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AN ANALYSIS OF
INTERNET'S MBONE:
A MEDIA CHOICE PERSPECTIVE

by

John Robert Gambrino

September, 1994

Thesis Advisor: James E. Suchan

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The study uses data gathered from the Monterey Bay Aquarium Research Institute's (MBARI) Internet conference experiment to compare MBONE versus face-to-face viewer perceptions of the different communication media and to support the theoretical analysis. The survey instrument used to gather data is presented in this thesis.

Research results showed that the compressed motion video image of MBONE filtered and restricted the conveyance of some non-verbal cues and that feedback could be delayed in one-to-many situations. MBONE is found to be more effective for reducing uncertainty than resolving equivocal communication situations.

This framework for analysis will enable those responsible for the selection of communication media within the Department of Defense (DoD) to have a basis for distinguishing between choices of video-teleconferencing systems.

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A Media Choice Perspective

by

John R. Gambrino
Captain, United States Marine Corps
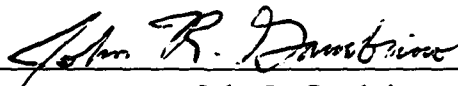B.S., St. Cloud State University, 1986

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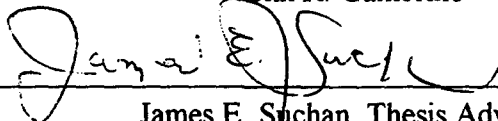
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Author: _____

John R. Gambrino

Approved by: _____

James E. Suchan, Thesis Advisor

_____

William B. Short, Associate Thesis Advisor

_____

David R. Whipple, Chairman
Department of Systems Management

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ABSTRACT

This thesis examines the perceived effectiveness of Internet's Multicast Backbone (MBONE) compressed-motion video-teleconferencing system and analyzes its capabilities and limitations. The analysis follows the media richness model of media choice and discusses seven influences on a managers' media selection. This study expands the video-teleconferencing branch of the continuum of communication media to include compressed-motion video-teleconferencing and the distinguishing factors between systems.

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I. INTRODUCTION

The rapid development of communication technologies in the past decade has presented managers with a variety of choices to meet their organizational communication needs. The decision whether or not to use teleconferencing -- communicating across a distance via electronic or computer means -- is one of the choices managers face. This study examines Internet's Multicast Backbone (MBONE) from a manager's media choice perspective. The particular emphasis of this study is on this compressed-motion video-teleconferencing system's perceived effectiveness from a manager's perspective.

A. BACKGROUND

Both full- and compressed-motion video-teleconferencing have seen an explosion in popularity for economic efficiency reasons: organizations can save money by cutting travel costs. This cost effectiveness is one reason why the Department of Defense (DoD) is interested in using video-teleconferencing. However, is video-teleconferencing the right medium to use to handle the communication demands of the users, or would face-to-face communication be worth the added travel expense? Specifically, do these systems provide a rich enough media to handle the communication demands of users? The manager needs to determine participants' reactions to the video-teleconference to determine whether or not their communication needs are met.

B. OBJECTIVES

The objective of this study is to determine and compare participants' reactions to information presentations broadcast over the compressed-motion video-teleconferencing medium (MBONE) versus those viewed face-to-face This study will also assess the richness of MBONE as a communication medium.

C. RESEARCH QUESTIONS

The primary research question is: Are there perceived differences in the effectiveness of information transfer between conference participants who received information presentations locally and conference participants who received information presentations through the compressed-motion video-teleconferencing medium (MBONE) at remote sites? Is the video-teleconferencing media used rich enough to provide for a successful information transfer? Where does the compressed-motion video-teleconferencing medium (MBONE) place on the media richness continuum?

D. SCOPE AND LIMITATIONS

This study used a survey to measure the perceived effectiveness and richness characteristics of the compressed-motion video-teleconferencing medium (MBONE). This study will describe the technology used and the difficulties encountered in the conference broadcast; however, this study is not a technical evaluation of the video-teleconferencing medium (MBONE). The focus is on media choice and perceived user satisfaction given the information presentation format of the conference. The results

from this study can be applied to potential DoD video-teleconferencing applications by a comparison of media richness characteristics.

The experimental nature of MBONE provided significant challenges in the conduct of this study, such as getting users connected to broadcast the video image, which ultimately affected survey sample size. These challenges are further discussed in the methodology chapter.

E. LITERATURE REVIEW AND METHODOLOGY

The literature review provides the framework necessary to examine MBONE as a communication medium. The factors affecting managers' media choice decisions are presented along with a model for communication media richness, a discussion of teleconferencing, and presentation of related video-teleconferencing studies.

A comparison survey was used to gather quantitative and qualitative data between face-to-face and remote user groups. Interviews with key personnel involved in the setup of this experimental video-teleconference were also used to gather qualitative data.

F. ORGANIZATION OF THE STUDY

This study is arranged in the following order: The *Literature Review* chapter gives the reader the necessary framework used for analyzing MBONE and the basis for understanding the importance of this research. The *Methodology* chapter provides a background of this study. The *MBONE* chapter discusses the capabilities of the communication medium and its potential uses. The *Analysis* chapter assesses the richness of MBONE and presents and assesses the data. The *Conclusions* chapter summarizes this

study's findings, discusses lessons learned, and provides recommendations for further

research.

II. LITERATURE REVIEW

According to Trevino, Daft, and Lengel (1990), managers spend approximately 80% of their time communicating. With the rapid pace of technological innovation in the last decade managers face a dynamic environment filled with myriad choices to fill their communication needs. The use of technologies like facsimile transmissions, voice-mail, electronic-mail across local and wide-area networks, audio, and video-teleconferencing is becoming more and more a part of the daily routine in the Department of Defense (DoD). Teleconferencing offers DoD the opportunity to conduct meetings or provide training and education without the expense and lost time due to travel. The potential budgetary savings of teleconferencing may be attractive to DoD managers, but how are they going to determine whether teleconferencing is the best medium for their communication needs?

The proper choice of a communication medium is vital to the success of managers and organizations. It may be the difference between effective or ineffective communication (Trevino, Daft, and Lengel, 1990). This chapter provides a theoretical framework for the analysis of Internet's MBONE as a communication medium. It will explore the importance of media choice and the major determinants that affect the selection of communication media, introduce the media richness model, provide a discussion of teleconferencing capabilities, and examine related studies of perceived effectiveness of the teleconferencing media.

A. MEDIA CHOICE

Managers make daily decisions on which media to use to fit their communication needs, often without much thought, effort, or conscious understanding of what they are doing. For example: Is face-to-face the best choice, or a telephone call, or an electronic-mail message? Each medium can be effective depending upon the desired purpose of the communication. However, the astonishing advances in communication technology threaten to overwhelm managers faced with media selection decisions (Lengel and Daft, 1988). One of these advances is the use of multimedia that incorporates sound, animation, still images, video, text, and graphics in information delivery.

Media choice is a strategic choice and has become a major challenge in the past decade due to the proliferation of computer networks such as the Internet. Inappropriate media choices can seriously impede successful communication, with potentially disastrous consequences (Trevino, Daft, and Lengel, 1990). An example of a media choice mistake with disastrous consequences is the choice of audio-teleconferencing by NASA managers with Morton-Thiokol engineers to make the decision to launch the space shuttle Challenger in January 1986 (Trevino, Daft, and Lengel, 1990). One interpretation of this disaster is that the communication medium failed to convey the strength of the engineer's negative feelings and anxiety about a shuttle liftoff in cold weather. Electronic communications such as the audio-teleconferencing described in the NASA example can filter emotions and feelings (Lengel and Daft, 1988) which can be critical to decision making.

To be better equipped to make decisions about when to use electronic communications, when to meet face-to-face, or when to send a letter, etc., managers need to have an understanding of some of the factors involved in determining which medium best fits their communication needs. The symbolic interactionism framework provides a basis for understanding the factors involved in managers' media choices (Trevino, Daft, and Lengel, 1990). These factors include the concepts of equivocality, uncertainty, media as a symbol, social presence, organizational considerations, critical mass of users, and comfort level of users. The following sections will discuss the symbolic interaction framework and the factors involved in managers' media choices.

1. Symbolic Interaction

The symbolic interactionist perspective has roots in early work in social psychology. The goal of interaction among individuals in an organization is to arrive at a common understanding or a shared system of meaning (Trevino, Daft, and Lengel, 1990). Symbolic interaction is the process for creating this shared meaning. However, certain ill-defined situations make it difficult for organization members to have a common understanding. Members work together to interpret ill-defined situations through negotiation and feedback, and the creation of symbols that establish new organizational meaning (Trevino, Daft, and Lengel, 1990). An example of this kind of symbol creation is the communication that was required to decide upon a new battle plan for Operation Desert Storm. Generals may disagree about the meaning of information obtained from intelligence reports, thus multiple interpretations of the battlefield are likely. Negotiation

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and feedback are essential for the generals to agree upon the meaning of the intelligence reports, establish a common interpretation, and devise an appropriate battle plan.

Symbols evolve over time and take on established meaning that allows organization members to act from a basis of mutual understanding (Trevino, Daft, an l engel, 1990). Mutual understanding eliminates the need for further negotiation and c   nsus building, so established symbols just need to be transmitted. An example of a well-defined military occurrence is a unit formation. Unit members have a shared meaning regarding what a formation involves, so the formation announcement is straightforward with no negotiation required. The understanding of this symbolic interaction process will support the following discussion of factors influencing managers' media choices.

2. Media Choice Factors

Numerous studies of managers' media selections have examined several factors that affect media choice. These influences on media choice are shown in Figure 1 (adapted from Trevino, Daft, and Lengel, 1990), and discussed below.
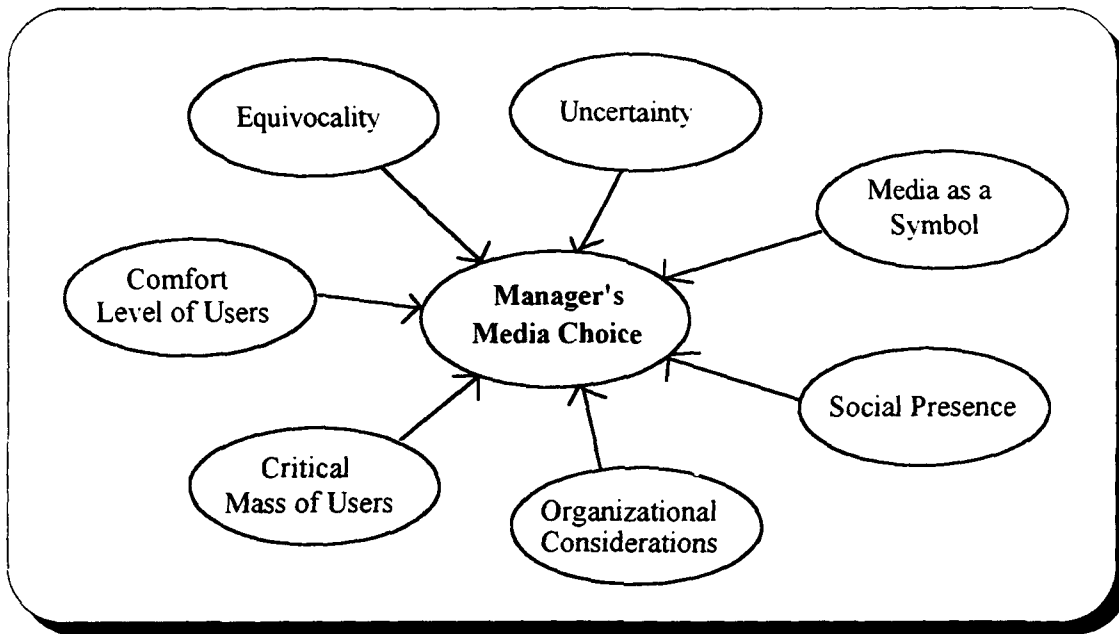
Figure 1 - Influences on Manager's Media Choices

a. Equivocality

The equivocality of a message should affect media choice based upon the symbolic interactionism framework. "Equivocality means ambiguity, the existence of multiple and conflicting interpretations about an organizational situation" (Daft and Lengel, 1986). With high equivocality there is confusion and a lack of common understanding about the interpretation of the subject matter. Manager's may be unsure what questions to ask because objective answers are not readily available (Trevino, Daft, and Lengel, 1990). A Rorschach inkblot that is subject to different interpretations depending upon the individual's perspective is an example of an equivocal message.

Different interpretations are overcome through negotiation and feedback using language and other cues. Equivocal situations often arise when individuals' frames of

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reference or knowledge bases differ. For example a Navy Supply Corps Officer may have difficulty understanding the perspective of an Army Infantry Officer because they may perceive problems differently from different backgrounds. The discussion of their different interpretations and pooling of opinions will help reduce equivocality. Daft, Lengel, and Trevino (1987) suggests that each communication medium is different in its ability to handle equivocal situations, and that equivocality resolution is therefore a significant factor in the decision to choose media.

b. Uncertainty

Unlike equivocality, uncertainty is the more traditionally studied variable in information processing and has come to mean the absence or lack of information (Daft, Lengel, and Trevino, 1987). The more formal definition of uncertainty is provided by Gailbraith (1977) as "the difference between the amount of information required to perform a task and the amount of information already possessed by the organization." As implied by this definition, uncertainty can be decreased by acquiring more information and processing data. Uncertainty is reduced when managers are able to ask questions and get timely responses (Daft, Lengel, and Trevino, 1987), or in short "as information increases, uncertainty decreases." Unlike equivocality resolution, manager's have a clearer understanding of what questions to ask to reduce uncertainty and more objective answers are available. A purchasing agent, for example, can reduce uncertainty about a product selection by gathering cost and performance data about product options and make a comparison. Information is processed to reduce uncertainty in order to make decisions.

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c. Media as a Symbol

An important aspect of media choice in an organization is the perception of the communication medium itself as a symbol. Trevino, Daft, and Lengel (1990) suggest that symbolic cues can be conveyed by the media itself independent of those in the message. For example, written media can symbolize formality (Fulk and Boyd, 1991), or in some settings "high tech" media such as electronic-mail and facsimile transmissions can symbolize power or competence (Sitkin, Sutcliffe, and Barrios-Choplin, 1992).

d. Social Presence

Media choices are matched with the amount of "social presence" (defined as the sense of psychological closeness achievable between partners using a communication medium) of the medium and complexity of the task (Short, Williams, and Christie, 1976). Social presence theorists place communication channels along a continuum with face-to-face on the most social end and written communication on the least social. For example, a telephone conversation can provide more social presence than a written memorandum to inform an individual about winning an award. The focus of this model is the specific communication interchange rather than matching media choice to the whole task or individual's job as a whole.

e. Organizational Considerations

Media choice is driven by organizational considerations, such as cultural norms, policies, and resource constraints (Fulk and Boyd, 1991). Organizations may have written or unwritten policies regarding communication medium usage, which are based on the

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organization's structure. The existence of more sophisticated or technologically advanced communication media available in the marketplace does not mean every company can afford them or has the personnel to operate them. More expensive media options may not meet the current needs of the organization.

f. Critical Mass of Users

Accessibility and critical mass of users are important determinants of media choice, especially for new technologies (Trevino, Daft, and Lengel, 1990). For example, an electronic-mail message will not be an effective communication medium choice if the intended receivers of this message do not have electronic-mail capability or access. However, if the intended receivers do have electronic-mail capabilities this medium provides an efficient means for reaching many users at the same time.

g. Comfort Level of Users

The preferences or "comfort level" of the communicator and receiver will influence media choice (Sitkin, Sutcliffe, and Barrios-Choplin, 1992). The communicator or receiver may feel more comfortable with one medium over another based upon education level, physical capabilities, and familiarity or competence with the medium. For example, manager's who have yet to overcome their "computer anxiety" are more likely to send a memo than an electronic-mail message.

B. MEDIA RICHNESS

The understanding of the factors involved in media choice also provide a basis for understanding the media richness model of media choice. Communication media can be

classified as "rich" or "lean" based upon their ability to facilitate shared meaning (Trevino, Daft, and Lengel, 1990). There are four characteristics or criteria that define the relative richness of a communication medium (Trevino, Daft, and Lengel, 1990):

1. The ability to provide for *instant feedback* in order to answer questions and make corrections to arrive at a shared understanding.

2. The ability to provide for *multiple cues* or channels, such as body language and voice tone and inflection, to convey part of the message.

3. The utilization of a *natural language* in order to convey subtle ideas, rather than the use of numbers.

4. The ability of the medium to convey the *personal focus* or the feelings and emotions of the intended communication.

The premise underlying the media richness model is that communication media vary in their ability to process ambiguous or equivocal messages and develop shared meaning. One thread of research on media richness supports a hierarchical ranking of various communication media in terms of their ability to reduce uncertainty and process equivocal information. The media richness hierarchy scale in Figure 2 is adopted from Lengel and Daft (1988).

```
             Highest  ┬─  Physical Presence (face-to-face)

                      │   Interactive Media (telephone, electronic media.
     Media            │     i.e. video-teleconferencing)
     Richness         │   Personal Static Media (memos, letters, tailored
                      │     computer reports)
                      │   Impersonal Static Media (flyers, bulletins, and generalized
             Lowest  ─┴─    computer reports)
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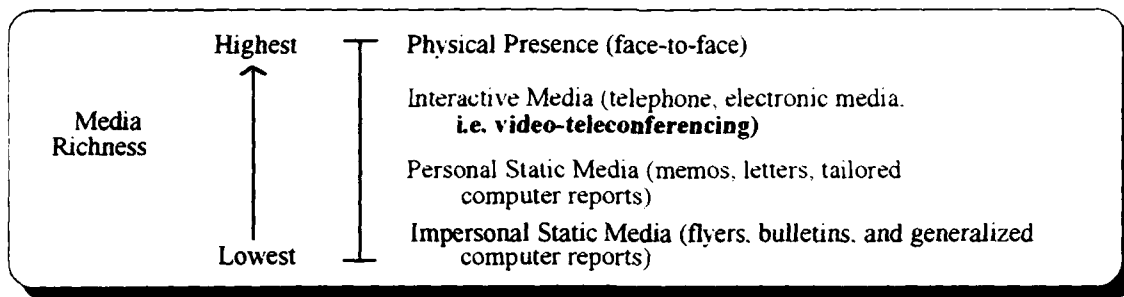
Figure 2 - Media Richness Hierarchy

Based on the media richness characteristics, it is clear why face-to-face is considered

the richest communication medium and written numeric data considered the leanest.

Lengel and Daft (1988) offer the analogy of a pipeline, relating the kind and amount of

liquid that can be pumped, to the characteristics of the medium that limit the amount of

information that can be conveyed For example written documents cannot convey verbal

or non-verbal cues so the characteristics of this medium are relative to the physical

characteristics of a thin pipeline, whereas, the characteristics of face-to-face

communication are relative to the physical characteristics of a very thick pipeline. The

higher the communication medium is on the richness hierarchy, the wider the pipe and

hence the more information can be conveyed.

Daft and Lengel's (1984, 1986) media richness model of media choice has been widely

studied by managerial communication researchers. Fulk and Boyd (1991) in their work on

"Emerging theories of communication in organizations" provide a comprehensive history

of the development of this model from its early roots in organizational information

processing and information richness. The following list summarizes these developments (Fulk and Boyd, 1991):

1. Trevino, Daft and Lengel (1987) modified the media richness model to the symbolic interactionist perspective, which proposed that a media choice can "carry symbolic meaning that transcends the explicit message (e.g., written media symbolize formality)."

2. Electronic-mail was added to the richness continuum above written documents (Trevino, Daft and Lengel, 1987).

3. The focus of analysis shifted from the individual's job as a whole to the individual communication interchange for matching media choices (Trevino, Daft and Lengel, 1987). This achieved a closeness with social presence theory, as described earlier.

4. Daft, Lengel and Trevino (1987) found that high performing managers were more media sensitive than low performing managers.

The question of which communication medium is the best choice for a communication situation can be answered by the "Message equivocality/media richness matching framework for communication effectiveness", shown in Figure 3 (Lengel and Daft, 1988; Trevino, Daft, and Lengel, 1990).

MESSAGE

	Unequivocal or Routine	Equivocal or Nonroutine
Rich (High)	**Communication Failure** Data Glut. Rich media's excess cues cause confusion and surplus meaning.	**Effective Communication** Communication success, because rich media matches with equivocal message.
Lean (Low)	**Effective Communication** Communication success, because media low in richness matched with unequivocal message.	**Communication Failure** Data starvation. Lean media used for equivocal message, with too few cues to capture complexity.

MEDIA RICHNESS

Figure 3 - Message Equivocality/Media Richness Matching Framework for Communication Effectiveness

The richness matching framework in Figure 3 provides a prescriptive approach to media choice. Effective communication occurs when there is a match between the richness of the communication medium and the nature of the message (routine or equivocal). Communication failures are the result of a mismatch between media richness and the nature of the message. For example, the Commanding Officer of a military base would not call for a meeting with the Commanding Officers of his/her major tenant commands in order to communicate a change (decrease) in the operating hours at the Officers' Club. This routine communication being conveyed through such a rich medium as face-to-face could result in surplus meaning, possibly leaving these officers to wonder

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about the future of their club, whereas a simple memo could have communicated this

change without much speculation about the club's future.

The media richness matching framework provides a blueprint approach to media

choice d. .sions. However, the challenge for further research within this framework is the

examination of new communication technologies, their placement on the media richness

hierarchy shown in Figure 2, and the consideration of the contextual factors (Figure 1)

that managers should be aware of when making media choice decisions.

C. TELECONFERENCING

Teleconferencing is a method of communicating across a distance via an electronic or

computer means. The various types of teleconferencing include: computer-conferencing

with electronic messaging back and forth, audio-teleconferencing, and

video-teleconferencing with full or compressed motion video capabilities. Daft, Lengel,

and Trevino (1987) stated that teleconferencing has not lived up to early predictions of

reducing travel and face-to-face communication. A reference to the claims of technology

by a communications consultant described by Meeks (1988) points out that when

technology does not live up to the "hype," or unreasonable claims of what it can do, it has

a damaging effect on the future users of the technology.

The potential for electronic mediated communication, specifically teleconferencing, to

supplant the need for face-to-face communication has been widely discussed for several

years (Daft, Lengel, and Trevino, 1987; Meeks, 1988). Teleconferencing will never

replace the need for face-to-face communication, nor will it solve all of management's

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problems (Daft, Lengel, and Trevino, 1987); however, it does have an appeal for

supplementing more traditional communication channels such as memos, telephone, and

face-to-face. An increasing number of organizations are using teleconferencing, especially

given the spread of computer literacy (Meeks, 1988). The introduction of new

teleconferencing systems into the marketplace is another reason for the growing number of

users.

Fish and associates (1993), in examining a newly introduced desktop

video-teleconferencing system, make the following observations:

> Insofar as audio and video communication mimics the features of face-to-face
> communication in being expressive, interactive, and focusing attention on personal
> attributes, it should function as face-to-face communication. Thus, the media
> richness and social presence perspectives both suggest that video teleconferencing
> should be well suited for informal communication, and especially good for aiding the
> more social, the more uncertain, and the more equivocal aspects of communication.

The teleconferencing system examined in this case is considered full-motion

video-teleconferencing, giving rise to the question of where would other types of

teleconferencing place along the media richness hierarchy. The continuum of

communication media presented in Figure 4 (Chidambaram and Jones, 1993) is a further

development of the top half (interactive media and above) of the media richness hierarchy

introduced in Figure 2. Chidambaram and Jones (1993) adopt the engineering term

"bandwidth" in a non-technical sense to describe a medium's ability to allow a variety of

information stimuli (e.g., multiple cues).
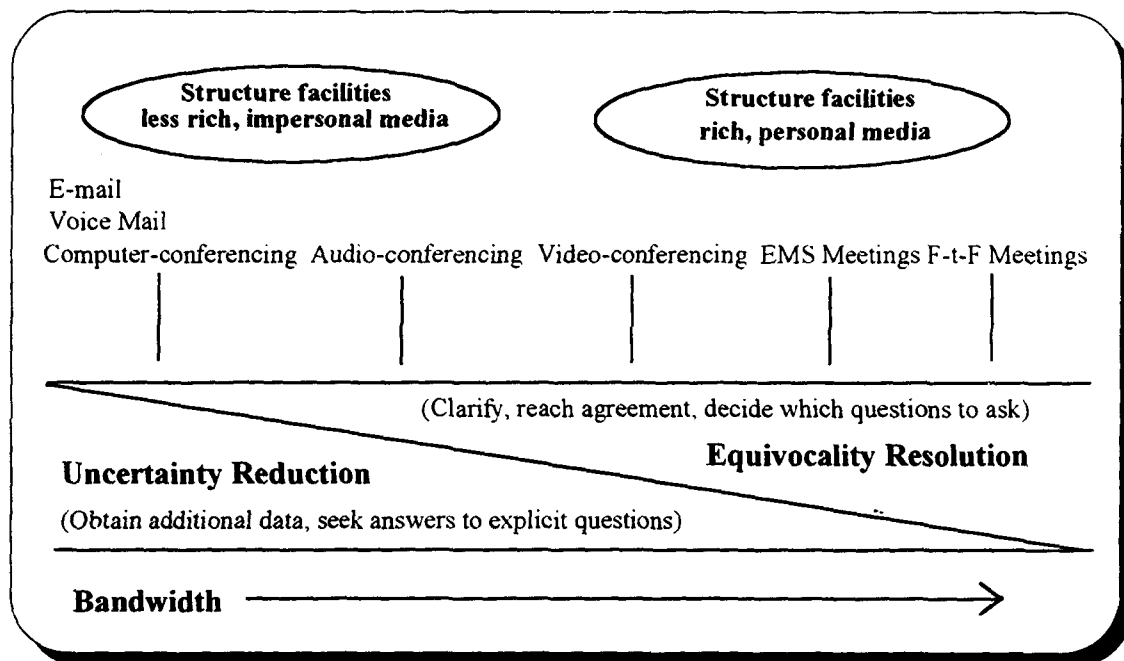
Figure 4 - Continuum of Communication Media

This communication media continuum better represents the teleconferencing end of the spectrum, and considers two major determinants of media choice: uncertainty reduction and equivocality resolution. However, the continuum still fails to capture the differences within the teleconferencing groups as well as contextual factors that affect media choice. For example, the different types of video-conferencing with full-motion and compressed-motion video capabilities are not distinguished in this continuum. Further, users may perceive differences in effectiveness between different systems within a type. For example, in comparing two different compressed-motion video systems, one system may have superior quality audio and better video images, thereby making it a more effective system by comparison to the other.

The expansion of the communication media continuum to include the placement of each teleconferencing system "on the market " suggests a need for further research within the media choice/media richness framework. The real media choice question involves the evaluation of each system or new technology as stand alone systems, and not in the grouping by major category. The full spectrum of media choices involves making selections within the major categories, not just between categories. For example, organizations deciding to purchase a video-teleconferencing system need to be able to distinguish between the different systems available in the marketplace. The potential for future research to determine the user's perceived differences in effectiveness of new systems is as limitless as the invention of new systems.

D. RELATED STUDIES

The media richness framework has spawned a number of different studies into the utility of various communication media and perceived effectiveness of new technologies. With the use of teleconferencing capabilities now gaining popularity as a tool for distance learning, there is increased opportunity for studies into the perceived effectiveness of new systems. However, an extensive computer search effort to find studies of teleconferencing systems, specifically video-teleconferencing, within the media richness model of media choice resulted in only one such study meeting this specific criteria. This study, by Fish and associates (1993), investigates "video as a technology for informal communication."

Researchers, using a desktop "video telephony communications system" in their work to develop multimedia communications, are examined by Fish and associates (1993). The

researchers are striving to emulate face-to-face communications to the greatest extent possible in their development of new systems. Fish and associates (1993) surveyed the perceptions of nine different media used by the researchers for a variety of communication tasks and found the video telephony system was judged inferior to face-to-face communication for most tasks. This finding is common to other studies of media appropriateness that are the basis for placing face-to-face at the top of the media richness hierarchy.

However, the pattern of perceived appropriateness of media differed across tasks, and the video telephony system was judged adequate for routine information exchange, checking on project status, and keeping in touch. The video telephony system was not used for the more "socially sensitive and intellectually difficult" communication situations and was perceived to be more similar to the telephone than face-to-face (Fish and associates, 1993).

This finding is consistent with Daft, Lengel and Trevino (1987). Although not specifically studying teleconferencing, they discuss teleconferencing implications for information systems and manager performance in the following quote:

> Video conferencing is somewhat less rich than face-to-face, but has greater information capacity than the telephone. Video conferencing has full video and audio capabilities, and feedback is fast. Some cues such as body language and nonverbal messages are restricted. The important regulating features of mutual gaze are filtered out. Teleconferences are less emotional in tone than face-to-face communications and thus may be better suited to the exchange of explicit information than to emotional conflict, bargaining, and negotiation.

Most work exploring user's perceptions of effectiveness in handling equivocal situations in computer-mediated conferencing involves group performance and group

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decision making. The prevailing methodology used for this type of study is a comparison of face-to-face and electronic meeting systems. Chidambaram and Jones (1993) used a post session questionnaire designed to assess social presence, communication effectiveness, and communications interface in their comparison of face-to-face and electronic meeting systems (primarily audio-conferencing). This comparison methodology provides an effective means for gathering data to test hypotheses relating new computer conferencing technologies to face-to-face. Their findings regarding user's perceptions of media were consistent with previous findings that consider face-to-face the "warmest" communication medium.

In summary, the research examining communication media within the media richness framework has not fully covered the spectrum of teleconferencing. Specifically, there are limited studies of video-teleconferencing. This suggests a need for further research to examine user's perceptions of video-teleconferencing effectiveness in meeting their communication needs. Researchers and developers of video-teleconferencing systems are striving to develop systems that emulate face-to-face communication to the maximum extent possible (Fish, et al., 1993). Managers need a means of evaluating the claims of these newly introduced systems to make media choice decisions.

III. METHODOLOGY

The methodology used for this research was semi-experimental, aimed at capturing perceived differences in the effectiveness of information transfer between conference participants who received information presentations locally (face-to-face) or by a video-teleconferencing medium (MBONE) at remote sites. This research design is consistent with previous comparisons of face-to-face and dispersed meetings (Chidambaram and Jones, 1993). The variable that is being measured between the two groups is the communication medium.

A. BACKGROUND OF THE STUDY

The impetus for this study of the perceived effectiveness of Internet's MBONE came from researchers at the Monterey Bay Aquarium Research Institute (MBARI). MBARI as the client organization in this study was interested in the use of MBONE as a collaborative research tool to establish a closer communication link with researchers from around the globe. Working with personnel from the Naval Postgraduate School (NPS), specifically Lieutenant Commander Don Brutzman (an NPS operations research instructor and computer science doctoral candidate), MBARI began to establish the technical connections necessary to broadcast selected presentations from an upcoming conference on subsea mobile robotics.

The decision by MBARI to attempt broadcast presentations over MBONE was to expose this new technology to other researchers, thereby promoting its use in future

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academic conferences. This broadcast was itself an experiment in using a new communication technology, and a learning experience for everyone involved in establishing the necessary communication links. In addition to the exposure of this new technology MBARI was interested in whether MBONE was an effective medium for conducting presentations. This broadcast provided the impetus for examination of the perceived effectiveness of information transfer over MBONE from a perspective of media richness.

The setting for this examination was an academic conference, the second workshop on Mobile Robots for Subsea Environments, sponsored by the International Advanced Robotics Programme (IARP). The nations represented at this conference included: France, Italy, Japan, UK, Russia, Spain, Australia, New Zealand, Brazil, Portugal, Canada, and the USA. The host organization for this week long conference was MBARI. The broadcast presentations over Internet's MBONE were planned for the final day of this conference.

The original intent for the Internet portion of the IARP workshop was to broadcast presentations over MBONE from four different locations (with a question and answer session to follow each presentation): Monterey Bay Aquarium in California, Woods Hole Oceanographic Institute in Massachusetts, University of Tokyo in Japan, and INRIA in France. This structure lent itself to a survey comparison of face-to-face and remote participants at each location. The Internet was utilized for on-line survey responses over electronic-mail from remote participants.

The planned format for the Internet presentations was revised due to difficulties in getting the aforementioned presenters connected to broadcast over MBONE and trained in using the system prior to the conference. The MBONE connection with INRIA in France was only a partial success; however, a decision was made not to attempt broadcast from that location. The difficulties encountered by the MBARI personnel promoting the use of MBONE for this conference highlight the experimental nature of this broadcast. When the intended MBONE setup and presentation schedule was deemed infeasible, the revised plan was to broadcast two presentations from the Monterey Bay Aquarium only.

B. THE SAMPLE

The changes in the format for the MBONE broadcast had significant impact upon the control of the sample population. The original plan for presentations from multiple sites provided a controlled audience to survey at remote locations. With these locations not connected for remote participation, the reliability for getting a critical mass of remote respondents decreased significantly. The final day before the broadcast became an attempt to recruit participants to view the conference from remote locations, specifically at the NPS visualization lab and computer science graphics lab.

The broadcast presentations were viewed over the Internet by approximately 20 to 40 people at any given time, from across the USA to France, Norway, Belgium, and Spain. However, their degree of participation and level of interest in the presentation subject matter may have ranged from watching the whole broadcast intently to viewing only a small portion of it. This degree of participation made relying on casual MBONE watchers

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over the Internet somewhat unreliable for survey response; however, these people were

contacted by electronic-mail over the Internet and requested to complete a survey if they

viewed a significant portion of the broadcast. Follow-up attempts to contact Internet

watchers individually and over MBONE conference bulletin boards proved unsuccessful.

The total response for remote participants resulted in 10 completed surveys. This low

response rate was attributed to the lack of control over the remote viewing audience that

resulted in the recruiting effort described and the relia¬¬e on casual Internet MBONE

watchers. This sample consisted primarily of NPS students and personnel with varying

degrees of familiarity with the presentation subject matter and the communication medium

(MBONE).

The total response for face-to-face conference participants resulted in 20 completed

surveys. These surveys were administered directly following the Internet presentation

portion of the IARP workshop to conference participants with a high degree of familiarity

with the subject matter. This was the target audience for the exposure to the capabilities

of MBONE as a potential tool for future collaborations. This audience, although viewing

the presentations live, was given an initial briefing about the capabilities of MBONE and

the broadcasting of the presentations. The audience also received first hand experience

hearing questions received from remote locations over the Internet.

C. DESIGN OF DATA COLLECTION

The design of the data collection was aimed at a comparison of two similar groups of

researchers interested in the presentation of selected topics on mobile robots for subsea

environments. This research design was consistent with previous research techniques used for evaluating the impact of different communication media on perceptions of effectiveness (as discussed in the Related Studies section of Literature Review). However due to the difficulties outlined in the conduct of the study, which are attributable to the experimental use of this new technology, the resulting groups surveyed for comparison have potentially dissimilar backgrounds. The effect of the differences in backgrounds of comparison groups is minimal since the measuring factor between the two groups is the communication medium and not their understanding of the presentation subject matter.

D. INSTRUMENTATION

The survey instrument used is the questionnaire found in Appendix A. The questionnaire administered for both face-to-face and remote participants contained three major parts: Likert-type statements of agreement/disagreement, bi-polar adjective scales, and background information questions. Remote participants were also given six open-ended qualitative questions, and four Likert-type statements of agreement/disagreement. The four Likert-type statements were designed to assess expectations prior to the conference. This design was aimed at the original format for the conference presentations, expecting a degree of control over the remote survey participants allowing the assessment of prior expectations.

The Likert-type statements of agreement/disagreement were constructed with the media richness framework as a guide. The statements were worded to assess the primary characteristics of a communication medium's richness: instant feedback, multiple cues,

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natural language, and personal focus. These statements were also aimed at assessing the level of participant satisfaction with presentation segments. This portion of the survey was developed from scratch due to the lack of "off the shelf " instruments available to assess media richness.

The bi-polar adjectives were on a semantic differential scale of 1 to 7. Items numbered 1 to 20 of this section, which evaluate media perceptions, were taken from Chidambaram and Jones (1993). This instrument was developed primarily from the work of Short, Williams, and Christie (1976), and was designed to measure social presence, communication effectiveness, and communications interface. The remaining 11 items on this scale were added to the borrowed instrument to assess the characteristics of media richness and level of satisfaction.

The overall design of this survey instrument was an iterative process aimed at testing question construction and measurement validity. The final instrument product found in Appendix A is strongly recommended for use in future studies of communication media.

E. ANALYSIS STRATEGY

The lack of critical mass of remote respondents places the statistical significance of this study's findings in question. This problem will be overcome with the supplemental use of qualitative data gathered from remote respondent surveys, interviews with key individuals involved in the physical set-up of this MBONE experiment, and interviews with first time MBONE viewers with managerial communications expertise. The analysis will test the characteristics of media richness and place MBONE on the media richness

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hierarchy, and evaluate other factors involved in the choice of MBONE as a

communication medium.

Before the analysis of the data collected, it will be essential to provide a discussion of

what exactly is MBONE. The following chapter is a background description of MBONE

and a discussion of its current and potential applications

IV. MBONE

In the rapidly changing environment of communication technology, there are numerous budding services aimed at providing video-teleconferencing capabilities. One service that can deliver one- or two-way video-teleconferences to desktop computers is the Internet Engineering Task Force's (IETF) Multicast Backbone, nicknamed "MBONE" (Wexler, 1993). This chapter provides a "reader friendly" description and background of one of Internet's most unique networks (MBONE), and discusses its current and potential uses. However, it is essential to first provide background information about the Internet and how it works because MBONE uses its existing network infrastructure.

A. INTERNET BACKGROUND

The Internet is the world's largest computer network, comprised by some estimates of over 6000 subnetworks located in 100 countries and connecting approximately 6 million users (Belsie, 1993). Other estimates claim there are more than 15 million people using the Internet (Abernathy, 1993). The scope of the Internet, referred to as the "information super highway," has seen rapid growth in the past ten years.

The Internet was conceived in the early 1970's as a US Department of Defense (DoD) network called the ARPAnet, named after the Defense Advanced Research Projects Agency (DARPA). The ARPAnet's original purpose was to advance military research in computer networking, specifically to determine how failures or outages could be mitigated in networks (Krol, 1992). The goal was to develop a methodology and topology

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(structure of network connections) so that if parts of a network were destroyed, other routes could rebuild the critical lines of communication.

The early experience with ARPAnet led to packet technology and eventually the Internet Protocol (IP). A packet is a "bundle of data," and the IP allows a packet to cross between multiple networks to its final destination (Krol, 1992). The various subnetworks that comprise the Internet are connected by computers called routers that transfer data between networks using the same protocol (set of rules governing network communication).

Over time other networks from around the globe have joined the ARPAnet, and the IP became an accepted networking standard by the International Standards Organization (ISO). The experimental network that started out as the ARPAnet evolved into what is now referred to as the Internet. Today just about anyone with a personal computer equipped with a modem can access the Internet from virtually anywhere in the world. Major commercial computer network companies, such as MCI™, CompuServe™, Prodigy™, and America Online™ provide access to the Internet for individuals willing to pay their fees.

The Internet is not one single network or organization, but a conglomeration of networks and organizations connected together. Five years ago the Internet consisted primarily of various federal networks, a set of regional networks, university campus networks, and a few foreign networks (Krol, 1992). More recently the Internet has grown with non-Internet Protocol-based subnetworks connecting via "gateways" that translate

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between the IP and the other subnetwork protocols (Krol, 1992). The National Science

Foundation network (NSFnet) and the Military Network (MILnet) have comprised the

backbone of the Internet because of their high speed links between various regions.

Interestingly, the Internet has no president or chief operating officer, and the only

policing done for the Internet is a voluntary adherence to various protocols and ISO

standards (Krol, 1992). The standards of operation for the Internet are governed by the

Internet Architecture Board (IAB), a "group of invited volunteers" that meet regularly to

decide on network architecture issues (Krol, 1992). This cooperative governance

provides the environment from which new communications capabilities such as MBONE

are developed.

B. MBONE DESCRIPTION

The MBONE is considered compressed-motion video-teleconferencing because

bandwidth (capacity of the physical communication line) considerations limit the frame

rate to significantly less than full-motion video. Standard full-motion video is 30 frames

per second, whereas MBONE sessions are typically broadcast at (1- 4) frames per second

at best over the Internet (Brutzman and Macedonia, 1994).

Users will see a video image in near "real-time" (as it happens) that seems to be

moving in very slow-motion or stop-motion. The MBONE video image can display

anything that can be captured by a video camera, and other media such as overhead

projection of material, video tapes, and computer injected graphics. At (1-4) frames per

second some of sudden or instantaneous movements in the video image will seem to be

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missed by the viewer. For example, the video image of an arm waving motion may appear to show the arm first in its starting position and then in its ending position, without seeing the arm move between these positions. However, still or inanimate images will appear clearly.

The compressed-motion video images broadcast over MBONE may seem to move slow when compared to watching a full-motion video image such as a television program; however, the compressed-motion video image is surprisingly effective when combined with telephone quality audio communication (Brutzman and Macedonia, 1994). "People are visually oriented, with approximately one third of the brain oriented to video, as evidenced by work in computer graphics" (Brutzman interview, 1994). The compressed-motion video images satisfy this visual orientation and enhance the effectiveness of audio-teleconferencing. The participants of an MBONE session will normally perceive audio conversations as if they are occurring in "real time" (Brutzman and Macedonia, 1994).

The MBONE sessions are primarily desktop to desktop conferencing. The desktops are typically workstation class machines, such as the Sun Microsystems SparcStations or Silicon Graphics Incorporated workstations, running the UNIX operating system. MBONE sessions can also be viewed over a projection screen to accommodate large audiences. MBONE sessions can connect one-to-one or one-to-many users, providing one-way video/two-way audio or two-way video/two-way audio. Interaction over

MBONE is done by audio and video; however, users cannot send keyboard messages back and forth.

This description section is intended to help the reader visualize what a typical interactive MBONE session would be like so as to provide a better understanding of the theoretical analysis of MBONE in the following chapter. The background section will discuss the evolution of MBONE, how it works, how it is governed, and how to get connected.

C. MBONE BACKGROUND

1. Evolution of MBONE

In 1992 a new communications capability was demonstrated by the Internet Engineering Task Force (IETF) at conferences in San Diego and Boston; the Multicast Backbone (MBONE) is an outgrowth of these two "audiocast" experiments (Casner, 1993). These demonstrations were the first known audio and video multicast transmissions utilizing packet switching technology over a predetermined IP multicast topology (multicasting will be addressed in the next section). The San Diego conference was broadcast across 40 subnetworks and 4 countries; the Boston conference exceeded that initial broadcast, covering 90 subnetworks and 10 countries. Today, some estimate that MBONE broadcasts cover over 750 subnetworks and span across 19 countries, which is a rapid growth given how long MBONE has been in existence.

2. How MBONE Works

The MBONE, which currently links Unix workstations, has been called a "virtual network" because it uses the physical Internet to support routing of IP multicast packets (Casner, 1993). Multicasting is a function that allows conservation of network traffic because a sending site can ship just one video packet that is replicated by a receiving router desiring to distribute the videoconference to multiple desktops (Wexler, 1993). The multicasting function has not been integrated into normal routers. Therefore, MBONE is layered over the Internet with multicast routers, called m-routers, which are typically dedicated workstation-class machines. Multicasting conserves bandwidth because one packet can touch all workstations on a network, so a (1- 4) frames per second video image uses the same bandwidth whether received by one workstation or 20 workstations (Brutzman and Macedonia, 1994). The video portion of the multicast is the most problematic because it requires the most bandwidth. However, as the physical links between networks are upgraded to increase bandwidth over time this limitation will become less of a problem.

3. How MBONE is Governed

Like the Internet, there is no single person in charge of this worldwide teleconferencing system. Rather it is a voluntary, cooperative effort by many people with various academic and commercial backgrounds and interests. Users participate in standard setting, day-to-day operation, and use of MBONE through electronic mailing lists. Cooperation is the key to scheduling events in order to prevent overloading of the

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network (Brutzman and Macedonia, 1994). The mailing lists are also an exceptional way to further develop MBONE. Development and refinement of software to operate MBONE is often done through feedback and suggestions which permeate the lists.

4. How to Get Connected to MBONE

The "Frequently Asked Questions on the MBONE" (Casner, 1993) provides the detailed steps on how to join the MBONE. The physical hardware setup of the multicast-router and topology for multicast distribution will require the skills of a network engineer. Brutzman and Macedonia (1994) state that MBONE network "setup is not for the faint of heart, but all the tools are documented, and help is available from the MBONE (mailing) list." The software that runs MBONE was developed entirely by volunteer programmers and computer scientists for educational and technology advancement purposes. The majority of this software is considered shareware because it is freely available to "download" over the Internet, complete with documentation (Casner, 1993). Therefore, the "cost of admission" to the MBONE network is relatively low, basically the cost of the hardware, the hookup, and the time necessary to make the connections (Brutzman and Macedonia, 1994).

Once the physical network and software to run MBONE are established, users can begin to take advantage of the potential of compressed-motion video-teleconferencing over the Internet.

D. MBONE USES

Today MBONE compressed-motion video-teleconferencing is used by thousands of researchers in collaborative efforts to further technology and other research efforts. A consortium of 20 companies including Compression Labs, Inc., IBM, and Sun Microsystems, Inc. meets via MBONE to further develop Internet video-teleconferencing (MBONE) capabilities (Wexler, 1993). This consortium is just one example of network research collaboration that has been called a "virtual corporation" (Wexler, 1993). As this collaboration indicates, "the MBONE is an excellent tool for doing research in networks and video-teleconferencing technology" (Brutzman and Macedonia, 1994). The capability for receiving feedback from a wide range of participants on MBONE has significantly improved the quality of MBONE tools, protocols, standards, applications and events (Brutzman and Macedonia, 1994).

The MBONE has been called the CSPAN of the Internet (Wexler, 1993) because of the informative and educational type of broadcasts that can be viewed over MBONE. Some of the most "exciting events" on the Internet are viewed over MBONE such as NASA Select, which is like an in-house cable channel broadcast during shuttle missions (Brutzman and Macedonia, 1994). Conferences on a wide range of topics from supercomputing to undersea robotics have appeared over MBONE, and broadcast lectures by distinguished speakers have been provided over MBONE. Furthermore, Internet Talk Radio (over MBONE) has presented talks by US Vice President Al Gore, talk-show host Larry King, and others (Brutzman and Macedonia, 1994). One of the unique advantages

of using this forum for information presentations is the capability to provide briefing scripts, or the academic papers presented, as "download" files available over the Internet.

Of all of the uses for MBONE to date, perhaps the most significant is the ability to provide learning at a distance. The capability to pump video-teleconferences across the world wide Internet has unleashed tremendous educational opportunities (Wexler, 1993). Distance learning over a worldwide hookup has the incredible potential to multiply training and education benefits, and provide significant savings in travel and lost time expenses. The Naval Postgraduate School (NPS) has used MBONE to provide remote training at the NPS Computer Center's Visualization Lab with one participant commenting that the two-way communication "was just like being there" (Brutzman and Macedonia, 1994). More recently, NPS personnel participated in a global lecture hall experiment over MBONE. The experiment, held on July 7, 1994, connected 51 sites in 19 countries in conjunction with the first International Conference on Distance Education in Russia titled "Distance Learning and New Technologies in Education." Future plans for NPS utilization of MBONE include running a large-scale distributed interactive virtual reality simulation.

The future of the MBONE as an educational tool holds great potential for those organizations willing to invest the time to experiment with this new technology. The MBONE is capable of providing one- or two-way compressed motion (approximately 3 frames per second over the Internet) video-teleconferencing with telephone quality audio. Although still considered experimental, this new communication technology is available

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for use now. The next chapter will analyze MBONE using the media richness framework

discussed in the Literature Review, and assess users' perceptions of MBONE's

effectiveness as a communication tool.

V. ANALYSIS

The previous chapter described MBONE to help the reader visualize what a typical interactive MBONE session would be like. This description will be helpful in understanding the theoretical analysis of MBONE that begins this chapter.

The theoretical analysis will first examine the media richness characteristics of a fully interactive MBONE setup, then discuss the influences on a manager's selection of MBONE as a communication medium, and place MBONE on the continuum of communication media. This section will use concepts and models outlined in the Literature Review chapter, and qualitative data gathered from interviews.

The presentation and analysis of quantitative and qualitative data gathered from the MBARI Internet conference experiment will follow the theoretical analysis.

A. THEORETICAL ANALYSIS

1. Media Richness Characteristics

This section assesses MBONE using the media richness model of media choice, and places it on the continuum of communication media richness. The four characteristics that determine the relative richness of communication media will be addressed individually, assuming the fully interactive capabilities of MBONE as described in the previous chapter.

a. Instant Feedback

The MBONE has the ability to provide near "real time" audio and video feedback to answer questions and clarify meaning to arrive at a shared understanding.

However, some time delays or communication failures can be expected due to network considerations. The packets of data that carry the audio and video signal across the network may become lost during transmission, causing communication failure. Brutzman points out that "remote participants may need to learn patience" with technical delays (Brutzman interview, 1994).

Depending upon the number of remote participants (e.g., one-to-many), some sort of rules or protocol may be necessary to facilitate a question/answer exchange, thereby slowing feedback times. Feedback in this situation may be slower than a telephone conference-call with all participants on the line at once ensuring rapid "give-and-take." However, a one-to-one communication over MBONE will provide near "real time" feedback because communication is directly between the two parties connected, without the added feedback delay of extra participants.

b. Multiple Cues

The MBONE has the ability to provide multiple cues within the limitations and filters of compressed-motion video-teleconferencing. A voice channel capable of telephone quality communication makes verbal cues like voice tone, voice inflection, and rate of speech easily identifiable. However, the compressed-motion video channel makes it difficult to capture all of the non-verbal cues due to the slow frame rate. Brutzman indicates, "there is some filtering effect on everything, but at least hearing the words and seeing some expressions is better than none" (Brutzman interview, 1994). However, body language, gestures, facial expressions, eye contact, and smiles, though muted because of

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compressed-motion, are still discernible. These cues can be enhanced if the presenter or participants "recognize the medium, and are clear and deliberate in delivery and gestures" (Brutzman interview, 1994). If the participants on camera understand that sudden or instantaneous movements may be missed by the viewer, they can compensate by slowing their own motions to ensure they are captured in the video image.

The cues captured in the video image can also be affected by improper camera placement, an inexperienced camera operator, or the camera showing another media such as overhead projected slides and not the person presenting. The problem of the video image showing other media, instead of the presenter, can be overcome by the use of two cameras to capture both images; however, using two cameras would exceed most MBONE bandwidth limitations (Brutzman interview, 1994).

c. Natural Language

The participants in an MBONE session are not limited in choice of language to communicate a range of meaning. For example, numbers can be used on an overhead projection to convey a precise meaning if desired, or natural language can be used to communicate more subtle ideas. The MBONE allows use of natural language over the voice channel (with some additional cues over the video channel) to convey understanding of a broad set of concepts and ideas.

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d. Personal Focus

Interaction over MBONE can convey a personal focus, or the feelings and emotions of the intended communication, within the limitations and filters of compressed-motion video-teleconferencing. Desktop-to-desktop communication over MBONE provides the ability to see and hear the individual on the other end in near "real time." For example, individuals can address each other directly by name and communicate on a personal level as if they were in the same room. However, as discussed in the multiple cues section, the video image does not clearly convey all of the non-verbal cues. This provides a setting where the strength of some personal feelings and emotions may be muted by the filtering effects of the video image. The combination of some non-verbal cues with a fully capable audio channel will convey an adequate personal focus, depending on the situation.

To summarize, MBONE can provide near "real time" feedback in one-to-one situations, use natural or a variety of languages, and allow multiple (verbal and some non-verbal) cues to convey meaning and personal focus within the limitations and filters of the compressed motion video image.

2. Media Choice Factors

This section examines each influence on manager's media choices presented in Figure 1 of the Literature Review and builds on the discussion of media richness characteristics. The focus of discussion will assume a fully interactive MBONE setup, and

clarify contextual factors with discussion from the MBARI (client organization) Internet conference experiment.

a. Equivocality

Message equivocality, the existence of multiple and conflicting interpretations, may eventually be resolved during an MBONE session. Equivocality is overcome through negotiation and feedback using language and other cues. As the discussion of these characteristics in the previous section indicated, a fully interactive MBONE session has the capability for some equivocality resolution using natural language, verbal and some non-verbal cues. However, there are limitations and filters due to the compressed-motion video image and the number of participants interacting.

One-to-one MBONE sessions can adequately resolve somewhat equivocal situations; however, one-to-many situations, even with an effective question/answer protocol, are affected by slower feedback. This slower feedback can compound the equivocality resolution problem by delaying clarification of different interpretations and spawning more questions. Some lost visual cues due to the slow frame rate may also adversely affect equivocality resolution.

Managers must consider the feedback and equivocality resolution limitations of MBONE in their media choice decision. MBONE may not be the best communication medium choice for highly equivocal situations, although somewhat equivocal messages may be resolved.

b. Uncertainty

The MBONE is capable of reducing information uncertainty, or the lack of information. Participants are able to ask questions and receive timely responses over the voice channel. Uncertainty reduction is not as dependent on the video channel as is equivocality resolution. The number of participants in the MBONE session will be a factor in the timeliness of feedback to reduce uncertainty. However, participants have a better idea of what questions to ask to reduce uncertainty, unlike equivocality, thereby accelerating the rate of exchange. MBONE is more effective for reducing uncertainty than equivocality.

c. Media as a Symbol

The use of a "high tech" medium like MBONE can symbolize many different things depending upon the user's perspectives. For MBARI and other similar research organizations it can symbolize a desire for worldwide collaboration and interest in exposing new ideas to a larger scientific community. Ideas can be exchanged over MBONE whether "down the hall or around the world" (Brutzman interview, 1994). MBONE use can also symbolize a desire for the "accomplishment of mutual goals" (Lee interview, 1994), through greater exposure of research efforts.

In other organizations more conservative in their use of new technologies, MBONE may symbolize the future, or tomorrow's technology, today. This is representative of the experimental nature of this new communication technology.

d. Social Presence

An MBONE session can achieve a degree of psychological closeness between participants through the ability to see and hear each other during communication. The media richness characteristic of personal focus is closely related to social presence, where the more "social" communication interchanges involve personal feelings and emotions. The participants' sense of psychological closeness may be limited somewhat by the filtering effects of the video image; however, when combined with the verbal cues, MBONE is well suited to communication situations requiring a moderate degree of social presence.

e. Organizational Considerations

The impacts of organizational considerations on the selection of MBONE as a communication medium is best described using an actual organization. The MBARI Internet conference experiment involved several organizational considerations.

The cultural norms of a research organization such as MBARI provide a comfortable environment for exploring new technologies for collaboration and sharing of ideas. The MBONE conference surveyed in this study was an attempt by MBARI to expose this new technology to other research organizations from different cultures around the world. Other cultures want to see it (the new technology) working before they'll use it -- the "show me" mentality (Brutzman interview, 1994).

The MBARI organizational structure impacted the experiment with MBONE because personnel critical to accomplishing the MBONE setup did not report organizationally to the originator of the experiment (Lee interview, 1994). This situation

created problems with communication and coordination across organizational levels or boundaries. MBARI conducted this experiment within the boundaries of their organizational structure; whereas; another organization may have considered the use of a team or task force approach to coordinate the experiment.

Some organizational cultures, such as MBARI, are willing to experiment with new technologies. In other cultures with rigid policies governing organizational communication, an experiment such as MBARI's may not have been allowed to develop.

As indicated here, organizational considerations such as structure, culture, and policies, can have a significant impact on the choice of MBONE as a communication medium.

f. Critical Mass of Users

As previously discussed, the MBARI experiment with MBONE was an attempt to expose this communication (collaboration) capability to other similar research institutions from around the world. MBARI's ultimate goal was to gain a critical mass of users of MBONE "to have a technology that allows users to be physically in different places and interact to accomplish mutual goals" (Lee interview, 1994). The first step in this endeavor was to "show the audience what is possible (with MBONE) and demonstrate the basic functionality" (Brutzman interview, 1994). While some of these potential users remain skeptical, others "are excited about the idea of using (MBONE) for international demonstrations (Lee interview, 1994).

The availability of MBONE does not mean that everyone will use it. The MBARI experiment illustrates the need for a critical mass of users, and the difficulties encountered in getting potential users interested in MBONE. These difficulties involved establishing the physical network connections between the potential user sites. Once established, the subnetworks will require capable administrators to coordinate its use and train new users.

Other media choice factors, such as the organizational considerations of other potential users, may impact the establishment of a critical mass of users. As previously discussed, the culture or policies of the organizations that MBARI desires to communicate with, may impact their use of MBONE. The comfort level of users also affects the critical mass of users.

g. Comfort Level of Users

If the first steps to accomplishing MBARI's goal (of using MBONE as an international collaborative research communication tool) were to expose MBONE to potential users and establish network connections, then the next step must be for new user organizations to ensure training and education on its usage. This step is vital to establishing a critical mass of MBONE users. Unless users are comfortable with the technology, they will not use it.

The comfort level of users with a particular communication technology is normally a function of the amount of training and education they have in its use. This training and education will include the network administrator and other personnel who will

help others to use MBONE to communicate in research collaborations. Once users have achieved a familiarity or a competence with using MBONE, they will be more inclined to use it as a communication tool.

3. MBONE on the Continuum of Communication Media

The discussion of MBONE's media richness characteristics and the factors affecting its choice as a communication medium provides a basis for understanding its placement on the continuum of communication media presented in the Literature Review. As indicated earlier the MBONE can provide near "real time" feedback in one-to-one situations, use natural or a variety of languages, and allow multiple (verbal and some non-verbal) cues to convey meaning and personal focus within the limitations and filters of the compressed-motion video image. These MBONE characteristics are compared to other communication media in Figure 5, a modified continuum of communication media.
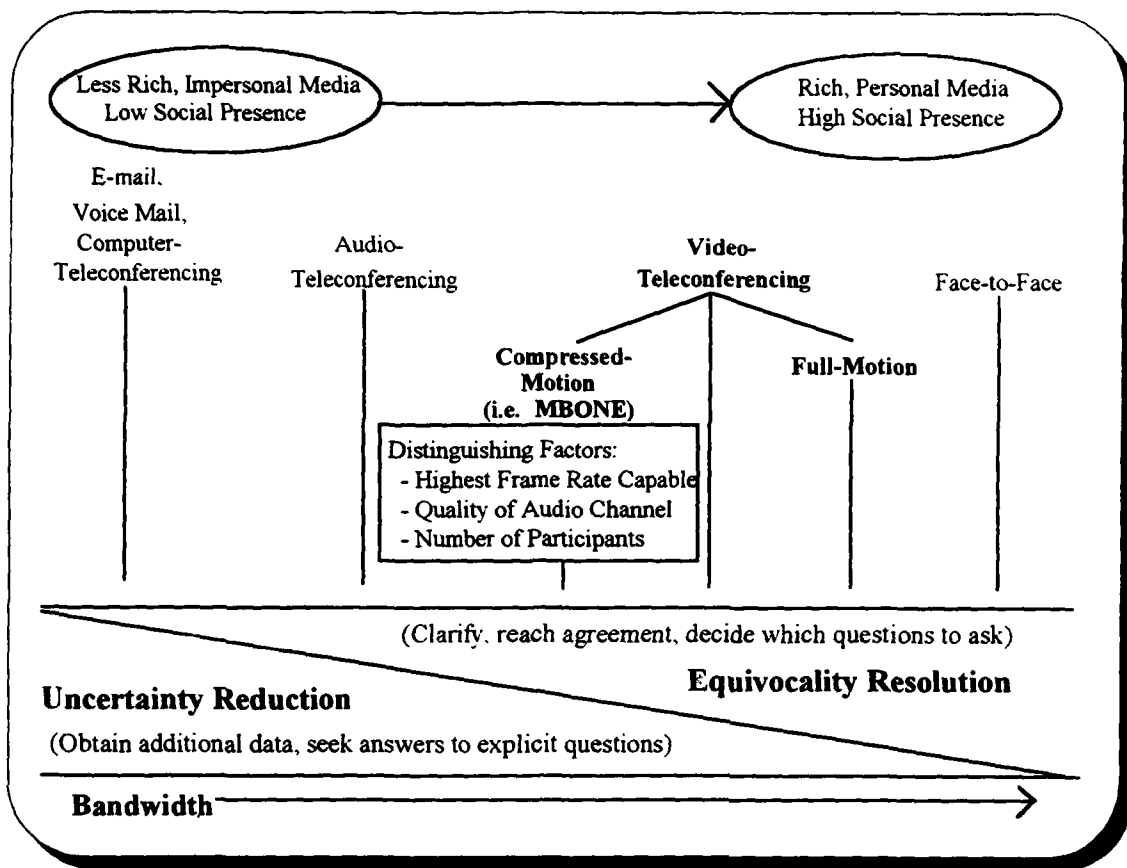
Figure 5 - Modified Continuum of Communication Media

This modified continuum highlights video-teleconferencing which branches into full-motion and compressed-motion. The MBONE is placed with compressed-motion video-teleconferencing systems in the middle of this continuum, based on its richness relative to the other communication media measured.

The continuum in Figure 5 addresses the three factors of media choice that can be compared between various communication media: social presence, uncertainty reduction, and equivocality resolution. The placement of MBONE on this continuum relative to these media choice factors is based on the previous discussion that found: MBONE is capable of handling somewhat equivocal situations, MBONE is more effective for

uncertainty reduction than equivocality resolution, and MBONE can provide a moderate degree or medium level of social presence. The other factors affecting managers' media choices (media as a symbol, organizational considerations, critical mass and comfort level of users) are peculiar to organizations' and individuals' differences.

The information communication bandwidth of MBONE is one step closer to full-motion video-teleconferencing or face-to-face than audio-teleconferencing. In addition, the modified continuum presents factors that will help distinguish or separate MBONE from other compressed-motion video-teleconferencing systems. These factors must all be considered when differentiating between compressed-motion systems. A higher frame rate will move systems closer to full-motion in their capabilities to convey non-verbal cues and greater personal focus; however, without a quality audio channel the additional non-verbal cues provided in the video image may be offset by lost verbal cues. The number of participants interacting in a compressed-motion video-teleconferencing session will affect the timeliness of feedback that is essential to equivocality resolution. The ability of a system to provide multiple participants with simultaneous interchange capabilities may yield a richer system.

To summarize, MBONE is placed in the middle of the continuum of communication media in a position capable of handling the highly uncertain, somewhat equivoce communication situations requiring a moderate degree of social presence.

B. PRESENTATION AND ANALYSIS OF DATA

This section describes the data gathered from the MBARI MBONE experiment, using the survey found in Appendix A, as outlined in the Methodology chapter. It will begin with a discussion of comparison group backgrounds, then analyze relevant quantitative data from the Likert-type statement and bi-polar scale results. The complete results of the Likert-type statements can be found in Appendix B. The qualitative data gathered from the MBONE viewers is presented in Appendix C, and will be used to support the quantitative data analysis.

1. Comparison Group Backgrounds

The following background information is provided on the *face-to-face* survey participants:

- Sample Size: n = 20.

- Ages: Range 27 - 59, Average 44.6.

- Gender: 19 Males, 1 Female.

- Education Level: All Bachelors Degree or higher, including 11 of 20 with PhDs.

- Previous Video-Teleconferencing (VTC) Experience: Range 0 - 30 times used, Average 4.1 times used.

- Conferences (including VTC) Attended per Year: Range 0 - 20, Average 4.8.

- Other than English as Primary Language: 4 of 20.

The following background information is provided on the *MBONE viewing* survey participants:

- Sample Size: n = 10.

- Ages: Range 27 - 37, Average 33.2.

- Gender: 9 Males, 1 Female.

- Education Level: All working on or possess Masters Degree.

- Previous VTC Experience: Range 0 - 50 times used, Average 8 times used.

- Conferences (including VTC) Attended per Year: Range 0 - 10, Average 2.9.

- Other than English as Primary Language: 1 of 10.

The background data show that the face-to-face group was on average 11 years older, more educated, and attended more conferences; however, they have less video-teleconferencing experience than the MBONE group. There are no major differences in gender or primary language.

Although not considered large enough to determine statistical significance, these groups were used to compare perceived differences in communication media effectiveness.

2. Likert-Type Statements

The relevant Likert-type statements analyzed here will be categorized according to speaker presentation of material, ease of viewing and multiple cues, personal focus, and MBONE viewer expectations. The comparison of responses to the interactivity related statements in Appendix B will not be discussed due to a lack of significant interaction over MBONE during the conference surveyed.

a. Speaker Presentation of Material

This category covers the statements shown in Table 1, regarding content of presentations, conveyance of ideas, overall presentation quality, professional needs, and effectiveness of idea transfer.

TABLE 1 - SPEAKER PRESENTATION OF MATERIAL

(2) I was able to understand the content of the presentations.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	10	70	10	10	0
FACE-TO-FACE	25	70	5	0	0

(3) The presenters clearly conveved their ideas.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	0	60	30	10	0
FACE-TO-FACE	15	55	30	0	0

(4) Overall, I felt the presentations were well done.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	0	80	20	0	0
FACE-TO-FACE	10	70	20	0	0

(5) My professional needs were met by these presentations.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	0	60	30	10	0
FACE-TO-FACE	10	65	20	5	0

(7) The presenters effectively transferred their ideas to me.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	10	60	30	0	0
FACE-TO-FACE	15	55	30	0	0

The data show: 15% more face-to-face viewers were able to understand the presentations' content, 10% more face-to-face viewers believed the presenters clearly conveyed their ideas, and 15% more face-to-face viewers felt their professional needs were met by the presentations.

The lack of significant differences in the perceived quality of the presentations (statement number 4), and the presenters effectiveness of idea transfer may indicate a closeness in the perceived effectiveness of the material presentations over the two communication media.

The small (10-15%) differences in favor of face-to-face communication are consistent with the earlier placement of MBONE on the modified continuum of communication media in Figure 5. Face-to-face communication has a higher information communication bandwidth than MBONE.

b. Ease of Viewing and Multiple Cues

(1) Ease of Viewing

Ease of viewing, shown in Table 2, is categorized with multiple cues because it directly affects the conveyance of visual or non-verbal cues to the participant.

TABLE 2 - EASE OF VIEWING

(8) The presentations were easy to see.					
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	0	40	30	30	0
FACE-TO-FACE	25	45	25	5	0

MBONE viewers found the presentations 30% more difficult to view, as evidenced by the following comments: "the video portion was very frustrating," "staggered video," "choppy picture," and "the video was not as clear as if I were there in person." These comments are consistent with the earlier description of MBONE's video portion as being similar to stop-motion. The compressed-motion video image has a filtering effect on non-verbal cues.

(2) Non-Verbal Cues

MBONE viewers' perceived difficulty with the video channel affected their ability receive or understand non-verbal cues. The statements shown in Table 3 address how the presenters' use of body gestures, eye contact, and facial expressions aided presentation understanding.

TABLE 3 - NON-VERBAL CUES

(12) The presenters' use of body gestures helped me to understand the presentations.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	0	20	20	60	0
FACE-TO-FACE	0	40	45	15	0

(13) The presenters' use of eye contact helped me to understand the presentations.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	0	0	20	70	10
FACE-TO-FACE	0	10	55	30	5

(14) The presenters' use of facial expressions helped me to understand the presentations.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	0	0	30	70	0
FACE-TO-FACE	0	25	60	10	5

The comparison group responses show that MBONE viewers found non-verbal cues less helpful to understanding the presentations than face-to-face viewers. The data show: 45% more MBONE viewers disagreed that body gestures or eye contact were helpful, and 55% more MBONE viewers disagreed that facial expressions were helpful.

The data support the theoretical discussion of non-verbal cues as being hard to capture, but still discernible, due to the staggered video image of MBONE. The larger, more obvious, body gestures are easier to detect, as evidenced by 20% agreement, than the more subtle facial movement or eye contact. The following MBONE viewer

comments provide support: "I was not able to really see the body language of the

speaker," "(I) can't see all gestures (or) eye contact."

(3) Verbal Cues

The statements shown in Table 4 address how the presenters' use of the

verbal cues voice inflection and rate of speech aided presentation understanding.

TABLE 4 - VERBAL CUES

(10) The presenters' vocal inflections helped me to understand
the presentations.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	20	30	30	10	10
FACE-TO-FACE	25	30	30	10	5

(11) The presenters' rate of speech affected my ability to understand
the presentations.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	30	40	20	0	10
FACE-TO-FACE	20	35	40	5	0

The comparison groups show: face-to-face viewers found the presenters'

use of vocal inflections only 5% more helpful than MBONE viewers, and MBONE

viewers found the presenters' rate of speech 15% more helpful than face-to-face viewers.

The rate of speech data only show a 5% difference in disagreement between groups.

The closeness between comparison groups' perceived effectiveness of

verbal cues, when compared to their differences on non-verbal cues, suggests MBONE's

audio channel was successful in conveying verbal cues (additional meaning). However, MBONE viewers commented that the "audio volume was unstable" and the audio was "sometimes poor." Regardless, the data from MBONE viewers suggests that verbal cues did affect their understanding of presentations.

The discussion of multiple cues in the theoretical analysis of MBONE said that verbal cues were easily identifiable. Given the close match between comparison group responses on verbal cue statements, they are almost as easily identifiable over MBONE as they are fac -to-face.

c. Personal Focus

The statements covered in this category construct a picture of the media richness characteristic of personal focus. Table 5 shows statements numbered nine and 15 through 18 regarding: conveyance of presenters' attitudes, credibility, physical presence, convictions, and emotional interest.

TABLE 5 - PERSONAL FOCUS

(9) The presenters' attitudes toward the subject matter were well conveyed during the presentations.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	0	100	0	0	0
FACE-TO-FACE	25	60	15	0	0

(15) I felt the presenters were credible.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	30	70	0	0	0
FACE-TO-FACE	35	55	10	0	0

(16) The presenters conveyed a strong physical presence.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	10	20	40	30	0
FACE-TO-FACE	15	25	50	10	0

(17) The presenters conveyed their convictions about the subject matter.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	0	90	10	0	0
FACE-TO-FACE	15	70	15	0	0

(18) The presenters conveyed an emotional interest in their subject matter.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
MBONE	10	70	20	0	0
FACE-TO-FACE	15	55	20	10	0

The comparison group responses show no differences between groups on the presenters' conveyance of attitudes, credibility, or convictions. Face-to-face viewers felt a stronger physical presence; whereas, MBONE viewers felt a stronger emotional interest from the presenter.

The similarity between comparison group responses to these statements suggests that MBONE is capable of conveying some personal feelings and emotions in communication as predicted in the theoretical analysis. The stronger physical presence felt by the face-to-face viewers is consistent with the limitations and filters of MBONE's video image in providing a personal focus.

d. MBONE Viewer Expectations

The four Likert-type statements shown in Table 6 were designed to assess prior expectations of MBONE viewers.

TABLE 6 - MBONE VIEWER EXPECTATIONS

(1) I expect the Internet video-teleconference will be an effective. communication medium.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
30	70	0	0	0

(2) I would rather attend this conference in person.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
20	20	40	10	10

(3) I expect to learn as much from the presentations as I would have in person.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
20	50	30	0	0

(4) I expect to be satisfied with this video-teleconference.

Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
10	80	10	0	0

All respondents expected MBONE to be an effective communication medium, and most (90%) expected to be satisfied with the conference. MBONE viewer responses to qualitative questions concur with these expectations. All respondents found the use of MBONE was a worthwhile learning experience.

Most respondents (70%) expected to learn as much from the presentations over MBONE as they would face-to-face: however, they were divided on whether they would rather attend the conference in person. The qualitative data provides reasons to support this division, such as "(it) depends upon the conference." Most respondents liked to have the option because "face-to-face still provides for best understanding," but "given a choice of video-teleconferencing or missing a conference, video-teleconferencing is a wonderful option."

3. Bi-Polar Adjective Scales

Comparison groups reported their perceptions of media by rating bi-polar adjectives on a semantic differential scale from one to seven. A score of one indicated negative perceptions of the medium, while a score of seven indicated positive perceptions. The comparison of average responses for MBONE and face-to-face viewers is found in Table 7. Note: some items from the original survey were reverse-coded for analysis.

TABLE 7 - BI-POLAR ADJECTIVE SCALES

Bi-Polar Adjective Scales

Note: x = Face-to-Face average response
       o = MBONE viewer average response

Negative Adjectives								Positive Adjectives
	1	2	3	4	5	6	7	
1. Constrained								Free
2. Complex								Simple
3. Bad								Good
4. Inaccessible								Accessible
5. Distorted								Accurate
6. Impersonal								Personal
7. False								True
8. Painful								Pleasurable
9. Cold								Hot
10. Distant								Close
11. Dehumanizing								Humanizing
12. Inexpressive								Expressive
13. Difficult								Easy
14. Unemotional								Emotional
15. Meaningless								Meaningful
16. Slow								Fast
17. Unsuccessful								Successful
18. Insensitive								Sensitive
19. Boring								Interesting
20. Constricted								Spacious
21. Useless								Useful
22. Lean								Rich
23. Conflict								Harmony
24. Stalemate								Negotiation
25. Confusion								Understanding
26. Ambiguity								Clarity
27. Unconvincing								Convincing
28. Indecisive								Decisive
29. Weak								Strong
30. Non-communicative								Communicative
31. Frustrating								Satisfying

This semantic differential scale was designed to assess social presence, communication effectiveness, communication interface, and media richness. The data show an overall closeness between the comparison groups, with eight outlying differences of approximately one scale point. The outlying adjectives consider MBONE communication more *constrained, complex, distorted, distant, dehumanizing, easy, interesting,* and *constricted* than face-to-face communication. With the exception of *easy* and *interesting,* these adjectives are consistent with the description and theoretical analysis of MBONE.

The video channel of MBONE can seem *constrained, distorted,* and *constricted,* with MBONE overall seeming *distant, complex,* and *dehumanizing.* The perception of MBONE being more *interesting* than face-to-face communication can be attributed to the novelty of this communication medium; whereas, MBONE being considered *easier* than face-to-face may involve the accessibility and availability advantages of attending the conference from a remote location, rather than attending in person. The qualitative data support the consideration of easier access to MBONE, with several advantages of remote attendance related to the ease of accessibility (see Appendix C, question number two).

To summarize, although not statistically significant the data provide support for the theoretical analysis of MBONE. Overall, the comparison groups displayed a relative closeness in the their perceived effectiveness of communication media. Certain characteristics of MBONE such as feedback were difficult to measure, while the theoretical analysis of multiple cues and personal focus found support in the data

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presented. These comparison findings were consistent with the expectations of MBONE's

perceived effectiveness.

VI. CONCLUSION

The MBARI experiment provided opportunity to examine the perceived effectiveness of MBONE as a communication medium. The previous chapter described the data gathered from this study and provided a theoretical analysis of MBONE's capabilities. This chapter summarizes the findings of this analysis, discusses recommendations for the use of MBONE, and suggest directions for further research.

A. CONCLUSIONS

The theoretical analysis assessed the richness characteristics of MBONE, examined the influences on media choice, and placed MBONE on the continuum of communication media. Data gathered from the MBARI MBONE experiment provided additional support for the theoretical analysis.

1. Media Richness Characteristics

In relation to media richness, MBONE is capable of providing near "real time" feedback in one-to-one situations with some feedback delay in one-to-many situations, using natural or a variety of languages to communicate a range of meaning. MBONE also allows multiple (verbal and some non-verbal) cues to convey meaning and personal focus within the limitations and filters of the compressed motion video image. The compressed-motion video image filters the conveyance of the more subtle non-verbal cues such as facial expressions and restricts the accurate transmission of larger body gestures.

2. Media Choice Factors

Seven media choice factors were examined in the Analysis chapter, with four of these discussed within the context of the MBARI MBONE experiment. These contextual factors such as media as a symbol, organizational concerns, critical mass, and comfort level of users are important to organizations considering the use of MBONE or any communication medium. These contextual factors affected the success of the MBARI experiment. The non-contextual factors examined were: equivocality resolution, uncertainty reduction, and social presence.

One-to-one MBONE sessions can adequately resolve somewhat equivocal situations; however, one-to-many situations, even with an effective question/answer protocol, are affected by slower feedback. The limitations and filters on the conveyance of visual cues also adversely affect equivocality resolution.

Uncertainty reduction is not as dependent on the video channel as equivocality resolution. MBONE is more effective for reducing uncertainty than equivocality; whereas, the amount of social presence, like equivocality, is limited somewhat by the filtering effects of the video image. MBONE is well suited to communication situations requiring a moderate degree of social presence.

3. Continuum of Communication Media

The continuum of communication media from the literature review was modified by this study. This modified continuum highlights video-teleconferencing, branches it into full- and compressed-motion, and adds the non-contextual media choice factor of social

presence. MBONE is placed with compressed-motion video-teleconferencing in the middle of this continuum (above audio-teleconferencing and below full-motion and face-to-face) based on its richness characteristics and non-contextual media choice factors.

The modified continuum also added three factors used to distinguish between MBONE and other compressed-motion video-teleconferencing systems that can be placed on this continuum. These distinguishing factors are: the highest frame rate the system is capable of providing, the quality of the audio channel, and the number of participants capable of interacting. These factors must all be considered when differentiating between compressed-motion video-teleconferencing systems.

The placement of MBONE on the modified continuum of communication media was supported by the data from the MBARI experiment. The higher information "bandwidth" of face-to-face communication was evident in this study's findings. MBONE's video image was found to have a filtering effect on the transmission of non-verbal cues. The video channel of MBONE can seem constrained, distorted, and constricted, with MBONE overall seeming distant, complex, and dehumanizing. MBONE's novelty makes it more interesting, and its accessibility and availability make it seem easier than traveling to a conference (face-to-face communication).

This study's support of the MBONE theoretical analysis adds another branch for exploration of the media richness continuum. The prevailing literature on media richness lumps all video-teleconferencing into one category. This study provides a means for

drawing distinctions between the media richness characteristics of different video-teleconferencing systems.

B. RECOMMENDATIONS

As a result of this study, DoD managers have a basis for understanding the capabilities and limitations of MBONE in their selection of communication media. It is recommended that MBONE be primarily used for the exchange of explicit information, rather than for use in communication situations involving emotional conflict, bargaining, and negotiation. In other words, MBONE is not the recommended communication medium choice to resolve highly equivocal situations; however, MBONE is recommended for use in communication situations involving uncertainty reduction.

MBONE is still an experimental technology, and does not offer a secure communication environment; therefore, the recommended uses for the DoD are limited to unclassified communication. In addition, MBONE is recommended for training and to some extent education over distances, as well as research collaboration, and continued research in video-teleconferencing technology. However, all users must consider the limitations and filters of MBONE. Consequently, presentations over MBONE for training, education, or research collaboration purposes should be pre-tested over MBONE to gauge the impact these barriers have on the remote audience. This action will prevent surprises during the presentation broadcast, allow presenters the opportunity to compensate for some restrictions of the compressed-motion video image, and improve the overall effectiveness of the MBONE presentation.

Video-teleconferencing technologies compete in the marketplace for DoD dollars, and each system whether full- or compressed-motion gives certain claims of effectiveness. It is recommended that DoD managers use the media choice framework of this study to examine the perceived effectiveness of these competing systems. This examination can be used in conjunction with a cost/benefit analysis to determine if each system delivers what it claims.

C. FURTHER RESEARCH

The developers of video-teleconferencing technologies are interested in making systems as effective as possible. The survey instrument in Appendix A that was sent to an MBONE conference electronic-mailing list over the Internet received requests for data and results from representatives of Sun Microsystems, GTE Laboratories, Picturetel Corporation, and Insoft, Incorporated, as well as a graduate student in computer engineering at North Carolina State University. This interest points to a need for further research into the perceived effectiveness of new communication media.

This study compared the perceived effectiveness of a compressed-motion video-teleconferencing system with face-to-face communication. Future studies within the DoD should be aimed at comparing the perceived effectiveness of competing technologies. For example, two compressed-motion video-teleconferencing systems can be compared by their distinguishing features to provide a basis for the selection of one system over the other. Additional research should emphasize the interactivity aspect of

video-teleconferencing systems to determine feedback, bargaining, and negotiation capabilities for equivocality resolution.

Future research on new communication technologies can benefit from the framework and analysis of MBONE provided in this study and the expansion of the continuum of communication media. The communication media choices facing managers in the future will become more complicated given the rapid proliferation of technology, and this study provides a means for examination of their perceived effectiveness.

APPENDIX A

SURVEY INSTRUMENT

This survey is designed to assess participants' attitudes toward and perceptions of video teleconferencing. Conference participants at both local and remote sites will be surveyed after the Internet segment of the conference.

Please read each statement carefully. Check only one response per statement. When thinking about each statement and your response, consider only the presentations you have heard during the Internet segment of the conference.

If you are taking this survey electronically please do not modify the statements. Your participation in this survey is essential to provide MBARI with data to determine the relative effectiveness of using the Internet to broadcast conferences to remote locations in the future. Your individual responses will be confidential.

(1) Prior to this conference I was familiar with the subject matter.

Strongly Agree	_____
Agree	_____
Neutral	_____
Disagree	_____
Strongly Disagree	_____

(2) I was able to understand the content of the presentations.

Strongly Agree	_____
Agree	_____
Neutral	_____
Disagree	_____
Strongly Disagree	_____

(3) The presenters clearly conveyed their ideas.

Strongly Agree	_____
Agree	_____
Neutral	_____
Disagree	_____
Strongly Disagree	_____

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(4) Overall, I felt the presentations were well done.

Strongly Agree   _____

Agree   _____

Neutral   _____

Disagree   _____

Strongly Disagree   _____

(5) My professional needs were met by these presentations.

Strongly Agree   _____

Agree   _____

Neutral   _____

Disagree   _____

Strongly Disagree   _____

(6) I was challenged by the ideas presented.

Strongly Agree   _____

Agree   _____

Neutral   _____

Disagree   _____

Strongly Disagree   _____

(7) The presenters effectively transferred their ideas to me.

Strongly Agree   _____

Agree   _____

Neutral   _____

Disagree   _____

Strongly Disagree   _____

(8) The presentations were easy to see.

Strongly Agree   _____

Agree   _____

Neutral   _____

Disagree   _____

Strongly Disagree   _____

(9) The presenters' attitudes toward the subject matter were well conveyed during the presentations.

Strongly Agree   _____

Agree   _____

Neutral   _____

Disagree   _____

Strongly Disagree   _____

(10) The presenters' vocal inflections helped me to understand the presentations.

        Strongly Agree   _____

        Agree   _____

        Neutral   _____

        Disagree   _____

        Strongly Disagree   _____

(11) The presenters' rate of speech affected my ability to understand the presentations.

        Strongly Agree   _____

        Agree   _____

        Neutral   _____

        Disagree   _____

        Strongly Disagree   _____

(12) The presenters' use of body gestures helped me to understand the presentations.

        Strongly Agree   _____

        Agree   _____

        Neutral   _____

        Disagree   _____

        Strongly Disagree   _____

(13) The presenters' use of eye contact helped me to understand the presentations.

        Strongly Agree   _____

        Agree   _____

        Neutral   _____

        Disagree   _____

        Strongly Disagree   _____

(14) The presenters' use of facial expressions helped me to understand the presentations.

        Strongly Agree   _____

        Agree   _____

        Neutral   _____

        Disagree   _____

        Strongly Disagree   _____

(15) I felt the presenters were credible.

        Strongly Agree   _____

        Agree   _____

        Neutral   _____

        Disagree   _____

        Strongly Disagree   _____

(16) The presenters conveyed a strong physical presence.

Strongly Agree _____

Agree _____

Neutral _____

Disagree _____

Strongly Disagree _____

(17) The presenters conveyed their convictions about the subject matter.

Strongly Agree _____

Agree _____

Neutral _____

Disagree _____

Strongly Disagree _____

(18) The presenters conveyed an emotional interest in their subject matter.

Strongly Agree _____

Agree _____

Neutral _____

Disagree _____

Strongly Disagree _____

(19) I felt free to ask questions.

Strongly Agree _____

Agree _____

Neutral _____

Disagree _____

Strongly Disagree _____

(20) Presenters responses to my questions were provided in a timely manner.

Strongly Agree _____

Agree _____

Neutral _____

Disagree _____

Strongly Disagree _____

(21) I felt free to ask follow-up questions.

Strongly Agree _____

Agree _____

Neutral _____

Disagree _____

Strongly Disagree _____

(22) The question/answer exchanges helped resolve difficult issues.

Strongly Agree _____
Agree _____
Neutral _____
Disagree _____
Strongly Disagree _____

(23) The presenters' use of **verbal** cues helped me understand responses to questions.

Strongly Agree _____
Agree _____
Neutral _____
Disagree _____
Strongly Disagree _____

(24) The presenters' use of **non-verbal** cues helped me understand responses to questions.

Strongly Agree _____
Agree _____
Neutral _____
Disagree _____
Strongly Disagree _____

(25) I had sufficient opportunity to verbally interact with the presenters.

Strongly Agree _____
Agree _____
Neutral _____
Disagree _____
Strongly Disagree _____

(26) My questions were clearly answered.

Strongly Agree _____
Agree _____
Neutral _____
Disagree _____
Strongly Disagree _____

(27) Different interpretations of presentation content were resolved during the question/answer session.

Strongly Agree _____

Agree _____

Neutral _____

Disagree _____

Strongly Disagree _____

(28) Overall, I was satisfied with this conference segment.

Strongly Agree _____

Agree _____

Neutral _____

Disagree _____

Strongly Disagree _____

(29) I was satisfied with the question/answer section of this conference segment.

Strongly Agree _____

Agree _____

Neutral _____

Disagree _____

Strongly Disagree _____

The items below are designed to determine your feelings and attitudes toward the communication media used during the Internet segment of this conference. Circle or place an (X) on the point along the scale which you consider to be the most appropriate response. Work rapidly; do not return to previously completed responses.

An example of the response breakdown for Constrained/Free would be:

1 - Very Constrained
2 - Constrained
3 - Somewhat Constrained
4 - Neutral
5 - Somewhat Free
6 - Free
7 - Very Free

	1	2	3	4	5	6	7	
1. Constrained	*	*	*	*	*	*	*	Free
2. Complex	*	*	*	*	*	*	*	Simple
3. Good	*	*	*	*	*	*	*	Bad
4. Inaccessible	*	*	*	*	*	*	*	Accessible
5. Distorted	*	*	*	*	*	*	*	Accurate
6. Impersonal	*	*	*	*	*	*	*	Personal
7. True	*	*	*	*	*	*	*	False
8. Pleasurable	*	*	*	*	*	*	*	Painful
9. Hot	*	*	*	*	*	*	*	Cold
10. Distant	*	*	*	*	*	*	*	Close
11. Dehumanizing	*	*	*	*	*	*	*	Humanizing
12. Expressive	*	*	*	*	*	*	*	Inexpressive
13. Difficult	*	*	*	*	*	*	*	Easy
14. Emotional	*	*	*	*	*	*	*	Unemotional
15. Meaningless	*	*	*	*	*	*	*	Meaningful
16. Slow	*	*	*	*	*	*	*	Fast

		1	2	3	4	5	6	7	
17.	Successful	*	*	*	*	*	*	*	Unsuccessful
18.	Insensitive	*	*	*	*	*	*	*	Sensitive
19.	Interesting	*	*	*	*	*	*	*	Boring
20.	Constricted	*	*	*	*	*	*	*	Spacious
21.	Useful	*	*	*	*	*	*	*	Useless
22.	Lean	*	*	*	*	*	*	*	Rich
23.	Conflict	*	*	*	*	*	*	*	Harmony
24.	Negotiation	*	*	*	*	*	*	*	Stalemate
25.	Understanding	*	*	*	*	*	*	*	Confusion
26.	Ambiguity	*	*	*	*	*	*	*	Clarity
27.	Convincing	*	*	*	*	*	*	*	Unconvincing
28.	Decisive	*	*	*	*	*	*	*	Indecisive
29.	Weak	*	*	*	*	*	*	*	Strong
30.	Communicative	*	*	*	*	*	*	*	Non-Communicative
31.	Satisfying	*	*	*	*	*	*	*	Frustrating

Background Information

(1) What is your age? _____

(2) What is your gender?   Male   _____
                             Female _____

(3) What is the highest degree that you hold?   None   _____
                                                  Associate _____
                                                  Bachelors _____
                                                  Masters   _____
                                                  PhD   _____
                                                  Other   _____

(4) How many times have you used Video Teleconferencing? _____

(5) How many professional conferences or seminars, including teleconferences,
do you attend in a typical year? _____

(6) Which site were you at for this conference?   In Person   _____
                                  (Remote Sites)Monterey   _____
                                                    Woods Hole   _____
                                                    MIT   _____
                                                    Florida   _____
                                                    Japan   _____
                                                    France   _____
                                                    Other   _____

(7) Is English your second language?   Yes _____
                                         No _____

The following open-ended questions are designed to provide remote video-teleconference participants an opportunity to express their opinions following the MBARI Internet conference. Please be as detailed as possible, and use additional space to write if desired.

(1) Overall, do you think the use of this video-teleconferencing medium (Internet MBONE) was a worthwhile experience professionally? Why?

(2) What do you feel were the **advantages** of your attending this conference via Internet?

(3) What do you feel were the **disadvantages** of your attending this conference via Internet?

(4) Would you like to see your organization make more frequent use of this video-teleconferencing medium so that you can attend more conferences?

(5) Would you prefer attending a conference face-to-face? Why?

(6) Was your conference experience hampered by a lack of in person social interaction (networking)? Why?

The following questions are designed to determine your expectations about the MBARI video-teleconference. Please answer these questions <u>before</u> you view the conference.

(1) I expect the Internet video-teleconference will be an effective communication medium.

                              Strongly Agree   _____
                              Agree   _____
    Neutral   _____
    Disagree   _____
    Strongly Disagree   _____

(2) I would rather attend this conference in person.

    Strongly Agree   _____
    Agree   _____
    Neutral   _____
    Disagree   _____
    Strongly Disagree   _____

(3) I expect to learn as much from the presentations as I would have in person.

    Strongly Agree   _____
    Agree   _____
    Neutral   _____
    Disagree   _____
    Strongly Disagree   _____

(4) I expect to be satisfied with this video-teleconference.

    Strongly Agree   _____
    Agree   _____
    Neutral   _____
    Disagree   _____
    Strongly Disagree   _____

APPENDIX B

LIKERT STATEMENT RESPONSES

Likert-type Statements of Agreement/Disagreement Responses

Note: MBONE and FACE-TO-FACE Group Responses Broken Down by Percentage

(1) Prior to this conference I was familiar with the subject matter.

	MBONE	FACE-TO-FACE
Strongly Agree	20	30
Agree	40	45
Neutral	10	10
Disagree	20	15
Strongly Disagree	10	0

(2) I was able to understand the content of the presentations.

	MBONE	FACE-TO-FACE
Strongly Agree	10	25
Agree	70	70
Neutral	10	5
Disagree	10	0
Strongly Disagree	0	0

(3) The presenters clearly conveyed their ideas.

	MBONE	FACE-TO-FACE
Strongly Agree	0	15
Agree	60	55
Neutral	30	30
Disagree	10	0
Strongly Disagree	0	0

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(4) Overall, I felt the presentations were well done.

	MBONE	FACE-TO-FACE
Strongly Agree	0	10
Agree	80	70
Neutral	20	20
Disagree	0	0
Strongly Disagree	0	0

(5) My professional needs were met by these presentations.

	MBONE	FACE-TO-FACE
Strongly Agree	0	10
Agree	60	65
Neutral	30	20
Disagree	10	5
Strongly Disagree	0	0

(6) I was challenged by the ideas presented.

	MBONE	FACE-TO-FACE
Strongly Agree	20	5
Agree	60	50
Neutral	20	40
Disagree	0	5
Strongly Disagree	0	0

(7) The presenters effectively transferred their ideas to me.

	MBONE	FACE-TO-FACE
Strongly Agree	10	15
Agree	60	55
Neutral	30	30
Disagree	0	0
Strongly Disagree	0	0

(8) The presentations were easy to see.

	MBONE	FACE-TO-FACE
Strongly Agree	0	25
Agree	40	45
Neutral	30	25
Disagree	30	5
Strongly Disagree	0	0

(9) The presenters' attitudes toward the subject matter were well conveyed during the presentations.

	MBONE	FACE-TO-FACE
Strongly Agree	0	25
Agree	100	60
Neutral	0	15
Disagree	0	0
Strongly Disagree	0	0

(10) The presenters' vocal inflections helped me to understand the presentations.

	MBONE	FACE-TO-FACE
Strongly Agree	20	25
Agree	30	30
Neutral	30	30
Disagree	10	10
Strongly Disagree	10	5

(11) The presenters' rate of speech affected my ability to understand the presentations.

	MBONE	FACE-TO-FACE
Strongly Agree	30	20
Agree	40	35
Neutral	20	40
Disagree	0	5
Strongly Disagree	10	0

(12) The presenters' use of body gestures helped me to understand the presentations.

	MBONE	FACE-TO-FACE
Strongly Agree	0	0
Agree	20	40
Neutral	20	45
Disagree	60	15
Strongly Disagree	0	0

(13) The presenters' use of eye contact helped me to understand the presentations.

	MBONE	FACE-TO-FACE
Strongly Agree	0	0
Agree	0	10
Neutral	20	55
Disagree	70	30
Strongly Disagree	10	5

(14) The presenters' use of facial expressions helped me to understand the presentations.

	MBONE	FACE-TO-FACE
Strongly Agree	0	0
Agree	0	25
Neutral	30	60
Disagree	70	10
Strongly Disagree	0	5

(15) I felt the presenters were credible.

	MBONE	FACE-TO-FACE
Strongly Agree	30	35
Agree	70	55
Neutral	0	10
Disagree	0	0
Strongly Disagree	0	0

(16) The presenters conveyed a strong physical presence.

	MBONE	FACE-TO-FACE
Strongly Agree	10	15
Agree	20	25
Neutral	40	50
Disagree	30	10
Strongly Disagree	0	0

(17) The presenters conveyed their convictions about the subject matter.

	MBONE	FACE-TO-FACE
Strongly Agree	0	15
Agree	90	70
Neutral	10	15
Disagree	0	0
Strongly Disagree	0	0

(18) The presenters conveyed an emotional interest in their subject matter.

	MBONE	FACE-TO-FACE
Strongly Agree	10	15
Agree	70	55
Neutral	20	20
Disagree	0	10
Strongly Disagree	0	0

(19) I felt free to ask questions.

	MBONE	FACE-TO-FACE
Strongly Agree	0	45
Agree	40	35
Neutral	30	15
Disagree	30	5
Strongly Disagree	0	0

(20) Presenters responses to my questions were provided in a timely manner.

	MBONE	FACE-TO-FACE
Strongly Agree	0	15
Agree	10	35
Neutral	80	40
Disagree	10	0
Strongly Disagree	0	0

(21) I felt free to ask follow-up questions.

	MBONE	FACE-TO-FACE
Strongly Agree	10	40
Agree	10	30
Neutral	40	25
Disagree	40	0
Strongly Disagree	0	5

(22) The question/answer exchanges helped resolve difficult issues.

	MBONE	FACE-TO-FACE
Strongly Agree	10	0
Agree	30	45
Neutral	50	50
Disagree	10	5
Strongly Disagree	0	0

(23) The presenters' use of **verbal** cues helped me understand responses to questions.

	MBONE	FACE-TO-FACE
Strongly Agree	0	15
Agree	40	35
Neutral	60	50
Disagree	0	0
Strongly Disagree	0	0

(24) The presenters' use of **non-verbal** cues helped me understand responses to questions.

	MBONE	FACE-TO-FACE
Strongly Agree	0	5
Agree	10	25
Neutral	50	70
Disagree	40	0
Strongly Disagree	0	0

(25) I had sufficient opportunity to verbally interact with the presenters.

	MBONE	FACE-TO-FACE
Strongly Agree	0	20
Agree	10	50
Neutral	50	20
Disagree	30	10
Strongly Disagree	10	0

(26) My questions were clearly answered.

	MBONE	FACE-TO-FACE
Strongly Agree	0	0
Agree	20	30
Neutral	80	70
Disagree	0	0
Strongly Disagree	0	0

(27) Different interpretations of presentation content were resolved during the question/answer session.

	MBONE	FACE-TO-FACE
Strongly Agree	0	0
Agree	20	55
Neutral	80	45
Disagree	0	0
Strongly Disagree	0	0

(28) Overall, I was satisfied with this conference segment.

	MBONE	FACE-TO-FACE
Strongly Agree	10	15
Agree	80	75
Neutral	0	5
Disagree	10	5
Strongly Disagree	0	0

(29) I was satisfied with the question/answer section of this conference segment.

	MBONE	FACE-TO-FACE
Strongly Agree	0	0
Agree	40	70
Neutral	20	25
Disagree	40	5
Strongly Disagree	0	0

The following questions are expectations from MBONE conference viewers only:

(1) I expect the Internet video-teleconference will be an effective communication medium.

Strongly Agree	30
Agree	70
Neutral	0
Disagree	0
Strongly Disagree	0

(2) I would rather attend this conference in person.

Strongly Agree	20
Agree	20
Neutral	40
Disagree	10
Strongly Disagree	10

(3) I expect to learn as much from the presentations as I would have in person.

Strongly Agree	20
Agree	50
Neutral	30
Disagree	0
Strongly Disagree	0

(4) I expect to be satisfied with this video-teleconference.

Strongly Agree	10
Agree	80
Neutral	10
Disagree	0
Strongly Disagree	0

APPENDIX C

QUALITATIVE DATA FROM MBONE VIEWERS

(1) Overall, do you think the use of this video-teleconferencing medium was a worthwhile experience professionally? Why?

- Yes. It exposes users to a wide variety of technical information.
- Yes. I think that there is a great deal of potential in video-teleconferencing.
- Yes. Easy to use, practical. Can be a nice way to maintain informed.
- Yes.
- Yes, availability on workstations
- Yes. The teleconferencing medium delivers higher information bandwidth than a telephone conversation but is still less than in-person. This is a technological limitation. The potential for teleconferencing is only beginning to be realized.
- Yes, worthwhile let's talk about it.
- Yes, for the exposure to it.
- Yes.
- Yes, even though I understood very little of the subject matter which was presented, it was the first time I ever saw this type of application.

(2) What do you feel were the advantages of you attending this conference via Internet?

- I can stay in my office and choose to "attend" or do other work.
- Being able to "attend" without having to leave the building. Allows more flexibility in attending specific portions of a conference.
- I learned and was exposed to MBONE.
- Access/not having to be there in-person.
- Accessibility is a biggest.
- Much better than reading about the information, and better than discussing subject matter over telephone.
- I probably could not have attended otherwise--class constraints.
- Comfort, possibility of discussion the subject without bothering the lecturer. Free.

(3) What do you feel were the disadvantages of your attending this conference via Internet?

- Still need some coordination work to make it easier to interact with the lecturer.
- Visuals not very clear-better to have made the slides that were shown on video-Ed and made them available on Mosaic or other Internet sources to allow Internet site attendees to scroll through the text and slides as the presenters discussed them. That would save some bandwidth, and allow better visuals selectable by the virtual attendees.
- Limited info bandwidth, limited interaction, can't see all gestures, eye contact, "impersonal".
- Technical preoccupation.
- Ability to watch whole picture of presenter as well as slides, choppy picture, poor lighting, slides not clear, sometime poor audio.
- The video was not as clear as if I were there in person, and I was not able to really see the body language of the speaker.
- The audio volume was very unstable. Click-on microphones should be used for a constant volume. The video portion was very frustrating. The overheads do not all show up well. They must be selected for this purpose. Each time an overhead is moved)which happened very often), I could not read it. Suggestions for improvement: 1) send a file containing all of the slides for the presentation that can be manipulated by the viewer and focus the camera on the speaker. 2) Use a computer presentation or slides rather than overheads so they are always adjusted for the camera.
- No isolation from my office distractions: E-mail, door knocks telephone--

(4) Would you like to see your organization make more frequent use of this video-teleconferencing medium so that you can attend more conferences?

- Yes.
- Yes, absolutely.
- Yes.
- Yes.
- Yes, to get more exposure for our organization and subject matter.
- Yes.
- Yes.
- Yes.
- Yes.

(5) Would you prefer attending a conference face-to-face? Why?

- Depends on the conference. Sometimes I may wanna do it because face-to-face we also have the chance to meet interesting people. Most of the times it will be cheaper and more practical to use MBONE.
- Yes, *it creates more interaction with other participants which tends to generate enthusiasm and stimulate new ideas. But, given a choice of video teleconferencing or missing a conference, video is a wonderful option.
- No, not until I feel more familiar with the material being presented.
- Yes, I still don't think that video teleconferencing can compete with face-to-face. (staggered video, sometimes poor audio). Maybe in the future but not now.
- Yes, if possible, face-to-face still provides for best understanding.
- Sometimes, for most important ones but VTC let's me attend others.
- Yes.
- Yes, personal interactions, no personal inconvenience time loss in travel and cost in $.
- Yes, for social interactions and isolation from local distractions.

(6) Was your conference experience hampered by a lack of in person social interaction (networking)? Why?

- Yes, it is helpful to know the presenter and the audience.
- Not this time.
- Yes. You are not as motivated to pay attention. Impersonal--not physically immersed.
- N/A.
- Yes, instant question clarification from the guy next to me always helps my understanding.
- No.
- No. I had plenty of in-person social interaction with the people I viewed it with.
- Yes, see above*...Much of the benefit of conferences comes from the side discussions with other attendees.
- No.

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   Monterey, California 93943-5002

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   160 Central Avenue
   Pacific Grove, California 93950

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   MCCDC, Code C46
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   Quantico, Virginia 22134-5027

10. Robert A. Gambrino   1
    Stearns County Commissioner
    Stearns County Administration Center
    705 Courthouse Square, Room 121
    St. Cloud, Minnesota 56303-4781

11. John R. Gambrino   1
    1021 11th Avenue North
    St. Cloud, Minnesota 56303