeks outs new technologies that will allow WPI to remain on the cutting edge of education. The CCC has over forty people working to accomplish the goals set forth in its mission.

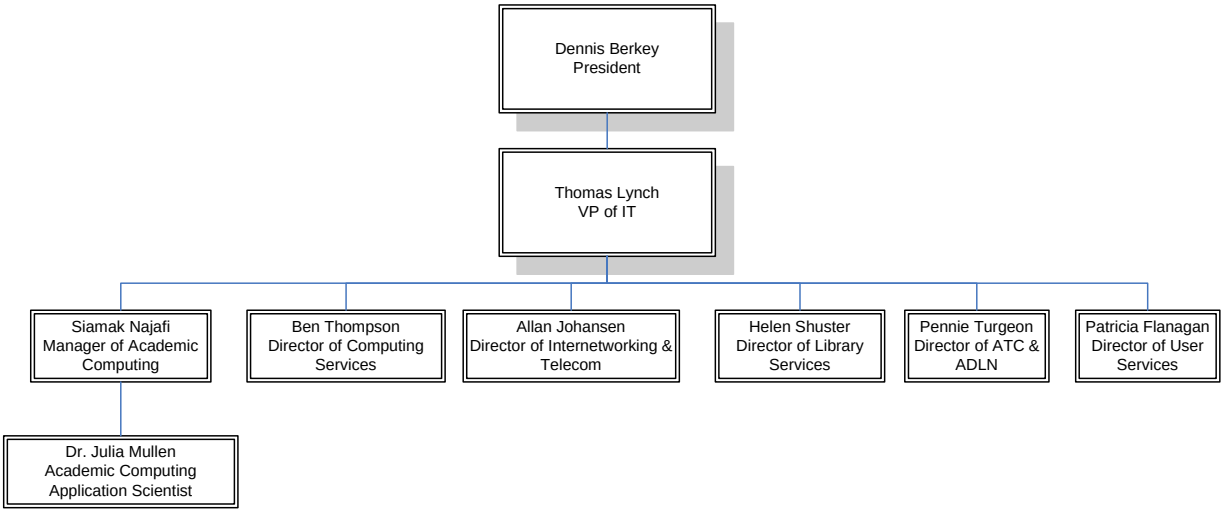


Figure 10 - IT Organization Chart

Appendix B What is an IQP?

The Interactive Qualifying Project (IQP) is part of WPI's project based learning program. This program, implemented in the 1970s is intended to give students a fuller academic experience, by exposing them to engineering project work, as well as exposing students to humanities and how technology affects society. The IQP's purpose is to have students "relate social needs or concerns to specific issues raised by technological developments." (WPI, "Projects Program," wpi.edu) The IQP is an important project because it helps students grasp the societal implications of technology.

This project deals with the impact a new technology has on a society. Since the Access Grid is so new, the WPI society has not had time to fully utilize it. The technology that our project deals with is the Access Grid. The purpose of our project is to help the WPI community use this technology to its fullest extent, and therefore help them make their global projects easier. Our project directly links technology and people, as it is an investigation to see exactly how people should use a technology, how the technology can benefit the people, and how the technology can be adopted by people easily and effectively.

Appendix C Interviews

INTERVIEW 1

Name: Jennifer Teig von Hoffman **Interviewers**: Ryan and Vince **Date**: 1/31/05

1. **What is your specialty/profession?**
   Lead on the Access Grid Documentation Project (AGDP). Collects technical and non-technical papers for instruction, education, and implementation of Access Grid technology.
2. **What are some important things that new users should think about when they are using the Access Grid?**
   - asking questions (simulating eye contact) not work well, need to directly ask individuals questions
   - time zone issues – don't take day factors (people may want to leave work, etc)
   - basic etiquette – don't multitask, pay attention
   - camera angle affects facial expressions
3. **What problems do you see currently with the Access Grid/your area?**
   The Access Grid is radically understudied. There are no usability studies.
4. **What are some areas that we might research/questions to think about that you think might benefit the Access Grid and/or our project?**
   - What modifications are necessary to the AG and different communication techniques users do/have that we don't think about (those with much experience when it comes to the AG)?
   - Get notes on peoples impressions of etiquette looking for from other side
   - What is it like to set up meetings – how much effort is it? How would you excite a sponsor to get them to go to the AG
   - AG tech mailing list – have a lot of enthusiasm for research – could be very useful
   - What does it take to set up a personal vs. a room node
   - Obstacles new users trip over – technical and behavioral
   - What options are there in setting up a personal node
   - Jabber Meadow – chat program used

INTERVIEW 2

Name: Professor Richard Vaz **Interviewers**: Vince and Julian **Date**: 2/10/05

1. **What is your specialty/profession?**
    a. ECE/Signals
    b. For IGSD's Global Perspective Program:
    c. Project Advisor: Washington D.C., Netherlands, London, Puerto Rico, Bangkok, Australia
    d. Site Director: Venice, Holland, Bangkok, Ireland
2. **Overall, how comfortable are you with various communication technologies (i.e. Email, Fax, Instant Messenger, Videophone)?**
    a. "Selective adopter" of technology
    b. Choose a small number of technologies and use them well – email
    c. Doesn't use IM, Cell phone, dislikes telephone use
    d. Telephone conversations are not enough
3. **Have you ever used the Access Grid? If so, how many times have you used the Access Grid?**
    No
4. **Please describe your first reactions to the Access Grid.**
    n/a
5. **Do you feel the Access Grid would be helpful to you in your particular field? If so how?**
    a. Would work well in MQPs, not so much in IQP
    b. Would be useful for communication from off-site to campus for teaching purposes
    c. Perhaps for students that go away for projects, where advisor can only stay for a couple weeks.

INTERVIEW 3

Name: Joseph Kalinowski **Interviewers**: Vince and Ryan **Date**: 2/15/05

1. **What is your specialty/profession?**
   - Assistant director of ATC at WPI
   - deal with communication technology at WPI – hardware and software
   - was the person in charge of designing and installing all of the audio and video hardware in the AG node room in Morgan
2. **Overall, how comfortable are you with various communication technologies (i.e. Email, Fax, Instant Messenger, and Videophone)?**
   - Very comfortable
   - Dealt heavily with H.320 and H.323 for distance learning coursework, a few job interviews, and subletting equipment and space to brokers (they pay for the service)
   - Interwise new software that ATC will be adopting by fall 2005.
3. **How often is videoconferencing used on campus?**
   - 8-12 times a year for job interviews
   - UTC (United Technology Corp) used H.320 for a virtual classroom
   - National Grid used H.323 for some management courses for employees
     - Technology was stable during meetings (in b and c)
     - There was a slow setup for the IP (H.323)
   - There was a five hour conference between WPI and Namibia (stable)
4. **What is your opinion on videoconferencing use for virtual classrooms/education?**
   - It depends on the learning style of the group being taught and the material that needs to be presented
   - If there is a strong visual component to the subject, then it could be beneficial
5. **Have you ever used the Access Grid? If so, how many times have you used the Access Grid?**
   - Twice for a product demonstration.

6. **Do you see any issues with the ATC supplying students with necessary equipment required for some sort of personal videoconferencing unit?**
   - Video cameras – yes that is doable
   - Headsets – probably doable, it is too personal of a piece of equipment. The students would have to buy their own
7. **Do you have any other comments you would like to share?**
   - His opinion –the AG or any other videoconferencing tool can be an advantage if it saves travel time, but it is in no way a replacement for a regular face-to-face meeting
   - Interwise might be easier to use than the AG for smaller groups
   - One must use technology based on ease of use – don't force complicated technology on situations that don't need it
   - Sometimes you can reach more people effectively using standard technologies
8. **Please tell us more about Interwise.**
   - Interwise.com
   - Version 5.5 - $60,000 license for 250 people to log on at any given time with unlimited participation once a session begins
   - Can create sessions called I-meetings and I-classes
   - December 2004 was when ATC began testing and set up the license
   - Intended Scope: Distance learning, faculty use, project work
   - Audio transmitted over dial-up, video requires better connection
   - Can pass privileges to people to modify the shared whiteboard
   - Full duplex for only 2 people at a time – up to 4 in next version
   - Video is not the focus – geared toward audio communication. Video is not necessary for many applications and uses much bandwidth.

INTERVIEW 4

Name: Charles Morse **Interviewers**: Group **Date**: 4/20/05

1. **What is your specialty/profession?**

   Associate Director of Student Development & Counseling Center

2. **Is it common for groups at remote sites to seek help from the counseling office?**
   It is not common, but it happens periodically. Faculty members identify problems and sometimes communication just occurs between faculty and students without counselors. Usually faculty emails counselor first to coordinate time to interact more fluidly over the phone and discuss how to help group.
   How many per term?
   Sometimes happens with teams but not often (2-3 times/year).
   How successful are those interactions?
   There are comfort level issues – not comfortable with technology right away. Meet with individual alone and then as a group (when in person).

3. **When groups do contact you, what methods of communication are currently used?**
   Usually we talk to faculty on how to manage the situation.

4. **How effective do you feel the current communication methods are?**
   The current system is effective; there seems to be a real limited need. Communications this way are fairly rare. If individual is having problems teleconferencing works. Groups would be good for video use. Faculty is ok with teleconferencing.

5. **If the Access Grid was available, would the counseling center be interested?**
   Yes, there is learning curve. But can pick up non-verbals. Half is the content and the rest is process. Non-verbals tell you a lot about how a group functions. Eye contact is important.

6. **What would it take to incorporate the AG into Consultation/Counseling meetings?**

   Do some tests and see what the true benefits are. Combine with normal methods and see what extra value is added.

7. **How do you feel about confidentiality?**

   a. Counseling has a high need of confidentiality. For counseling – if concerned about well being then confidence can be broken. AG would not be a safe use. Liability due to distance – need safe and effective counseling.

b. Consultation does not have as high of a need; it is not as important. For Consultation – not as important. Will be discrete but can't guarantee confidence with information that is important for certain individuals to know. More fluid communications possible if you had a group to help consult on the one end because there are more individuals working on the problems of the students. Would want a lot more privacy than the Morgan room can provide, need something more like a small conference room.

8. **How important are non-verbal communications in the type of work you do?**

   a. Non-verbals – where they sit, proximity to each other.

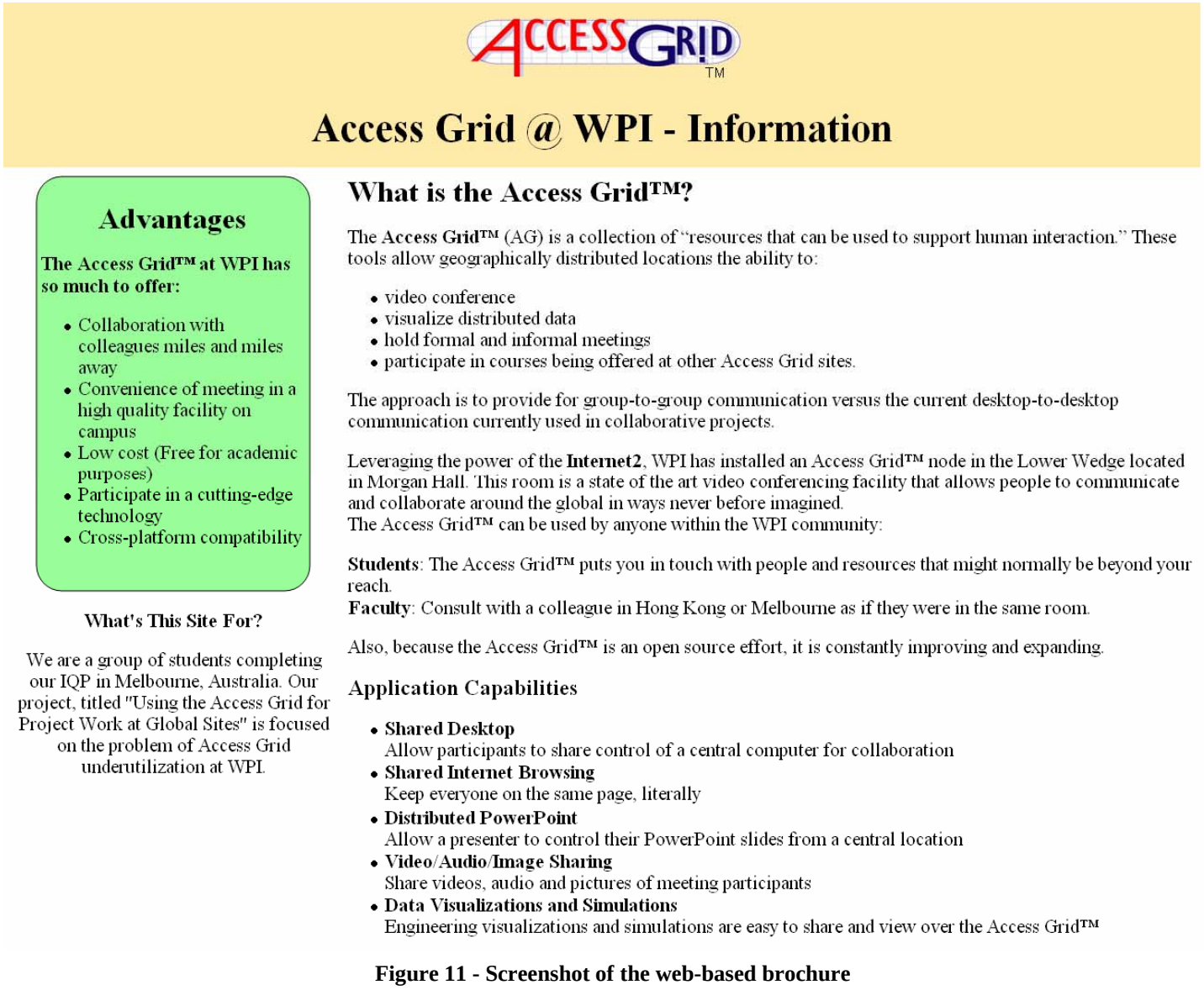
   b. Eye contact between group members can show who takes on certain roles.

   c. "Presence" that someone shows exhibiting that they are a group leader or some other role in a group.

   d. One who isolated themselves may not be participating.

   e. Pick up things like frustration or hurt: "as people we are wired to pick up these things naturally when we see them".

Appendix D Web-brochure



Access Grid @ WPI - Information

Advantages

The Access Grid™ at WPI has so much to offer:

- Collaboration with colleagues miles and miles away
- Convenience of meeting in a high quality facility on campus
- Low cost (Free for academic purposes)
- Participate in a cutting-edge technology
- Cross-platform compatibility

What's This Site For?

We are a group of students completing our IQP in Melbourne, Australia. Our project, titled "Using the Access Grid for Project Work at Global Sites" is focused on the problem of Access Grid underutilization at WPI.

What is the Access Grid™?

The **Access Grid™** (AG) is a collection of "resources that can be used to support human interaction." These tools allow geographically distributed locations the ability to:

- video conference
- visualize distributed data
- hold formal and informal meetings
- participate in courses being offered at other Access Grid sites.

The approach is to provide for group-to-group communication versus the current desktop-to-desktop communication currently used in collaborative projects.

Leveraging the power of the **Internet2**, WPI has installed an Access Grid™ node in the Lower Wedge located in Morgan Hall. This room is a state of the art video conferencing facility that allows people to communicate and collaborate around the global in ways never before imagined.
The Access Grid™ can be used by anyone within the WPI community:

Students: The Access Grid™ puts you in touch with people and resources that might normally be beyond your reach.
Faculty: Consult with a colleague in Hong Kong or Melbourne as if they were in the same room.

Also, because the Access Grid™ is an open source effort, it is constantly improving and expanding.

Application Capabilities

- **Shared Desktop**
  Allow participants to share control of a central computer for collaboration
- **Shared Internet Browsing**
  Keep everyone on the same page, literally
- **Distributed PowerPoint**
  Allow a presenter to control their PowerPoint slides from a central location
- **Video/Audio/Image Sharing**
  Share videos, audio and pictures of meeting participants
- **Data Visualizations and Simulations**
  Engineering visualizations and simulations are easy to share and view over the Access Grid™

Figure 11 - Screenshot of the web-based brochure

Node Types

There are two types of nodes you can use to connect to the Access Grid™:
A **Room Node** consists of a room with multiple cameras, video screens and hardware that supports large group meetings.

A **Personal Interface to the Access Grid™ (PIG) Node** is quite simple and consists on merely a camera, a computer, and audio hardware (a headset with microphone).

What Do You Need for a PIG node?

In order to use the Access Grid™, you need some basic equipment:

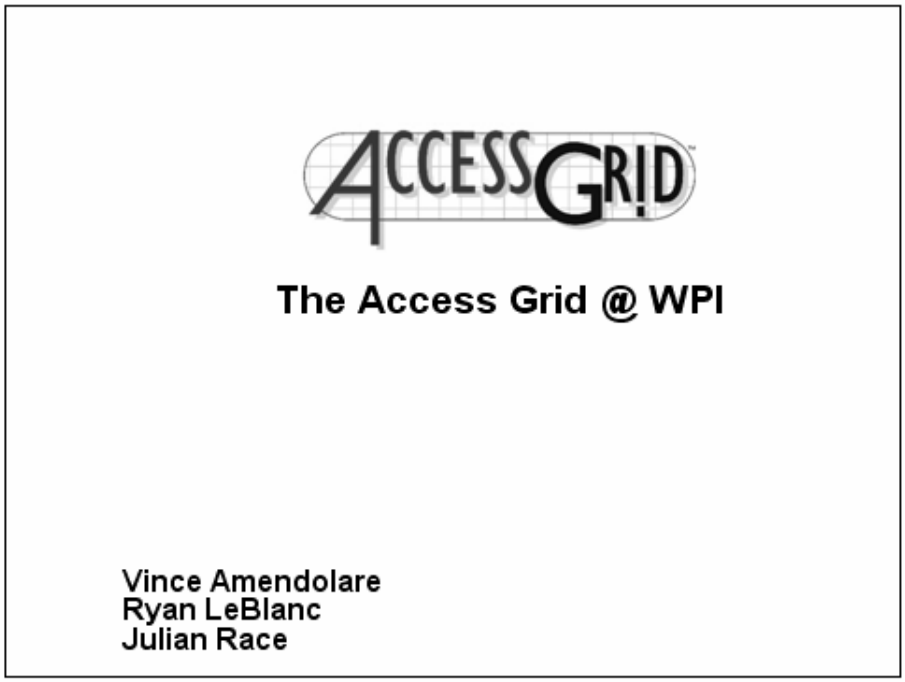
- Computer
- High Speed Network Connection
- Access Grid Software (free)
- Video Camera
- Audio Hardware

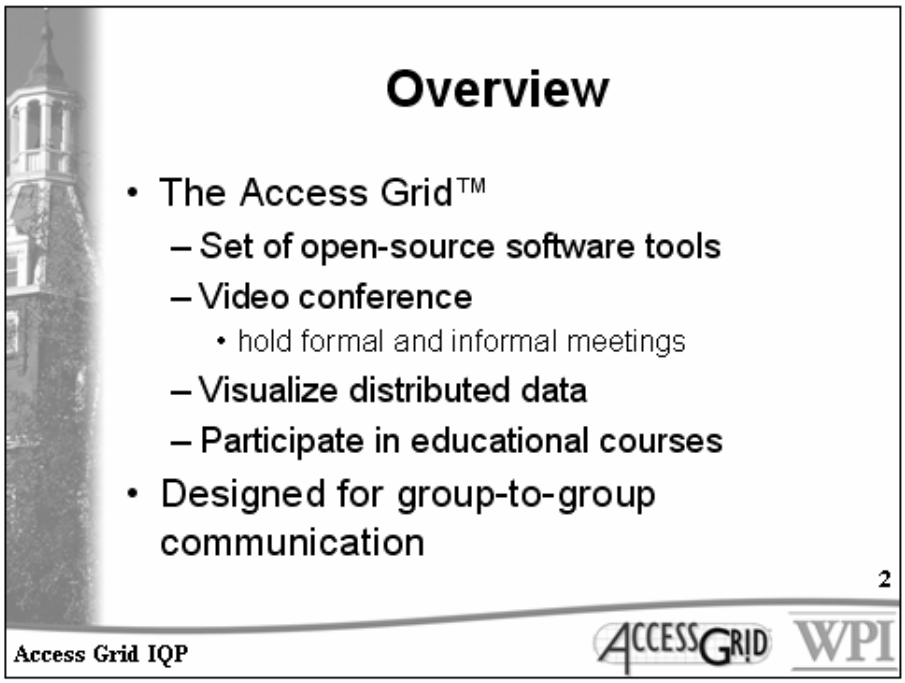
For more information about our project, contact us at agproject@wpi.edu.

Vince Amendolare
Ryan LeBlanc
Julian Race

Figure 12 - Screenshot of the web-based brochure (Cont.)

Appendix E PowerPoint Presentation





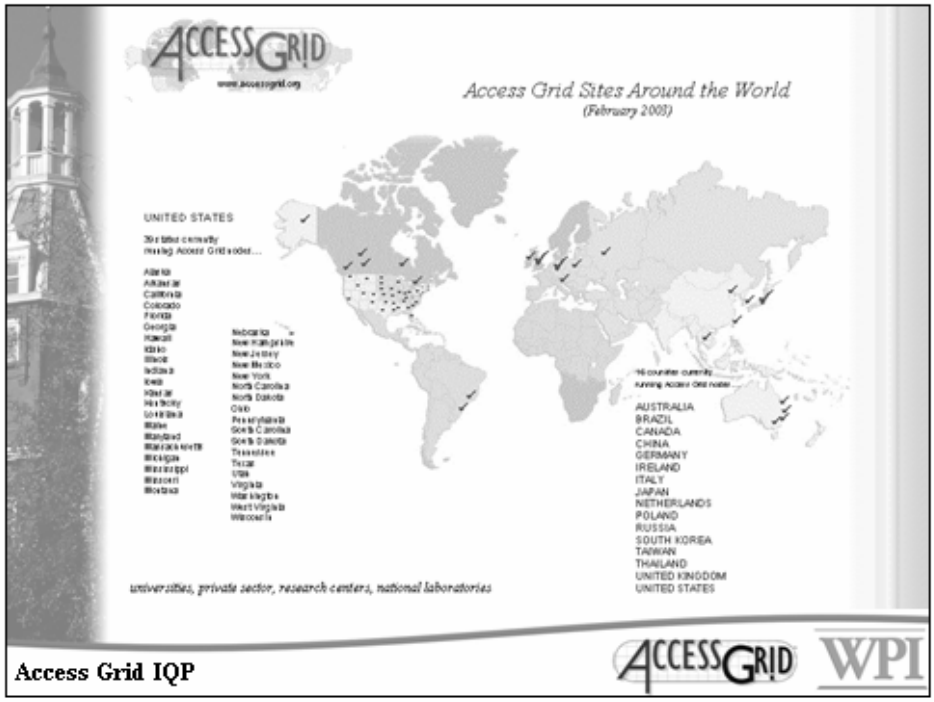
Features and Capabilities

- Shared data, simulations and visualizations
- Shared PowerPoint
  - Distributed PowerPoint uses client/server technology to insure a clear image at all locations
- Shared web browsers
- Shared whiteboard (in development)

3

Access Grid IQP

ACCESS GRID WPI



Access Grid IQP

ACCESS GRID WPI

How to Connect to the AG

- PIG (**P**ersonal **I**nterface to the Access **G**rid)
  - Computer
  - Headset
  - Webcam
  - Free Access Grid Software
- AG Room Node
- Fast Internet Connection

5

Access Grid IQP

ACCESS GRID WPI

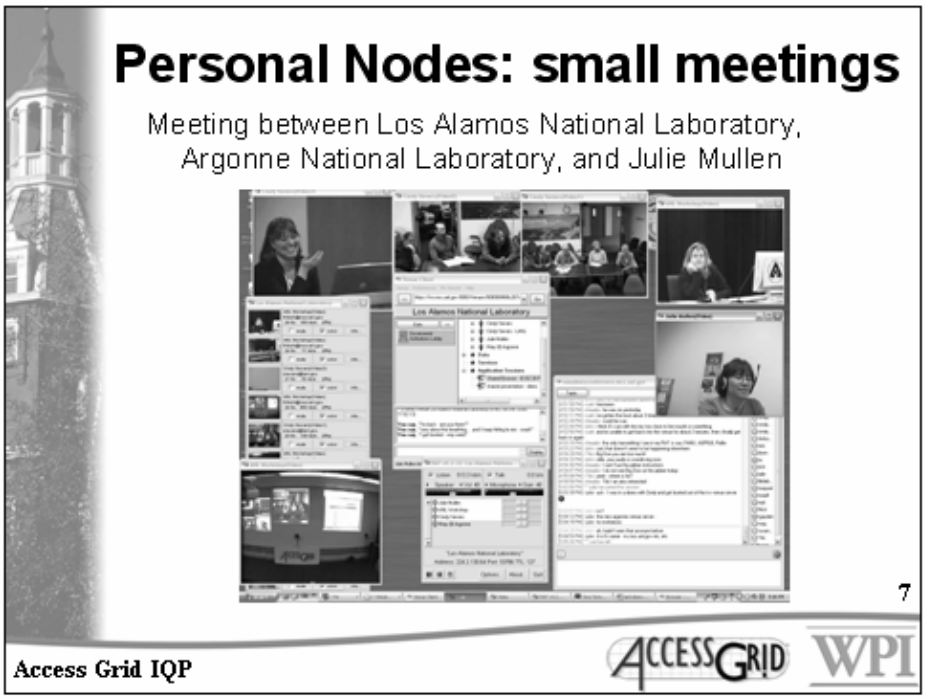
Personal Nodes: large meetings

February Town Hall – Feb. 2, 2005

6

Access Grid IQP

ACCESS GRID WPI


Personal Nodes: small meetings
Meeting between Los Alamos National Laboratory, Argonne National Laboratory, and Julie Mullen
7
Access Grid IQP
ACCESS GRID
WPI

Appendix F Site Director Focus Group Questions

1. What are the remote-communication needs for the students/advisors/sponsors before and during projects?
   What technologies are currently being used, other than phone/email?
   How effective is the current communication? Are there any problems?
   Have you ever used videoconferencing and do you think it could be an effective solution to these problems?
2. In what situations do you see participants at your site benefiting from the AG?

   Keep in mind that both large room nodes (like at WPI) and small personal nodes could be used.
3. Which of the shared applications available for use in the Access Grid would be most beneficial for use in the projects?
   What specific uses can you envision for these applications during the projects?
4. One of the major limitations of Access Grid technology is bandwidth requirements. What is the internet connection/bandwidth available where the students work/live at the remote site?
5. Do you know of any large Access Grid room nodes near the project site?
6. We understand that at some MQP sites, the advisors do not stay for the entire duration of the project.
   Does this occur at your site? If so, please describe any communication problems that arise from this.

   Do you feel that these problems could be alleviated by having communication between the students and the advisor(s) over the Access Grid?
7. Are there culturally-specific communication issues at your site?

   If so please explain. (These issues could be in the form of acceptable behavior, ways of formally addressing those you are conversing with, etc)
8. We understand that at the London project site, since there are C and D-term projects, sometimes there are projects in D-term that are a continuation of a C-term project. How common is this?

   Do you feel that the Access Grid could be use to facilitate meetings during C-term to keep these groups on the same page?

Appendix G Project Advisor Survey Questions

1. What were the remote-communication needs for the students/yourself/sponsors before and during projects?

   What technologies were being used for remote communication when you advised at this site?

   How effective was this communication?

2. Which of the shared applications available for use in the Access Grid would be most beneficial for use in the projects?

   What specific uses can you envision for these applications during the projects?

3. Do you feel that project participants at your project site would benefit from using the Access Grid?

   If not, could you explain why you think so? If so, in what situations do you think it could be used? Keep in mind that both large room nodes (like at WPI) and small personal nodes could be used.

4. Do you know any specific project students that you think we should contact for more information?

5. (London IQP): We understand that at the London project site, since there are C and D-term projects, sometimes there are projects in D-term that are a continuation of a C-term project. How common is this?

   Do you feel that the Access Grid could be use to facilitate meetings during C-term to keep these groups on the same page?

6. (MQP): We understand that at some MQP sites, the advisors do not stay for the entire duration of the project.

   Does this occur at your site?

   If so, please describe any communication problems that arise from this.

   Do you feel that these problems could be alleviated by having communication between the students and the advisor(s) over the Access Grid?

Appendix H Student Survey Questions

1. How easy was it to contact your sponsor during your PQP? Did you receive responses from your sponsor in a timely fashion? How often did you contact your sponsor?
2. What forms of communication did you use during PQP? (Check all that apply)
3. When you arrived at your project site, did your current proposal meet the expectations of the sponsor? Do you feel project work could be improved by more frequent or better communication during PQP?
4. Based on our explanation of the Access Grid (the brochure), would you be/have been willing to use it for project work at off-campus sites?
5. What features of the Access Grid interest you the most? (Check all that apply)
6. Can you think of any other communication needs that the Access Grid might be able to address? If so, please tell us.

   Do you have any further comments you would like to share?

Appendix I Project Sponsor Interview Questions

1. How many WPI projects has your organization sponsored?
2. How much correspondence do you have with project directors when setting up projects? Locally? When the director is at WPI?
3. How much contact do you typically have with students during the pre-project period?
4. What means of long-distance communication do you typically use? Have you found it effective?
5. Do you find that students arrive on site with project goals consistent to your own?
6. Do you feel that the Access Grid could help keep goals more consistent during the pre-project period?
7. Would you be willing to travel to a nearby room node (VPAC) to meet with project students? Would paying a fee to use the facility deter you from this?
8. Would you be willing to set up a personal Access Grid node at your place of operation to meet with project students? What kind of bandwidth is available?

Appendix J Access Grid Participant Survey

1. Please rate the effectiveness of the Access Grid as a means of presenting the content of this event.

Excellent	Very Good	Good	Fair	Poor	N/A
5	4	3	2	1	

2. Overall how would you describe your experience at this event?

Excellent	Very Good	Good	Fair	Poor	N/A
5	4	3	2	1	

3. Overall how did your experience compare with what you expected?

Far Exceeded	Exceeded	Met	Fell Short	Poor
5	4	3	2	1

4. What were the best features of this event?
5. What significant problems, if any, did you encounter?
6. To what extent did these problems impact the quality of your broadcast?
7. Would you be interested in participating in Access Grid meetings in the future?

   _____Yes

   _____ No

   _____ Unsure at this time

8. Please add any comments you would like to share:

Appendix K WPI Global Project Sites

Figure 13 World Map marking all current Project Site locations (Color coded by project type).
(WPI IGSD, 2005)

Table 4 - Project Sites and the corresponding terms in which they are conducted.

Project Site	Project	Term				
		E	A	B	C	D
London, England	Sufficiency	X		X	X	
San José, Costa Rica	IQP	X				
Venice, Italy	IQP	X				
Limerick, Ireland	MQP		X			
MIT Lincoln Labs, Lexington, MA	MQP		X			
Washington, D.C.	IQP			X		
Wall Street, NY	MQP			X		
Worcester, MA	IQP			X	X	
Silicon Valley, CA	MQP				X	
Nancy, France	MQP				X	
Bangkok, Thailand	IQP				X	
Hong Kong, PRC	IQP				X	
Madrid, Spain	Sufficiency					X
Boston, MA	IQP					X
Copenhagen, Denmark	IQP					X
Melbourne, Australia	IQP					X
San Juan, Puerto Rico	IQP					X
Windhoek, Namibia	IQP					X

(WPI IGSD, 2005)

Appendix L Pilot Test Results

Pilot Test Results: Evaluating Access Grid Use for the Hearing Impaired

Subject: Hearing Impaired Students

Objective: To determine what can be done to accommodate hearing impaired individuals who wish to communicate over the Access Grid.

Initial Questions:

Could you please describe the nature of your hearing impairment?

“The severity of a hearing loss is classified into five degrees: normal, mild, moderate, severe, profound. I have a severe to profound bilateral sensorineural hearing loss.

The cause of the loss is damaged hair cells in the cochlea. Without my hearing aids, I can hear drums, trains, men shouting in my ear. Loud, low frequency sounds. As frequency increases, my ability to hear them drops off.

“My hearing aids amplify and compress parts of the normal hearing range into that range where I can hear. It is difficult to classify how well I can hear with the hearing aids; however I will try to get you guys a scan of an audiogram. The same issue with high frequency sounds exists, and I am not able to hear some sounds such as the 's' sound nor discriminate between 'ch' and 'sh'. In addition to lack of hearing at higher frequencies, I also cannot localize sound or separate them easily from background noise (i.e., be able to choose which of two simultaneous speakers to listen to).

“To correct for these problems, I use an FM system to eliminate noise and multiple-speaker issues. I also use lip-reading to make up for some of the sounds I cannot hear.”

In what situations do you find it most difficult for you to understand what someone else is saying?

“It is easiest for me to understand speech when I have clear, uninterrupted view of the speakers lips for lip-reading, there is little to no background noise, the speaker's voice is loud, I've listened to the speaker before, and the speaker has clear articulation.

“When any of those factors are missing, my ability to hear drops. For example, in group situations where the conversations quickly shifts between people, I cannot identify the speaker or move my focus fast enough to resume lip-reading and follow the conversation. There is a large variability in how well I can understand speech. Some people's speech is difficult to understand no matter how long I've known them, such as young children. Others, although they have heavy accents, it does not interfere with my ability to hear them (I may not even be able to hear the

accent). And yet others speak so clearly that I do not need to listen to them for a while before understanding them well."

Have you ever used videoconferencing before?

"I've used videoconference several times. I used the Access Grid to attend a lecture on a high level approach to defining Linux firewall rules. I've also used instant messaging with webcams."

What is you opinion of videoconferencing with regard to your impairment?

"I was unable to lip-read the speakers on Access Grid. I believe it was due to camera angle, lack of resolution on (or even visibility of) the speakers lips, and lack of tight video/audio synchronization. I enjoyed the PowerPoint slides though.

"On instant messaging systems, video is a redundant information stream.

Since it's primarily a text medium, there are no communication issues arising from hearing loss."

Trial #1: Room Node

How zoomed out can the camera be from a person's face and still allow their lips to be read?

We tested the subject by reading randomly generated sentences and having the subject repeat them back. The first distance we attempted contained the speaker's head and upper torso in the frame. From the first distance the subject successfully repeated 2/3 of these sentences. Next the camera was zoomed in such that the speaker's face took up almost the entire frame. From this distance the subject successfully repeated 3/3 of these sentences.

How much does lag (video and audio out of synch) affect one's ability to read lips? Is the Access Grid frame-rate sufficient for lip reading?

The subject stated that the video audio synchronization was acceptable for him to read lips in conjunction with his hearing aid. The subject also stated that the video frame rate was acceptable for him to read lips in conjunction with his hearing aid.

Trial #2: PIG Node

We tested having the hearing impaired participant use a PIG node to determine if this is easier to understand than him using the room node.

The participant stated that having the computer display close to his face, it was easier to see compared to the large display wall. The headphones however, were harder to hear initially. The first test we ran he scored 1/3.

We connected the subject's microphone/earpiece system directly to the Access Grid's audio feed to determine its effectiveness.

Once we connected his earpiece to the Access Grid's audio feed, the participant stated that the audio became much clearer. He scored 3/3 on understanding sentences.

Trial #3: Captioning (unable to perform)

Currently in development is an Access Grid captioning tool. While we will not be able to test this method of communication, we will discuss it in our recommendations as a possible solution.

Comments made by the Participant:

- A lot harder to follow conversation than the random sentence tests.

Room Node:

- Very difficult to understand

- Easier to use than telephone

- Harder to use than in person meeting

- Acoustics of the room make audio difficult to hear.

PIG Node:

- Better for those with hard of hearing

- A lot easer to understand now then before

- Captioning tool would be much preferable

- Prefers text messaging to face-to-face communication, even in person so the Access Grid, even if it perfectly simulated a face-to-face meeting, would not be very effective for the subject

- Would not want to use it while away on MQP

- One on one communication is doable, but add more people and it becomes "crazy" due to fact that he cannot follow conversations of more than 1 person

Pilot Test Results: Faculty Meeting with Graduate Students

This meeting occurred on 4/11/05 and consisted of a WPI Professor who was advising projects in Melbourne, Australia meeting with three graduate students back at WPI. The professor spoke with each student individually, as they were working on separate projects. The discussion was on engineering, and thus became quite technical at times. The professor spoke to his students and also wrote on a whiteboard to relay information. This configuration included a typical whiteboard with a video camera on it as a separate video feed. There were some technological issues that impeded the meeting due to some Access Grid instability causing the video to freeze on one end. This issue was quickly rectified, but did interrupt the meeting.

The students gave us the following feedback.

Please rate the effectiveness of the Access Grid as a means of presenting the content of this event.

Excellent 5	Very Good 4	Good 3	Fair 2	Poor 1	N/A

Two out of three students responded 4, one out of three responded 5.

Overall how would you describe your experience at this event?

Excellent 5	Very Good 4	Good 3	Fair 2	Poor 1	N/A

Two out of three students responded 4, one out of three responded 5.

Overall how did your experience compare with what you expected?

Excellent 5	Very Good 4	Good 3	Fair 2	Poor 1	N/A

Two out of three students responded 5, one out of three responded 3.

The professor responded the following.

Please rate the effectiveness of the Access Grid as a means of presenting the content of this event.

Excellent **5**	Very Good 4	Good 3	Fair 2	Poor 1	N/A

Overall how would you describe your experience at this event?

Excellent 5	**Very Good** **4**	Good 3	Fair 2	Poor 1	N/A

Overall how did your experience compare with what you expected?

Far Exceeded 5	Exceeded 4	**Met** **3**	Fell Short 2	Poor 1

The professor expressed that the technological issues (mentioned above) did impede the meeting. The professor also stated that the best feature of the meeting was being able to write on the whiteboard and be seen in Worcester. The professor also indicated that he would be willing to participate in Access Grid Meetings in the future.

Pilot Test Results: Project Advisor Meeting with IQP Students

This meeting occurred on 4/12/05 and consisted of a WPI Professor who was situated in Melbourne, Australia, with two students he was advising that were working in Worcester during the pre-project period of their IQP. This meeting was not very technical in nature and consisted more of qualitative discussion.

The students gave us the following feedback.

Please rate the effectiveness of the Access Grid as a means of presenting the content of this event.

Excellent 5	Very Good 4	Good 3	Fair 2	Poor 1	N/A

Both students responded 1, since they thought using the Access Grid was unnecessary for this meeting.

Overall how would you describe your experience at this event?

Excellent 5	Very Good 4	Good 3	Fair 2	Poor 1	N/A

Both students responded 5, since the meeting itself ran smoothly.

Overall how did your experience compare with what you expected?

Far Exceeded 5	Exceeded 4	Met 3	Fell Short 2	Poor 1

Both students responded 1, since they felt it was no more effective than a telephone conversation.

The students stated that this meeting could have just as easily been done over the phone and saw no reason to go out of their way to use this technology.

The professor responded the following.

Please rate the effectiveness of the Access Grid as a means of presenting the content of this event.

Excellent **5**	Very Good 4	Good 3	Fair 2	Poor 1	N/A

Overall how would you describe your experience at this event?

Excellent **5**	Very Good 4	Good 3	Fair 2	Poor 1	N/A

Overall how did your experience compare with what you expected?

Far Exceeded 5	**Exceeded** **4**	Met 3	Fell Short 2	Poor 1

The professor was quite pleased with his experience of the Access Grid. The aspect he found most useful was that he could tell who was speaking more out of the two students and easily prompt the student who was less talkative to speak. He also stated he was willing to participate in more Access Grid meetings.

Pilot Test Results: Practice Final Presentations from VPAC to WPI

Access Grid Participant Survey (see Appendix J)								
Student Responses	**Question Number**							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
A	3	3	4	Get outside sources' opinions. Interact with people far away.	Slight tech problems with screen loading.	Broke flow of presentation.	YES	N/A
B	3	3	4	Utilizing cool technology.	VNC dropped. Static in Q&A session. Slow loading.	Awkward when VNC dropped. Static was bad but not really intrusive.	YES	Tech. is cool. Once perfected will be useful. The need for facilitators seems to indicate that the interface could be improved.
C	3	3	3	Ability to see ourselves, our slides and audience.	Long delay in advancing the slides.	Pausing after slides to let them load affected flow slightly.	NOT SURE	I would use this tech if it was the only way to present to someone.
D	4	3	4	Can see everything and everyone.	Lack of a real audience in front of us.	Helped us keep the tone less conversational.	NOT SURE	Small audience, not quite live feeling made it easier to present. Quality of video feed/ projector significantly decreased ability to identify body language in viewers.
E	4	3	2	Clear audio. ease of Q & A session.	The video lag was not expected.	Been easier if we knew setup and limitations.	YES	It was really awkward to talk to a camera and a wall.
F	2	4	3	Real-time feed was interesting.	Lag to what the other end was seeing in presentation was hindering flow	This made it difficult to talk because I focused on the lag.	YES	If the slide viewing could have been in the AG then I would have rated quest 1 and 3 higher.
G	4	3	4	See people from home.	Hard to remember to look at the camera and not the people	It didn't appear that I was talking to them.	YES	N/A
H	3	3	4	Being able to interact with the audience.	Delay in the feed threw me off	Audience could answer better how this affected them.	YES	This tech. should be used.
I	4	3	3	Helpful to hear opinions of people removed from the project.	Some tech problems with the website loading.	Interrupted the flow a bit.	NOT SURE	N/A
J	4	4	3	Able to switch between PowerPoint and web browser easily on the PIG.	Slow slide loading and disconnected from VNC once	No major issue.	YES	N/A

The site director at these presentations responded the following.

Please rate the effectiveness of the Access Grid as a means of presenting the content of this event.

Excellent 5	**Very Good** **4**	Good 3	Fair 2	Poor 1	N/A

Overall how would you describe your experience at this event?

Excellent 5	**Very Good** **4**	Good 3	Fair 2	Poor 1	N/A

Overall how did your experience compare with what you expected?

Far Exceeded 5	Exceeded 4	**Met** **3**	Fell Short 2	Poor 1

This professor stated that "It was a great opportunity for the future participants to be introduced to typical projects from the Melbourne project center. I was especially pleased that even at the end of term, about 1/3 of next year's students as well as one of the advisors were able to attend the presentations. Technical 'glitches' were relatively minor." The professor went on to say that these problems did not hinder the meeting "to any great extent. A few delays in the video, but not significant."

Appendix M Focus Group Minutes

Access Grid Focus Group

3/31/2005

In Melbourne: Limerick MQP Site Director, Bangkok Thailand Site Co-Directors, Melbourne Site Co-Directors, Melbourne Site Advisor

In Worcester: Melbourne Site Director, London Site Director

Using the Access Grid for PQP

- A visual component would be an excellent addition to communication. Could be difficult for liaisons to get to an AG location. Other technology that is less costly and uses less bandwidth might be worthwhile. The proposed guidebook would help but may not be enough.

- Issues are broadband availability and it's too complicated

- The AG can bring in other technologies (phone calls, other video streams)

- Could play to WPI's natural strength of using technology well

- Firewall issues should also be considered

- Should talk to the London IQP teams. High speed internet was available but with no tech support. Have to allow for low level of technical knowledge and keep frustration factor down.

Remote Advising

- Security (confidentiality) issues are a concern

- Physical security is not a problem at WPI facility

- Who's going to pay for it? How is timing to affect meetings?

- ISRP is where students go someplace that is not a project center and could represent a need for videoconferencing. IGSD administers this process.

- MQP in CA. How is project team going to get advice? Students could get support from faculty in the project discipline.

Judiciary Hearings

- Ability to have on-campus hearing board in the loop would make process similar for off-campus students. "Uniformity" of institutional response to allegations. Getting Phillip Clay onboard would be a step in the right direction.

- VERY interested in removing decision making process from the advisors who are also teaching the students.

- Participation by more people could lead to better solutions to issues.

- Faculty function in a range of capacities. “Any way technology can bring resources of the campus to remote sites could improve the experience.” Team dynamics sessions with the counseling center also could be a use for the AG. “body language” is important in counseling sessions. Group or individual counseling could be important.

Presentations via the AG

- Seems useful. AG could provide a wider audience for presenters.

- Would like to see his projects final presentations but wouldn’t want to inconvenience sponsors or students.

- PIG node could provide the experience

- Time zone issues become important at remote sites

- Could be a good test of the AG

- Big room could be turned into an AG node

- Ask yourself what we wish we knew 14 weeks ago. Could give a presentation that would help students get ready to go away.

- We could provide snippets of other project presentations.

- Big question of AG use is cost. Would need to add it to budget for IGSD. Is it cheaper than a plane ticket?

- Need to be able to just “turn it on and go”

- Cost of connection, user fees, human resources costs should be looked into.

Appendix N Key Correspondence

We had a large amount of correspondence with participants in the Global Perspective Program. Some of the most important instances of this are given below, that which we sited directly in the report.

Consecutive Term Project Group: March 16, 2005

They were queried the following early in D-term:

Email to D-term London Project Group:

“I observed the London Access Grid presentations last term and saw how you are going to London this term, in a follow-up project to the one being completed C-term. I myself in Australia for IQP. My project has to do with using the Access Grid, seeking its possible uses in the global perspective program. My group feels that the position your group is in could be a possible use. Do you feel like if your group had been able to meet with the other group over the Access Grid a few times this term it would have helped you? Would you be interested in having one or more meetings with them this term over the Access Grid if they are willing?”

The response:

“The Access Grid meeting was very beneficial. Basically, that meeting created the structure for the entirety of our methodology. I would've loved to have a few a meetings earlier and more often. It would be good to meet with them, but I'm not sure how it would impact the results of our project. We kind of are where we are and I don't want to inconvenience them. Anything that we've needed we've just e-mailed.”

London Site Advisor response to Advisor Survey:

March 29, 2005

We would appreciate if you could answer a few questions for us:

1. What were the remote-communication needs for the students/yourself/sponsors before and during projects? What technologies were being used for remote communication when you advised at this site?

How effective was this communication?

“The biggest need in London is basic internet access. Currently faculty there have only dial-up access, and student access is unreliable. Until this issue is addressed, no real progress is possible.

The most important advantage we had at the Access Grid node at Imperial College was its good connectivity."

2. Which of the shared applications available for use in the Access Grid

would be most beneficial for use in the projects? What specific uses can you envision for these applications during the projects?

"The applications are nice, but the biggest advantage, in my view, is being able to see and hear everyone almost instantaneously. Anything that helps make it possible for everyone to see and touch documents at the same moment is a real plus."

3. Do you feel that project participants at your project site would benefit from using the Access Grid? If not, could you explain why you think so? If so, in what situations do you think it could be used? Keep in mind that both large room nodes (like at WPI) and small personal nodes could be used.

"Strange question. We did use the Access Grid in C-term; this made it possible for a number of people in Worcester to see and ask questions about the final presentations of three of the teams in London. I think everyone involved saw the advantages of using the Access Grid."

4. We understand that at the London project site, since there are C and D-term projects, sometimes there are projects in D-term that are a continuation of a C-term project. How common is this? Do you feel that the Access Grid could be use to facilitate meetings during C-term to keep these groups on the same page?

"There are maybe one or two C-term groups with ties to D-term groups, and these "ties" do not necessarily constitute a "continuation." It would not be possible to have anything like weekly meetings at a node in London; it's just too far removed from the sponsors. It only makes sense to use the [Access] Grid for final presentations, and/or perhaps one special meeting during the seven weeks."

Phillip Clay, Dean of Students, regarding idea on Judiciary Hearings:

April 18, 2005

"I have been in consultation with IGSD since hearing from you regarding the possibility of using the Access Grid to help facilitate judicial hearings for violations of the code of conduct which occur at an off campus project site. After discussing the merits and potential problems associated with such an undertaking, we have decided that it does not make sense to pursue this use of the Access Grid for judicial proceedings.

"The major reasons have to deal with the judicial time frame associated with the site proceedings (hearings are held within 48 hours of notification of charges) and the judicial proceedings on campus. (10 days waiting period from charges for cases going to the Campus Hearing Board). For the Campus Hearing Board to hear a case from a project center requires the full board (8 justices, alternate justices, chief justice, and case officer). Due to the number of participants involved, it would be impossible to assemble a full board within a 48 hour time period.

"For hearings that are currently held on campus, they are scheduled at the end of the school day (usually 5:30 pm) because that is the only time that all members of the campus hearing board are available for the hearings. This time is not compatible with all of the project centers due to the time zone differences-- what would be a reasonable time to hold the hearing at a project center site would not be so at WPI, and visa versa.

"These factors, when considered together with issues of confidentiality of the hearings, lead us to believe that it does not make sense to pursue this option. Using the access grid for hearings would actually take more time than it currently does for a judicial case at project center to try and adjust for the factors for each case/project center.

"Thank you for thinking about the possibility of including the judicial process for project sites for your project on uses for the Access Grid. We wish you well with the rest of your project."

Appendix O Sponsor Interviews: Summary

Sponsor Interview Protocol

Five out of Nine Project Sponsors in Melbourne, Australia were interviewed.

How many WPI projects has your organization sponsored?

3/5 of sponsors replied that this was their first project this year. The other two had 3-4 and 6-7 total projects.

How much correspondence do you have with project directors when setting up projects? Locally? When the director is at WPI?

All sponsors explained that this took place during meetings with the site directors when they were in Melbourne, with maybe some limited contacted via email/telephone contact when the directors were in Worcester.

How much contact do you typically have with students during the pre-project period? What means of long-distance communication do you typically use? Have you found it effective?

All sponsors said that there was a fair amount of contact: mostly email and occasional phone calls (teleconferencing). All sponsors stated that they felt this contact was sufficient.

Do you find that students arrive on site with project goals consistent to your own?

All sponsors declared that the students arrived onsite with goals that were quite consistent with their own. One sponsor explained that the project itself actually changed somewhat when the students arrived. Another sponsor stated that some things were hard to clarify however through phone and email, so he waited to have the group in Melbourne to discuss some material. Possibly an increased availability of technologies would be able to help this.

We then showed sponsors our presentation on the Access Grid.

Do you feel that the Access Grid could help keep goals more consistent during the pre-project period?

One sponsor said probably not. The others stated that the Access Grid had potential to improve communications, as long as it was easily accessible to use.

Would you be willing to travel to a nearby room node (VPAC) to meet with project students? Would paying a fee to use the facility deter you from this?

Four out of five sponsors declared that meeting over the Access Grid would not yield enough of a benefit to warrant going out of their way to have a meeting,

when they could use the phone from their office and have a sufficient meeting. One sponsor said that they would be willing to travel to VPAC for a meeting once or twice during the pre-project period to meet with the students.

Would you be willing to set up a personal Access Grid node at your place of operation to meet with project students? What kind of bandwidth is available?

Most sponsors stated that they did not think it made sense to set up this equipment to hold merely one or two meetings a year on. Some stated that they may look into using a personal node for other uses, and if they had one that they would use it to communicate with project students.

Appendix P Student Survey Results Summary

1. What project site did you attend?

We obtained responses from 107 students of various project sites giving us a good representation of the general body of students who went away on a global project in the last year (approximately 20%).

2. How easy was it to contact your sponsor during your PQP? Rank answer from 1 to 5, 1 being easiest, 5 being most difficult.

The following table represents the data we found.

Difficulty	Totals
1 - Easy	12
2	22
3	27
4	31
5 - Hard	15

3. Did you receive responses from your sponsor in a timely fashion?
68.3% Affirmative

4. How often did you contact your sponsor?
Less than once a week: 73.8%
One to three times a week: 25.2%
More than three times per week: 0.9%

5. What forms of communication did you use during PQP? (Check all that apply)
All students stated that they used email, 63% stated they used phone, and a small few stated that they used other tools such as Instant Messaging, postal mail, and VoIP.

6. When you arrived at your project site, did your current proposal meet the expectations of the sponsor?
73.8% Affirmative

7. Do you feel project work could be improved by more frequent or better communication?
85.0% Affirmative

8. Based on our explanation of the Access Grid, would you be/have been willing to use it for project work at off-campus sites?
81.9% Affirmative

Appendix Q Access Grid Guidebook

(See AG_Guidebook.pdf)