Rhodes University

Grahamstown

AN INVESTIGATION OF A FRAMEWORK TO EVALUATE COMPUTER SUPPORTED COLLABORATIVE WORK

A thesis submitted in fulfilment of the
requirements for the degree of

MASTER OF SCIENCE

at

RHODES UNIVERSITY

by

ERIK ALEXANDER MAOUI BEAUVAIS

February 1999

Declaration

I acknowledge that all references are accurately recorded and that unless otherwise stated, all work contained herein is my own.

Erik Alexander Maoui Beauvais

An Investigation of a Framework to Evaluate Computer Supported Collaborative Work

ABSTRACT

Rapidly changing technology constantly modifies the way in which tasks are conceived and executed. Furthermore, leading organisations also encourage the use of new technology to support and establish innovative ways of doing business. For example, technology has helped to drive the globalization and tighter integration of world markets. This has facilitated, and even necessitated, business organisations to compete for work across national borders. For geographically dispersed organisations, collaboration has become critical. But this has presented time and space work complexities. Communication and collaboration technologies, for example, are needed to support such emerging co-operative business practices.

The short development cycle of technology, communication and collaborative technologies included, leaves little time for testing and less for understanding the impact of new technology. To compound the problem, no established formulae exist for matching technology with work: over-investment is a waste of resources, while under-investment could lead to work failure. This research proposes a framework to assist organisations in selecting the appropriate level of technology with the work required.

In this study, the methodology developed by the Evaluation Working Group, the DARPA Intelligent Collaboration and Visualization program is extended, and a matrix framework is constructed which compares the success of generic work tasks against a range of technology resources. The framework is tested using a low resource configuration, with selected work task types generally found in software development. (The Joint Application Development (JAD) methodology for software development is used as the contextual basis of the experiment.) All activities are evaluated according to selected measure components of success. A collection of research methods known as ethnography is used to examine and test the framework. Methods employed include questionnaires, interviews, interaction analysis and ethnomethodology.

The results indicate that even at a low resource level, given selected criteria, collaborative technology successfully supports certain collaborative work activities. Findings also indicate that softer people issues require much more attention in order for technology to support natural collaborative work. Finally, user defined parameter testing has indicated that the framework functions as expected and designed.

This work has been funded by the Telkom Teletraffic Initiative Programme, and has been undertaken under the auspices of the Rhodes University Computer Science and Information Systems Departments' Distributed Multimedia Centre of Excellence (http://cs.ru.ac.za/coe).

ACKNOWLEDGEMENTS

Anyone who has embarked upon the road to a thesis will know the effort required to walk that long road. However, some people make that road easier to travel. In particular, I would like to thank my supervisors Prof. David Sewry and Prof. Peter Clayton for their effort and guidance. Their persistence has required me to deliver my best, making this a thorough and rewarding experience.

Fortunately, I have not been alone in this walk. To Rob Laubscher, Paul Littlejohn and Nico Schoken, thanks for sharing the hardship. I would also like to thank Nick Vat for his valuable input and friendship. My thanks also go out to the Information Systems ANALYZE team of 1998 for making my work possible.

Throughout the duration of my postgraduate degrees I have been privileged to have been part of the Information Systems Department, so much so that some of the staff confuse me with the furniture. I want to thank them for the many years of support and friendship. At the same time I wish to express my sincere thanks to the people from the Honours classes of ‘95, ‘96 and ‘97 for their friendship and for all the good times that we shared.

I am a firm believer in balance, so along with the academic life must come the social life. To my many friends at Rhodes University who have helped to define and maintain the spirit of the Rhodian, thanks and all the best - I’ll miss you.

Finally, I would like to thank my parents for the freedom to go where I wanted to go and for their support.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1
INTRODUCTION

1.1 Problem in Context

Technology plays an increasingly larger part in the daily routines of millions of people. The rapid pace of technological development redefines the way in which the world operates and how people relate to each other. Two areas particularly affected by the constant influence of new information technology are work and entertainment. Kies (1997) argues that the very nature of the way work is performed is shifting dramatically. Rosen (1996) clarifies this thought by claiming that the culture of competition is moving to collaboration. While businesses still require competition, the approach is changing. Instead of working alone, working with others to achieve business objectives is becoming more accepted. This trend, together with an increasing global market and economy, has emphasised the fact that collaboration is becoming critical for many organisations, especially those that manage multiple sites and geographically dispersed teams (Collaborative Strategies, 1997).

The explosion of the Internet and intranets, facilitated by the networked computer, has provided a viable mechanism to support collaboration through highly interactive applications. The use of this new mechanism presents a challenge to organisations that seek to find the best solution for supporting communication and maintaining collaboration between dispersed teams and individuals. To simplify this challenge, and to make the successful adoption of collaborative technology easier, a mechanism is needed to assist organisations in selecting the appropriate level of technology with collaborative work needs.

1.2 Towards Collaboration

Several authors have noted the shift in work cultures from competition to collaboration, each highlighting various aspects and impacts of this trend.

Rosen (1996) focuses on the immediate demands made upon the business professionals. He also identifies the changing work environment noting that collaboration is becoming increasingly important to competing effectively and boosting the bottom line. To enable the needed collaboration, communication is vital. Tools such as video conferencing help to advance collaboration. However, Rosen (1996) points out that technology is only a partial solution. The changing environment requires a social focus by rethinking jobs, organisational structures and lifestyles.

Zuboff (1988) notes that task performance dependence is shifting from physical performance to cognitive skills. To understand how people operate in these environments requires that we change our methods used to analyse the way people operate. This is further complicated by yet another trend where shared work environments are being established for remote group members. Kies (1997) sites two significant reasons for this trend. Firstly, through systems such as Lotus Notes™, common collaborative working environments are being established. Secondly, there is an ability, and even a requirement, to communicate over computer networks, using text (email), audio (Internet telephony and streamed audio) and video (desktop video conferencing and multicast video). He further states that the traditional communication media (memos, letters and telephony) is being augmented and even replaced by computer mediated communication.

Unfortunately for implementors of information technology, the selection of technology to support remote collaborative work is not as easy as buying a traditional application package to complete a task. An in-depth understanding of how groups work and communicate, and how (and what) technology can support collaboration, requires extensive knowledge and experience, which is not available in every organisation. A mechanism to assist implementors of collaborative technology to make the right selection is a definite advantage.

A negative or push factor exists as to why there is a need to collaborate. A shortage of suitably skilled and experienced workers, especially in software project development, forces people to be drawn from afar to collaborate in order to complete work. Locally, South Africa is no exception to the problem. Compounding factors such as limited educational facilities, exacerbated by difficulties in recruiting industry professionals, affirmative action and a general negative socio-economic climate, fuel the high levels of emigration experienced by IT professionals. This, in combination with a global market where anyone can compete for software project tenders, is a cause for concern for the average South African IT organisation. Some solutions to these problems are available. Companies may seek international clients and projects, and where there is a skill shortage, companies may seek expertise and consultants from other organisations. Usually this would come at an enormous expense of relocating consultants for the duration of a project and repeated travel costs to liaise with clients. To reduce this cost, co-operative technologies such as video conferencing may be used. The assumption is made that organisations wish to exercise effective resource management. In such a case, collaborative technology could assist small and large organisations to minimise costs.

1.3 Emerging Business Technologies

User level collaborative technology, especially computer mediated communication, is readily available as a result of technical innovations, popular marketing and social reasons. Video conferencing technology, for example, has been available for many years but has only recently come to the fore. Technological reasons for this include: lower costs, the expansion of networks, increased bandwidth, faster computing power, improved compression algorithms and improved operating systems. Social reasons include the need to explore more effective ways of communicating, a better understanding and appreciation of the capabilities of such technology and a smaller, more competitive global market economy.

The developed world is faced with a vicious cycle of new technology, technology which changes the way people conduct their work. Yet at the same time, people are forcing technology to meet the needs of their work environment. Often these technological changes are made and introduced with little thought of how these changes alter the original task or how they impact on other areas of the user's life. Using computer supported communication characteristics (full-duplex audio verses half-duplex audio) as an example, Kies (1997) remarks that it is unfortunate that little research has been conducted evaluating how and to what level technological variables impair the communication processes beyond what is considered acceptable by the user. Therefore there is a particular interest in the effects of changing collaboration technology on task success, performance and user acceptance, to name a few.

1.4 Problems with Researching Collaborative Work

In a collaborative work environment, workers are physically dispersed, but communicate about a shared activity through computer networks. Ross *et al* (1995) claim that the central problem lies in determining how to assess the numerous permutations of interaction that can occur between the users and the system. Many factors influence the interaction that occurs; at an individual level, the user's personality and background; while at a group level, factors such as social, motivational, economic and political dynamics are difficult to assess in evaluations (Grudin, 1990). These factors, usually ignored in traditional studies, have a profound influence in the use of collaborative applications.

Because of the hybrid nature of this field, clear and well-defined methods of evaluation are not easily identifiable. The human component of evaluation is catered for by fields such as social psychology and anthropology, while the computer component is addressed by fields such as human factors engineering and human computer interaction. Yet an effective means to evaluating, not a human-machine, but human-machine-human situation is not readily available. Kies (1997) remarks that "the computer interface has transcended the role of an object to be communicated with to that of a medium through which two or more humans can interact, communicate, and collaborate". He notes that this transformation has resulted in a highly-interdisciplinary field which, for evaluation purposes, needs to develop research methods, tools and vocabulary by borrowing and adapting from its component origins, such as communication, anthropology, ethnography and information systems.

1.5 Problem Statement

To develop a framework to evaluate collaborative technology which is used to support collaborative work.

1.5.1 Sub-problems

To discuss the techniques available for studying human interaction in a collaborative work environment, with the intention of selecting appropriate methods and techniques for evaluation. In addition, related issues pertaining to technology which impact collaboration must be revealed. [Chapter 2]

To construct and describe a framework, using and developing suitable measures and metrics, where required, for the purposes of evaluation. [Chapter 3]

To validate the framework by testing. This is done by conducting a suitably constructed experiment. [Chapter 4]

To conduct an ethnographic analysis of the experiment, based on questionnaires, contextual inquiry, and interaction analysis. [Chapter 5]

To determine the effectiveness of the framework based on the external user defined conditions. [Chapter 6]

1.6 Summary of Results

The investigation of a framework to evaluate computer supported collaborative work (CSCW) has yielded a framework based on a simplified adaptation the Methodology for Evaluating Collaborative Systems (Cugini *et al*, 1997) and the evaluation processes derived from the Empirical Methods for Evaluating Video-Mediated Collaborative Work (Kies, 1997). The proposed framework is targeted at an organisation level, where methods of evaluation are subjectively qualitative, practical and easy to use, requiring minimal expert knowledge on evaluation. Further more, the framework is parameter driven to allow maximum flexibility and customisation. Under these user defined parameters, the framework is tested with industry respondents' parameters. Results from this test show that the framework functions as designed, indicating task support failure under strict conditions.

Actual experiment results show that, within the parameters and low level technological environment set by the framework, the technology supports the selected collaborative work, but lacks satisfactory support for certain communication and group processes, noticeably feedback, awareness and role support.

1.7 Thesis Organisation

Chapter 2. This chapter reviews of the related literature. The discussion centers on the key issues involved in this study, namely: collaboration, communication, evaluation and technology. The work presented forms the foundations for subsequent discussions.

Chapter 3. This chapter introduces the framework to evaluate computer supported collaborative work. The adopted foundation framework is detailed along with the extensions which determine the new proposed framework. Also detailed are the workings of the new framework and how to apply it.

Chapter 4. This chapter describes the testing of the proposed framework. In order to do this, an experiment is constructed and conducted. All the details pertaining to the experiment's construction (including the subjects, experiment scenario, materials and equipment, and the procedure) are described along with a summary of the actual experiment activities.

Chapter 5. This chapter presents the results, analysis and findings of the experiment. The discussion of the results includes the results of the application of the framework, while the data analysis discusses trends and anomalies. The semi-structured interview findings are explored in the light of previous research, and lastly the interaction analysis utilises the breakdown analysis technique to characterise the communication flows experienced in the experiment.

Chapter 6. This chapter explores the framework from parameters suggested by various Information Technology specialists in industry. This exercise tests the framework further to assess its quality and applicability. This chapter also presents reflections about the framework.

Chapter 7. This final chapter concludes the study by summarising the important findings of this investigation of a framework to evaluate CSCW.

CHAPTER 2
REVIEW OF THE LITERATURE

2.1 Introduction

In order to study the field of computer supported collaborative work and to provide an effective evaluation framework, several key issues need to be addressed. This chapter reviews literature from four areas: evaluation, technology, communication and collaboration, which when intersected, allow for a firm foundation for the development of a framework to evaluate collaborative technology supporting collaborative work.

2.1.1 Collaboration

In this section, computer supported collaborative work is discussed along with its function in the context of this research.

2.1.2 Communication

Issues relating to communication focus on the impact of computers as a medium for communication. Various normal face-to-face factors, such as body language, presence, space and group dynamics, are explored in the visual medium offered by computer mediated communication.

2.1.3 Evaluation

This section focuses on methods and techniques of evaluation utilised in the field of collaborative work. A broad overview of evaluation is presented, including the history and a taxonomy of evaluation. Current evaluation techniques and methods are discussed with reference to their contextual use, objectives, weaknesses and strengths. Further, design problems in constructing evaluation environments are addressed.

2.1.4 Technology

Video conferencing technology, with a collaboration bias, is the focus of this section. Areas impacting the implementation of video conferencing technology are discussed. These areas manifest themselves as resources. Low resource video conferencing is described.

2.2 Collaboration

2.2.1 Defining CSCW

"The goal of CSCW is to discover ways of using computer technology to further enhance the group work process through support in the time and place dimensions" (Pfeifer, 1995). Pfeifer further notes that the focus of the CSCW goal lies in the social interaction of the people, rather than the technology alone.

It is evident that many terms are used to embrace the concept of computer systems which support cooperative work: groupware, collaborative computing, workgroup computing, computer-mediated collaboration. Individually, these terms attract criticism as they are perceived to be loaded. Various authors including Grudin (1994a), Ramage (1997) and Coleman (1997) have discussed the issue at length, essentially agreeing that these terms are synonymous with CSCW. Sommerville *et al* (cited in Ramage, 1997) give a workable definition of CSCW: "systems which are essentially cooperative in the sense that they are team based". For completeness, Ramage (1997) provides a more comprehensive definition of cooperative systems: "a combination of technology, people and organisations that facilitates the communication and coordination necessary for a group to effectively work together in pursuit of a shared goal, and achieve gain for all its members". For the purposes of simplification, the term CSCW and groupware will be used interchangeably.

2.2.2 CSCW: Evolution and Context

In figure 2.1, Grudin (1994a) identifies the academic and industrial contexts of CSCW through its historical movement. Each ring broadly represents a focus of the computer systems development and the primary user/customer. Associated with each ring are: (left) Software development contexts, (right) major research areas associated with the development and use of systems software, (bottom) applications and systems infrastructures, and (top) the customer or user level. The outer ring represents unique software systems that support the entire organisation, software that cannot be bought off the shelf, while the inner ring represents single-user systems or applications that are commonly bought off the shelf. Recently, market activity has focussed on the two middle rings, representing large projects (electronic meeting rooms and workflow automation

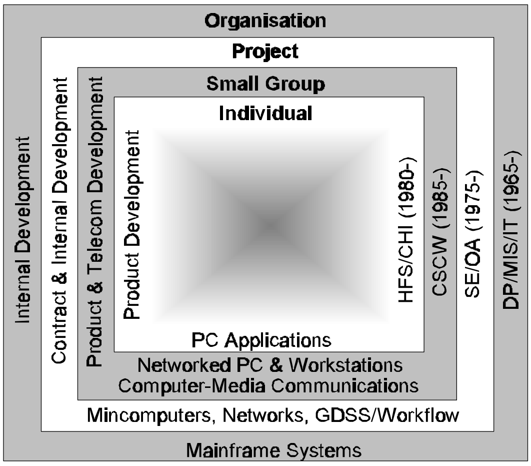


Figure 2.1 U.S. Research and Development Contexts for CSCW and Groupware.

systems, for six or more people) and small groups (desktop video conferencing and collaborative writing applications, for three to four people). Grudin (1994a) cautions that while figure 2.1 represents central tendencies, it obscures issues that transcend from the divisions. He notes that CSCW is not strictly bound to one ring (i.e. firms may contract CSCW system development and augment it with commercial applications), rather, it draws upon influences from CSCW researchers and developers coming in from pre-existing cultures, different communities and cultures. In summary, it is noted that the current direction of CSCW conferences is the increasing interest in small-group applications. This shift has been facilitated by PCs and workstations being networked, creating many small group opportunities. Traditional single user applications now support groupware features, generating a need for communication and coordination support. At the same time, telecommunications companies are exploring ways of increasing the demand for bandwidth through the use of multimedia applications and multimedia technology.

2.2.3 CSCW in the Context of this Study

Both Grudin (1994a) and Ramage (1997) argue that CSCW is multi-disciplinary in nature. This multi-disciplinary view enables us to utilise a familiar groupware topology (table 2.1). Table 2.1 is a variant of DeSanctis and Gallupe's (1987) widely used space and time categorisation. Representative applications illustrate the different cells. This matrix provides an easy mechanism to categorise general classes of applications. It must be pointed out that this matrix is too simple as most real work activities span different categories. For this study, however, the matrix serves its purpose by confirming and highlighting where video conferencing (the chosen medium) fits in, in relation to other groupware applications.

Place		Time: Same	Time: Different but Predictable	Time: Different and Unpredictable
Place	***Same***	Meeting Facilitation	Work shifts	Team rooms
Place	***Different but Predictable***	Teleconferencing Video conferencing Desktop	Electronic mail	Cooperative writing
Place	***Different and Unpredictable***	Interactive multicast seminars	Computer Bulletin Boards	Workflow

Table 2.1 A 3x3 Matrix of Groupware Options.

It is suggested that video conferencing may fall into other time-place categories as collaborative work activities change to meet business needs. The value of video conferencing under these conditions is explored in this study's context.

2.3 Communication

2.3.1 Issues in Video Mediated Communication

Of particular interest is how humans communicate, and how technology can support this to the most natural extent. The following summary highlights a few of the many issues that, over the years, have come to impact the utilisation of technology for face-to-face communication.

A contentious issue is the role that the visual channel plays in communication. Generally, video mediated communication research findings indicate that the visual channel offers little over and above the audio channel. There is, however, some debate amongst researchers that this is always the case. But there is at least some agreement in that the audio channel is the most critical for task performance.

General appearance cues, head movement and eye behaviour have been found to be important elements in head and face communication. Studies undertaken which explore visual cues within the scope of the medium, indicate that at least three aspects of technology limit visual cues:

1. Restricted field of view: Limits peripheral vision and perceptual exploration.
2. Resolution limitation: Close examination of objects does not reveal finer detail.
3. Depth perception limitation: Limited exploration and inspection.

In addition, findings show that video mediated technology alters size, shape and pace of gestures (Kies, 1997). But again, the majority of research has found that task performance is not adversely affected by lack of the video channel. This should not be taken as final, as careful consideration must be taken of the types of tasks measured and users' opinions.

From a theoretical perspective, three theories are particularly relevant to examining human communications mediated by technology.

1. Social Presence Theory (Short *et al*, 1976).

A goal of technologically mediated communication, such as video conferencing, is to establish a sense of presence, like that of a face-to-face meeting. This theory claims that media such as audio offer less presence than video, which in turn offers less than face-to-face interaction.

2. Media Richness Theory (Daft and Lengel, 1986).

This theory attempts to explain how the richness of a medium affects the richness of the communication it supports. On a technology scale, video is rich and text is poor. The degree of richness is theorised to impact a group's ability to resolve uncertainty among members in striving to reach a goal.

3. Social Information Processing Theory (Fulk *et al*, 1987).

This theory has a slightly different focus, that of group behaviour and the impact of individual influences. This theory proposes that the dynamics and past experiences of the group and individual play an important role in the acceptance of various communication media.

Neale and McGee (1998) argue that the crucial question of how video conferencing supports communication and genuine work has not been adequately addressed. Their concerns relate to task context, technology configuration and support for telepresence. These factors, they say, impact the success of communication and task using video conferencing. They propose that three conditions are perpetuating this problem:

1. The lack in addressing appropriate task contexts that can benefit from video;
2. The lack of sufficiently configured equipment to support different tasks associated with video, and;
3. The lack of support for telepresence that affords users a “common ground” for collaborative work.

In noting the lack of research in telepresence, essential in video mediated communication (Buxton, 1992), Neale and McGee (1998) suggest that CSCW research should aim to understand telepresence and whether it supports objective and subjective task performance necessary for effective video conferencing.

Neale and McGee (1998) define media spaces as virtual spaces created by information technology through the integration of video and groupware. These spaces support social and technical practices of contemporary collaborative work. An important distinction is made that technology used to create media spaces can either support communication about work or represent the work itself. Neale and McGee claim that video used to support interaction where it represents the work itself, such as in sharing physical objects, has received little attention. They further state that considering the conditions under which technology supports collaborative work content and process has important implications for the effectiveness of media spaces. Essentially the configuration of technology is a critical factor in supporting different work contexts.

Gaver *et al* (1993), in conducting video conferencing with multiple views of participants, have found that tasks involving social cues such as negotiating are affected by multiple views. The implications of such findings are significant for low resource video conferencing. Typically a configuration of low resource video conferencing would allow for only a single view, talking heads scenario. Therefore tasks in which communication with body language and complex social cues, such as a JAD session, are severely restricted by the use of low resource video conferencing.

2.3.1.1 Telepresence

Mühlbach *et al* (1995) define telepresence as the "degree to which the participants of a telemeeting get the impression of sharing space with interlocutors who are at a remote physical site". Telepresence may be described by other terms, including: co-presence, virtual presence and spatial presence.

In accordance with media richness theory and social theory presence, the degree to which video (and other technologically supported communication mediums) can emulate face-to-face interactions will determine its effectiveness as a communication medium and its ability to produce a sense of telepresence (Neale and McGee, 1998). This would indicate that the richness of the technology will affect the ability to create telepresence. By design, low resource video conferencing is often technologically poor. Hence the implication and speculation is that low resource video conferencing may not be able to effectively create a telepresence needed in some tasks.

Neale and McGee (1998) motivate that Media spaces create three types of collaborative spaces, each with their own associated telepresence.

1. Shared workspace telepresence: Users experience telepresence with groupware applications that allow users to interact with shared screens.
2. Interpersonal workspace telepresence: Telepresence created by video conferencing which generates a feeling of togetherness for the user in their individual locations.
3. Remote workspace telepresence: Telepresence occurs when video is used to visually share physical objects in one or more participants' remote location.

Finally, Buxton (1992) makes a distinction, defining person telepresence as interpersonal telepresence and task presence as shared workspace telepresence. Buxton states that the technology used, its configuration, and the demands of a particular task environment can all affect when and what type of telepresence the user will experience.

During the discussion pertaining to the analysis and findings of this study, presented in Chapter 5, some time will be taken to reflect on the issues mentioned above and how these issues have impacted the collaborative work supported by video mediated communication.

2.4 Evaluation

2.4.1 Methods for Studying Computer Mediated Communication

Kies (1997) discusses method selection by noting that the selection of a research method is highly dependent upon the objectives and philosophy of the researcher. In the many years that mankind has been learning about the world, many methods of studying the world have evolved. The scientific methods can, however, be divided into two primary classes: *Positivism* and *Naturalism*.

In positivism the objective is to build or test a theory. It generally works by comparing two or more situations in which all the variables are kept constant, except the independent variable of interest. Kies (1997) further claims that the advantage of this approach is that if this method is applied correctly, one can make claims about a theory (prove, disprove or explain). The disadvantages of such an approach include, low ecological validity, costly experimental designs (i.e. statistical sufficient sample sizes) and uncertainty that all extraneous variables have been controlled. This approach is perhaps best suited to laboratory experiments where external variables are more easily controlled. In experiments where human nature and behaviour are present, isolating the independent variable is extremely difficult.

Naturalism on the other hand contains a family of methods (symbolic interactionism, hermeneutics, and phenomenology) which seek to understand behaviours, without necessarily seeking a unifying theoretical explanation. Of interest is phenomenology, which encompasses ethnography, as it seeks to understand regular living activities from the perspective of the individual. Figure 2.2 maps these methods. The arrow connecting Naturalism and Positivism is a link relation indicated by Hammersly and Atkinson (1995). They show that naturalism (specifically ethnography) can be used to test hypotheses.

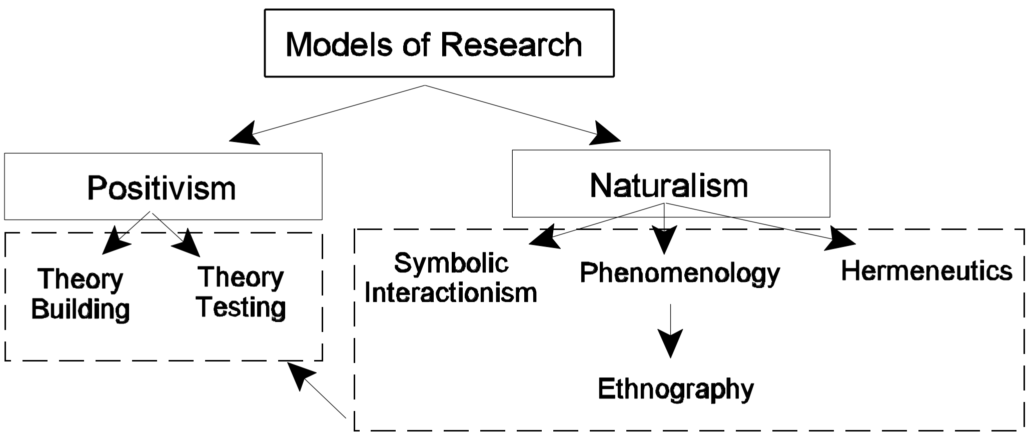


Figure 2.2 Research Methods for the Behavioural Sciences (Kies, 1997).

Human factors researchers and engineers have a variety of methods at their disposal to conduct their work. Each of these methods possesses advantages and disadvantages which affect the findings, but no method is considered the 'best'. McGrath (1995), cited by Kies (1997) emphasizes that the selection of method(s) in order to address research questions requires careful thought. Ramage (1995) in his examination of evaluation methodologies for CSCW, proposes that, due to strengths and weaknesses of various methodologies, a multiplicity of methods is perhaps the best option. This section therefore provides a taxonomy of the pertinent methods, touching on each method's purpose, mechanics, advantages and limitations. The diverse influences of CSCW can be seen in the approaches of the evaluation methods. The contributing discipline of a method, as cited by Ramage (1995), is indicated in parenthesis.

Table 2.2 provides a rough hierarchy of the selected models, methods and techniques usable in the field of CSCW.

Models	Naturalism, Positivism
Methods	Field Studies, Heuristic Evaluation (HCI - Human Computer Interaction), User Testing (HCI), Lab Experiments or Controlled Experimental studies (Cognitive/Social Psychology), Interviews & Questionnaires (Social Psychology), Focus Groups and Customer Feedback (Social Psychology), Longitudinal Trials and Semi-realistic ethnography (Sociology), Ethnography (Sociology/Anthropology).
Techniques	Contextual Inquiry, Psychophysics (Psychology), Conversation Analysis and Interaction Analysis (Ethnomethodology), Breakdown Analysis (Computer Science/Philosophy), Interviews & Questionnaires (Social Psychology).

Table 2.2 Evaluation Models, Methods and Techniques.

Heuristic Evaluation (HCI)

Heuristic evaluation is based on intuition and immediate reactions in the context of design and usability attributes. It is an inevitable part of any system design process, as designers do something and then test to see if they like it. It can be applied to almost any process that has alternatives in execution or in achieving a goal.

User Testing (HCI)

User testing usually takes the form of studies conducted by system designers with real users in a semi-realistic use context. It determines system use, usability and functionality issues. Data is more than often qualitative. A danger resides in the semi-realistic environment as other human factors may have a negative effect on the use of such evaluated systems.

Lab Experiments or Controlled Experimental studies (Cognitive/Social Psychology)

Laboratory experiments are conducted on randomly selected subjects to collect quantitative data about a single specific factor (independent variable), attempting to screen out other influences. Problems like those in user testing are encountered: decontextualisation and artificial nature of the experiments. This is not particularly useful in CSCW, given its nature and focus on group interaction in real working conditions, but is suitable in the early stages of an evaluation where uncomplicated issues can be dealt with.

Interviews & Questionnaires, Focus Groups and Customer Feedback (Social Psychology)

Various methods involving direct user reactions used to obtain various qualitative data about users' experiences with systems (either immediately or a little while after use). The data is subjective in nature and this makes it both useful (in that direct user opinions are being collected) but limited. Validity of the data can be gained through greater sample sizes.

Longitudinal Trials and Semi-realistic ethnography (Sociology)

These methods lie somewhere between the unsituated lab experiment and the messy, real-world ethnographic study. Often this approach involves using a system for some time with an easily accessible and controllable group or individual (such as colleagues), before performing the evaluation with a 'real' group. The danger is that these studies can become inwardly focussed on research teams (with their unique working relationships) performing the evaluation. However, Ramage (1995) states that in practice this method is highly instructive if care is taken about the system's wider applicability.

Conversation Analysis and Interaction Analysis (Ethnomethodology)

These methods study real group interactions as revealed by their (directly recorded) conversation and actions (Woofitt, 1991; Suchman & Trigg, 1991; Luff *et al*, 1992). The focus is on the detailed features of interaction (at various levels), either on conversations or on interactions between people and between people and technology. However, the usefulness of this approach is offset by the high level of detail and the enormous amount of data collected, which results in masses of transcripts and/or video-tape to be analysed.

Breakdown Analysis (Computer Science/Philosophy)

A breakdown is defined as any incident where the user has cause to focus on the system rather than the task (Winograd & Flores, 1986). The aim of breakdown analysis is to study group interactions and conversation transcripts to highlight such breakdowns. This is a useful method for identifying key problems associated with user-system (or user-user) communication (Urquijo *et al*, 1993). However, the focus is necessarily restricted, disregarding many other interesting aspects of collaborative work, such as the distribution of roles and power amongst the group members. As with many of the methods presented above, this method is more useful when used in conjunction with other methods.

Psychophysics (Psychology)

The objective of psychophysics is to map psychological experiences to physical stimuli or to determine perceptual thresholds. The advantage of using this method is that it establishes a direct relation between the physical stimuli and the psychological experience. Many techniques are available under the psychophysical method. Such techniques include magnitude estimation and category scaling. An example of magnitude estimation is: "Is this video quality acceptable?" or "Is the audio clear?". Subjects would rate their physical stimuli by assigning a numeric value. A weak stimulus would result in a low value, while a strong stimulus would receive a high value. However, this method is not without weaknesses. Kies (1997) states that findings may not reflect realistic tasks, and may not generalise well to other applications. Also, it does not account well for individual differences. Psychophysics and laboratory experiments share common traits since magnitude estimation data can be neatly collected in controlled experiment studies.

Ethnography (Sociology/Anthropology)

Ethnography is a loose collection of techniques for developing rich characterisations of individuals and groups as they interact with each other and with supporting artifacts in a *realistic* work setting over a prolonged period of time. Data collected includes audio and video-tapes of work practices, field notes, descriptions and diagrams of the work setting, and samples of various artifacts (such as documents) which illustrate the nature of work being conducted.

As a subtle point of interest, this style of evaluation was also described by Harold Garfinkle (1967), but under the term *ethnomethodology*. Hence, there is some confusion regarding the use of the terms ethnography and ethnomethodology. Sharpio (1994) suggests that when most CSCW researchers refer to *ethnography,* they really mean *ethnomethodological ethnography*. To avoid confusion Kies (1997) uses the terms ethnography and ethnomethodology synonymously.

Of the methods used to collect data under the header of ethnography, participatory design, contextual enquiry and scenario-based design are included. The central objective of many of these methods is to understand the world, through daily activities, as a collection of socially-constructed phenomena.

To provide further insight into ethnographic research, this section further describes the methods: ethnomethodology, interaction analysis and contextual inquiry.

2.4.1.1 Ethnomethodology

Kies (1997) describes ethnomethodology as the "systematic and detailed study of ordinary tasks in daily life from the perspective of a subject". It differs from other methods in that its focus is on ordinary mundane tasks. In the context of CSCW, it is useful to video tape users interacting with a system, so that detailed observations can be made. This, in conjunction with information from an 'insider' (an informant or researcher), allows understanding of an environment to be gained from a user's perspective. Traditionally, this would require a long period of immersion, from months to years, in the study setting before the ethnographer can perform an informed analysis. This is often not practical in a systems design project. Hughes *et al* (1994) categorises four classes of study which are relevant to system design:

- Concurrent (Long term, throughout system development process, constant feedback).
- Quick and Dirty (Short studies of representative work situations, informs initial design stages).
- Evaluative (Short studies, assess design in summation).
- Reassessment (Re-evaluation of studies to determine commonalities relevant to new system design).

This method, like all others, is not without its shortcomings. It has limited application in theory testing. The interpretation of data may be influenced by the observers' bias and preconceptions, and hence may lack objectivity. Problems also exist in comparing results amongst other studies, due to the numerous formats for reporting and interpreting data.

Therefore, it would be best to use this approach in conjunction with other methods to balance strengths and weaknesses.

2.4.1.2 Interaction Analysis

This method allows researchers to analyse conversations and interactions between individuals, in conjunction with the use of physical artifacts in their environment. This method is well developed, starting in 1950's.

Studies by Suchman and Trigg (1991) contend that studying workers in their actual environment is ideal, but that re-creations can be made in the laboratory so that prototype systems can be evaluated using real workers performing real tasks. They describe four classes of data collection:

- Setting-orientated records: Video tape footage of physical workspace environment.
- Person-orientated records: Tracking of movement and position of workers, relative to other workers and technology of interest.
- Object-orientated records: Tracking of movement and control of technological object or artifact (such as a mouse).
- Task-orientated record: Recording of details relating to tasks where workers strive towards a common goal.

Fafchamps (1991) takes the analysis slightly further, defining the following analysis techniques: thinking aloud, structured observations (video and audio recordings of interactions between workers in the context of their task), written artifact analysis, focussed interviews (interviews conducted which explore aspects of work not effectively identified) and guided tours.

The results of the Fafchamps analysis may be divided into several themes, including: breakdowns, routines and processes, one-of-a kind actions, artifacts and procedures.

Jordan and Henderson (1995), representatives from Xerox PARC and IRL labs, in a method-orientated paper, provide suggestions to making methods more effective with a dynamic malleable set of interests or 'foci of analysis'. Seven points of interest are presented, with the selection dependent on the researcher's objective.

1. *Structure of events* - Interest lies in where activities start and end, and what occurs immediately before and after those points.
2. *Temporal organisation of activity* - The periodicity and rhythms of activities or any activities which seems repetitive are of interest.

3. *Turn-taking* - The transitions divided between end points of talk-driven interaction (speech) and instrument interaction (physical objects, tools and workspace - as in sharing input and output devices).
4. *Participation structures* - Focuses on the manner in which participants locate themselves during the activity. In group situations this may reflect attitudes towards their work.
5. *Spacial organisation of activity* - Closely related to participation structures, but the interest lies in positioning, with the aid of furniture and technology, in relation to social comfort and power struggles.
6. *Communications breakdowns* - Focus is on the reasons for communication breakdowns and the mechanisms used to repair them. Clearly this is a concern in computer mediated communication.
7. *Artifacts and documents* - Much is revealed concerning the way in which people work and communicate by tracking the control of key documents and artifacts in collaborative work settings.

These foci are particularly evident in Cugini *et al*'s (1997) methodology, from aspects of requirements to metrics and measures which are identified, classified and listed.

The advantages in using interaction analysis include:

C Data is collected in a highly realistic work environment, one which reflects organisational structures and pressures, time pressures and physical work spaces.

C A direct gathering of data which does not rely on post hoc recollection from participants (Suchman, 1983).

However interaction analysis is not without its limitations:

C It lacks precision and comparability with other studies, due to a variety in data collection techniques and the inability to eliminate extraneous factors (this is both its strength and weakness).

C This approach is enormously time consuming and cumbersome.

2.4.1.3 Contextual Inquiry

Contextual inquiry employs interviews and questionnaires as instruments for data collection. Usually this occurs after the participants have completed part or whole of an activity. The approach ranges from structured to semi-structured to free flowing interviews, each of which strive to gain a deeper understanding of users' perspectives about a system. The approach looks for work flows and disruptions, and relationships between the system and its support for the task.

2.4.1.4 Using Scenarios for Evaluation

A scenario may be defined as an encapsulated description of a specific system, used by an individual or group, to achieve a specific outcome, under specific conditions, over a specified time interval.

Kies *et al* (1995) introduce the use of scenarios in design and evaluation as a historically informal technique, although recently, there have been attempts to formalise it. The use of scenarios in evaluation, design, demonstration or theory testing is advantageous in that the evaluator can codify explicit aspects of a realistic use case, incorporating user, environment and task factors for which the system is to be used. Kies *et al* (1995) single out the study of video conferencing as a prime case for the use of scenarios as the flexibility of scenarios is beneficial for investigating the effects that group configuration and task have on the effectiveness of video conferencing as a communication tool. In the case of evaluation scenarios, scenarios provide a detailed specification of user tasks for the evaluation process. Scenarios, claim Cugini *et al* (1997), allow natural interaction, providing experimenters a way of determining the apparent and intuitive use of a system.

From literature, it appears that a scenario provides a 'wrapper', a context or formalised environment before embarking on an evaluation exercise. Therefore various techniques of data collection and analysis, as discussed above, would be employed in conjunction with formalised scenarios. This is perhaps also the downfall of this approach, as there is no standard to data collection. Yet it is also a strength as it allows researchers to select techniques best suited to collect data in their area of interest.

Cugini *et al* (1997) advocate the use of scenarios in evaluating collaborative systems as the scenarios can be developed for reuse. Once a scenario has been scripted, it can highlight interactions that need to be repeated, facilitating more accurate comparisons across systems or across multiple implementations of the same system. Appropriate to this study, is their definition of a scenario: "A scenario is an instantiation of a generic task type, or a series of generic tasks linked by transitions. It specifies the characteristics of the group that should carry it out, and the social protocols which should be in place. It describes what the users should (try to) do at the requirements level, but not how they should do it."

The notion of a scenario is used later in this study.

2.5 Technology

For this study, desktop video conferencing (DVC) is the particular choice of video mediated technology. DVC is a relatively new technology. Advances in hardware, video and audio compression and miniaturisation has resulted in fairly cheap products, targeted at a mass end-user Internet market. Hence more people will be trying to communicate and attempt to conduct work using this technology. Therefore, it would seem apt to select this level of technology which will form the lower end of the resource scale in the proposed framework.

This study does not attempt to compare products. Rather, it looks at how this class of technology can support a collaborative environment. However, this study would be incomplete without at least an overview of the technology, standards and issues which shape the use of this technology.

2.5.1 Characteristics of DVC

Video conferencing describes the process by which two or more people see and hear each other over a network. Video conferencing can be implemented in a variety of ways, utilising a range of different features, such as platforms, protocols, video and audio encoding and standards. Table 2.3 provides an example of key features, along with a sample range of current options, as surveyed by Hewitt (1996).

Key Feature	Description	Example
Platform	Specific hardware platform used to host VC equipment.	PC, Macintosh, SUN, DEC, SGI, HP9000, IBM RS6000, Alpha.
Protocol	Network protocol used to carry VC data.	TCP/IP, UDP/IP, IPX.
Audio Encoding Standard	Method of encoding or compression used for audio data.	G.711, G.722, G.728, GSM, PCM, AppleTalk.
Video Encoding Standard	Method of encoding or compression used for video data.	H.261, RGB8, HDCC, DVI, IP Multicast, JPEG, CellB.
Interoperability Standard Support	Umbrella standard which enables interoperability between various audio and video standards.	H.320.
Collaboration Features	Features which enable VC users to work collaboratively.	Shared clipboard, drawing area, file transfer, OLE links, video playback, application sharing.

Table 2.3 Key Video Conferencing Product Features with Example Options.

The content of the transmission may also vary. By definition, video conferencing relays audio and video signals. There is, however, an increasing tendency to offer more sophisticated features to enable users to work collaboratively. This expands the role of video conferencing to that of data or multimedia conferencing. This research uses the term video conferencing to include multimedia conferencing.

2.5.2 Standards

Standards aspire to provide transparent interoperability. Telecommunication standards are set by the International Telecommunications Union (ITU), an agency of the United Nations. There are four main standards bodies concerned with developing standards relevant to video conferencing, especially desktop video conferencing. The purpose of these bodies is to ensure compatibility amongst systems by making compliant devices interoperable on a world wide basis. These bodies are:

1. **ITU-T** (International Telecommunications Union)
   - H.320 An umbrella standard, widely used by video conferencing systems. H.320 defines the transmission of video and audio over digital networks (primarily ISDN).
   - T.120 Defines a standard for application sharing.
   - H.324 Defines a standard for delivering good (at < 20 Kbps) audio and video over POTS (Plain Old Telephone System).
   - H.323 Defines a standard for H.320 using LAN communication. It includes specifications for LAN to ISDN bridge functions.
2. **IETF** (Internet Engineering Task Force)
   - The IETF's work is primarily related to M-Bone (Multicast Backbone) tools which use TCP/IP, in particular IP multicasting, to transport audio and video.
3. **ISO** (International Standards Organisation)
   - MPEG : This standard defines compression of digital video and audio. MPEG-1 and MPEG-2 are currently defined. MPEG-4 is currently being developed. It is possible that this standard may succeed H.320 as the widely used video conferencing protocol.
4. **IMTC** (International Multimedia Teleconferencing Consortium)
   - The IMTC aims to support the completion of standards for audio/video conferencing over standard phone lines (H.324), audio/video transmission

over local area networks (H.323), including gateways to wide area networks, as well as extensions to the T. 120 standards for multipoint data conferencing.

Since the ITU standards dominate DVC, table 2.4 lists ITU standards relevant to desktop video conferencing according to the communication medium used.

	ISDN Conferencing H.320	LAN Conferencing H.323	POTS Conferencing H.324
Video	H.261	H.263, H.261	H.263, H.261
Audio	G.711, G.722, G.728	G.711, G.722, G.723, G.728	G.723
Data	T.120	T.120	T.120

Table 2.4 ITU Applicable Video Conferencing Standards (Intel, 1995).

2.5.3 Transport Media

Video conferencing is supported over a variety of transport media, including LANs, ISDN and regular telephone lines using a modem (POTS). These media each have unique characteristics which will influence the way in which video conferencing is deployed. Table 2.5 highlights these characteristics.

	Bandwidth	Latency	Isochrony	Resource Contention	Availability	Supports Data Conferencing	Supports Video Conferencing
POTS	Low	Medium	Yes	At call request	High	Yes	Yes
ISDN	Medium	Medium	Yes	At call request	Medium	Yes	Yes
LAN	Varies/High	Medium	No	Ongoing	High	Yes	Yes

Bandwidth	The transport media should have sufficient bandwidth to transport voice, video and data at a level of quality which would show facial expressions and movements, hear comments and work on documents.
Latency	The media should facilitate voice and video transmission with minimal delay.
Isochrony	Isochrony describes the regularly timed delivery of data. Support for isochronous transmission ensures that video and audio are delivered on time.
Resource Contention	Ideally the media should guarantee the user a fixed amount of bandwidth at all times. Users should not have to compete with each other for bandwidth.
Availability	The transport media should be widely available and accessible.

Table 2.5 Transport Requirements (Intel, 1995).

Each of these technologies, ISDN, LANs and POTS are suitable for video conferencing, but ISDN lines and LAN connections are the best alternatives available today (Intel, 1995). Closely linked to the choice of transport media are the network transport protocol options. Network protocols play an important role in the quality of video conferencing systems. This is largely due to the close association between the network carrier's bandwidth and network protocol. Typically, protocols such as ATM are associated with expensive high bandwidth networks (greater than 155 Mbps), while protocols such as IPX, ISDN and TCP/IP are associated with cheaper low bandwidth WAN and LAN (less than 10 Mbps) networks. This research addresses low resource concerns, hence only solutions using low bandwidth are considered.

2.5.4 Desktop Video Conferencing Products

Clearly it is important to consider the capabilities of a product. As DVC technology becomes more mature and as standards become more entrenched, so DVC products will become more able to address quality issues such as resource contention, bandwidth and latency: issues which affect the way we perceive the realism and value of video conferencing. Products on the market today may sideline this technology due to cost, poor image quality, latency or usability. But future products will certainly facilitate collaboration in a seamless manner. Therefore at this stage in the development of low end DVC technology, this research will work within these limitations, interpreting findings with this factor in mind.

2.6 Towards a Framework

Theory and practice abound regarding the evaluation of the interaction between humans and computers and the interaction between humans facilitated by computers. Many of the reviewed methods have evolved over time and are well suited to their evaluation environments, assessing particular aspects of computing and placing different demands on system developers, users and evaluators. Cugini *et al* (1997) recognise that field studies offer the best form of evaluation, but note that field studies are not without their disadvantages. Rather, to fulfil certain aims and objectives such as generic work context, broad applicability and target high-level collaborative systems, Cugini *et al* (1997) present a framework based on scenarios. The primary task of Cugini *et al*'s (1997) work is the "definition and validation of low-cost methods of evaluating collaborative environments, such that any researcher in the collaborative computing research community can use these methods to evaluate their own or other research products". Other goals of Cugini *et al*'s (1997) work include:

C To develop, evaluate and validate metrics and a methodology for evaluating collaborative work.

- To provide reusable evaluation technology, such that groups can assess their own progress.
- To provide evaluation methods that are cheap relative to the requirements.

These goals are upheld in the proposed framework.

2.6.1 Framework Contributions

The proposed framework is an adaptation of Cugini *et al*'s (1997) methodology for evaluating collaborative systems. Their methodology is well suited for a research environment, but fails in a commercial environment because the method is too broad, detailing a wide spectrum of collaborative system elements and their measures. This is both its strength and weakness. By offering so many points of evaluation, the methodology is not easily applied, therefore too much expert knowledge is required to perform the evaluation. Understandably Cugini *et al*'s (1997) methodology falls short of describing how to perform the evaluation as the many different measures suggested require different processes of evaluation. Since the proposed framework is targeted at a business environment, it requires less work and expertise to make an evaluation of a collaborative work support system. To facilitate the practical approach suggested by this work, the rigorous and often costly process of gathering quantitative data is removed in order to focus on gathering qualitative information. In order to develop the proposed system, Cugini *et al*'s (1997) method is simplified and the suggested measures (specifically user ratings) are developed to provide usable metrics. Questionnaires are employed to gather these metrics. In addition, the proposed framework provides a mechanism to state whether or not a collaborative system has successfully 'passed' its evaluation. The process of the evaluation is well demonstrated by Kies (1997) for user ratings, and thus his work processes are followed.

In order to validate the framework and the research, the evaluation methods identified and used by Kies (1997), specifically structured interviews (contextual inquiry) and interaction analysis, are used. Both these methods are suitable as they reveal group interactions and users' perspectives. These methods are not offered by the proposed framework under normal evaluation conditions.

This research extends the theoretical base of Cugini *et al*'s (1997) work to provide implementors and users of collaborative technology, specifically team managers, a low cost guide for selecting the appropriate collaborative technology for the collaborative work required to be completed.

2.7 Conclusion

This chapter reviewed collaboration, communication, evaluation and technology. In the collaboration dimension, CSCW is studied from its evolution. The communication dimension offered a glimpse into the complex issues challenging computers as an effective medium for communication. The evaluation dimension touched on the vast field of evaluation, noting the many methods along with their context and their strengths and weaknesses. Lastly, the technology dimension offered some insight into the multitude of variables which constitute the use of current technology for the purpose of collaboration, specifically video conferencing. At the heart of the intersection of these dimensions lies the core focus of this study, surrounded by the primary objective of practical application. In order to meet this goal, a methodology is adopted upon which to build the framework to deliver a mechanism for meeting this goal. Chapter 3 explores this framework.

CHAPTER 3
A FRAMEWORK FOR TASK AND RESOURCE SELECTION

3.1 Introduction

Collaborative technology spans a broad range of hardware devices and software tools, each requiring acquisition, installation, maintenance and existing infrastructure resources. The variables are endless. In order for meaningful collaborative work to be conducted, it is important that the right combinations of resources are in place to support the work. The task of ensuring this, in the face of rapidly changing technology, is complex and daunting. This study aims to provide a mechanism to simplify the process of matching the resources with the task at hand. The mechanism is in the form of a matrix framework, which allows for a matching of minimal resources to support the desired collaborative task. This chapter presents the framework, its foundations, assumptions, and mechanism.

3.2 Frameworks

Bunge (1974) suggests the following ways to represent concepts, based on scope and complexity:

- Schema and object models (focus on properties);
- Diagrams (focus on relations);
- Theoretical models (focus on logic); and
- Frameworks or generic theories (focus on basic definitions and generic structures).

This research attempts to build a framework which provides a structure for mapping a problem to a solution. It dictates the processes and procedures to follow and the factors or variables that need to be defined and quantified. Frameworks also have their shortcomings in that they are incomplete in their representation (Bunge, 1974). This may be as a result of its context which often leads to assumptions about the problem domain.

A framework should have the following characteristics if it is to have any practicality: generic, widely applicable, reliable, accurate, easy to use, consistent, and most importantly, solves the problem at hand. The proposed framework attempts to embody these properties. It aims to provide a mechanism for the selection of co-operative technology against the nature of the work required to be completed (or vice-versa) at the least possible technological cost.

The assumption made is that, under normal circumstances, organisations wish to maximise the use of their investment in technology and people and minimise the resources required. "What is the most I can get for as little as possible?" approach, a simple case of resource management. To manage resources, two possible approaches are presented in which the framework is utilised, one which is *system centric* ("We have X system, what task can we achieve with it?") and the other which is *task centric* ("What system do we need in order complete X task?"). Note that the term *task* is used synonymously with *collaborative activity*.

a) System Centric Application

This application stems from organisations which have already invested in collaborative technology and wish to maximise their investment. This may go hand in hand with seeking other and newer ways of conducting business. Here a mapping is made from resource to task to see what tasks can be achieved with the given level of resources. With resource management and preservation in mind, the correct approach to the selection of an appropriate task is to first identify the given video conferencing system resources. This will indicate the generic tasks types that are successful (based on certain criteria for success) using that resource configuration. Activities which are composed of those generic tasks types will (with a degree of confidence) succeed, or at least, one would be sure that the collaborative system will not hinder the success of the task.

b) Task Centric Application

This application is more common as the majority of organisations lack installed collaborative technology. If these organisations now wish to conduct geographically dispersed collaborative work they need to ask the question, "What resources do I need in order to achieve the task?" This is done by mapping from task to the resource which achieves the task. Once again with resource management and preservation being a consideration, the correct approach to the selection of an appropriate collaborative system is first to identify the kind of collaborative work which needs to be completed. Then the work or job needs to be analysed and broken down in to its generic work task types. At this point the framework mapping is applied.

3.3 Framework Foundation

The proposed framework is based on Cugini *et al*'s (1997) Methodology for Evaluation of Collaboration Systems. The framework provides for a group to describe their work requirements and to ascertain how well a given CSCW system supports their work. In addition, it provides CSCW developers with a mechanism to describe their system and to determine the types of group work that can be accomplished using it.

The framework is composed of four levels: requirement, capability, service and technology (figure 3.1). This approach generates a functional categorisation of a collaborative environment and is described by Cugini *et al* (1997) as follows.

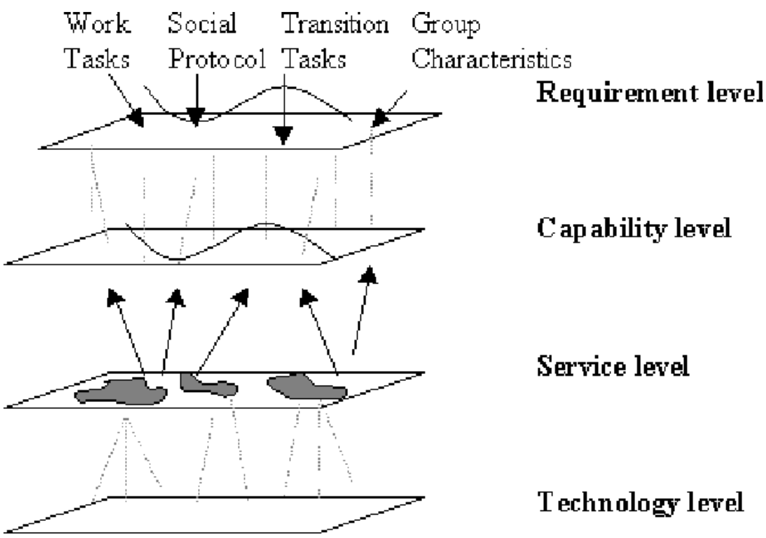


Figure 3.1 Cugini *et al*'s (1997) Collaborative Framework.

The *requirement level* of the collaborative framework describes the requirements of the group with respect to the tasks being performed by the group and the support necessitated by the characteristics of the group. The tasks described in the framework include work tasks as well as transition tasks. Requirements for supporting different types of groups include support for the social interactions of the group as well as the requirements due to group size, location, computer platforms, etc. The requirement level is divided into four sections: work tasks, transition tasks, social protocol requirements, and group characteristics.

The *capability level* of the framework describes functionality that is needed to support the different requirements. The capabilities can be divided into subsections that correspond to the four subsections of the requirement level. The functionality described in capabilities can be obtained from different services. For example: the capability to have a side chat with another meeting participant during an electronic meeting could be accomplished by a text chat service or by telephone service. Certain capabilities may be necessary or recommended to support work and transition tasks, social protocols, and group characteristics in the requirement level.

The *service level* describes services such as e-mail, audio, video, application sharing, networking services, etc. that can be used to support the capabilities needed in CSCW systems. Different types of services can be used to provide the same capabilities needed to support specific requirements. Comparisons and tradeoffs of performance and cost can be made at this level.

The *technology level* describes specific implementations of services. This level could be considered as the set of all possible components needed to build a given CSCW system, including integration and user interface components. For example, all different e-mail systems would exist at this level, as would the numerous ways to implement floor control, and the various algorithms to control documentation locking and requesting, and the various networking services such as ATM. Specific implementations can be compared with respect to performance, cost, functionality, and usability.

Cugini *et al* (1997) illustrate how their framework is used to evaluate a CSCW system by offering two approaches, top-down (requirement level to technology) or bottom-up. Table 3.1 describes the approaches. The different approaches allow the evaluator to select a subset of available systems or alternatively to determine whether or not a single system will support a group adequately.

Level	Top-Down	Bottom-Up
Requirement	Identify tasks, social protocols and characteristics. Select systems that support these.	Given the capabilities that can be supported, select the system which supports the most tasks of the group, provides the best task outcome and best supports the needed social protocols and group characteristics.
Capability	For systems using different capabilities, use scenarios to execute tasks using those capabilities and compare. For a single system, determine if the results are acceptable.	Given the services available, select only those systems having capabilities which can be supported using those services.
Service	For systems with desired capabilities, compare services if different ones are used. For a single system, determine if the results are acceptable.	Select only those systems that can be supported with the services available.
Technology	For systems with desired capabilities and services, select those with the desired performance and usability thresholds. For a single system, determine if the threshold levels are met.	Select only those systems that meet or exceed a desired threshold.

Table 3.1 Evaluation Questions (Cugini *et al*, 1997).

This study focuses specifically on the requirement level, where evaluations show how well a CSCW system supports the works tasks, transition tasks, social protocols and group characteristics. These four components are further discussed.

3.3.1 Work Tasks or Collaborative Activities

Cugini *et al* (1997) define *Tasks* or *Collaborative Activities* (used synonymously) as the things people do, or wish to do collaboratively, while *subtasks* are smaller chunks into which a task may be broken. It is usually the case that tasks are composed of many smaller sub-tasks. To this end, Cugini *et al* (1997) have incorporated McGrath's (1984) classification of generic tasks based on group research, with the addition of their own additional classification 'Dissemination of Information' tasks.

3.3.1.1 Task Type Definitions

In order to decompose collaborative activities into their generic task types, it is important to have an understanding of the generic task type definitions. The eight task types presented by McGrath (1984) are represented diagrammatically in figure 3.2.

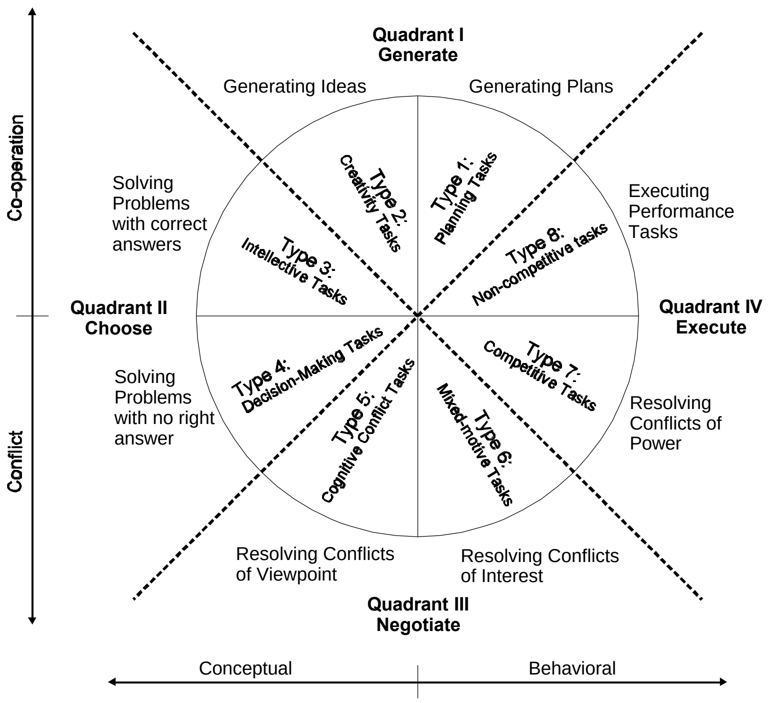


Figure 3.2 McGrath's (1984) Task Types.

The following summary of task types, by Cugini *et al* (1997), will offer some insight to the task type assignments in the experiment activities described later in this chapter.

Type 1: Planning tasks (McGrath): Group members are given a goal (previously chosen objective) and asked to develop a written plan for carrying out the steps needed to reach that goal. The written plan should include alternative paths or actions.

Type 2: Brainstorming and group creativity: Members of a group are given a particular topic area and asked to brainstorm on ideas.

Type 3: Intellective tasks: The group is asked to solve a problem for which there is a recognized solution. The group is asked to determine a concept, given instances of the concept. Alternatively, groups can be asked to generate an instance of a concept and are given feedback as to whether it is or is not the concept.

Type 4: Decision making task: Group members are asked to develop consensus on issues that do not have correct answers.

Type 5: Cognitive conflict tasks: Members of the group hold different viewpoints. The group is asked to make a series of decisions from available information that is imperfectly correlated with criterion. The group has to arrive at a decision.

Type 6: Mixed motive tasks: Mixed motive tasks present a range of tasks, differentiated by the degree to which a group member's outcome is affected by a combination of his own actions and the group's outcome.

> *Type 6A - Negotiation task:* The group is divided into x subgroups with a negotiator elected for a subgroup. The different subgroups disagree on an issue but an outcome has to be reached. Tradeoffs have to be made in multiple dimensions. It is not necessarily a zero-sum problem.
>
> *Type 6B - Bargaining task:* A conflict of interest must be resolved among two individuals, but in this case whatever one individual gains, results in a loss for the other individual. A tradeoff is made on a single dimension, such that what one party gains, the other party loses.
>
> *Type 6C - Winning coalition tasks:* Subsets of members make agreements. The subset that wins then allocates the resources among the group members. The two research questions are the formation of the coalition, and the allocation of the resources.

Type 7: Competitive performances: Groups are competing against each other with no resolution of conflict expected. Rather the goal of each group is to win over the other group. Subgroups are paired against each other an equal number of times, under an equal pattern of situations.

Type 8: Non-competitive contests - against standards: Groups perform some sort of complex group task. The plan for the task has already been decided upon. In this type of task, the group is merely executing the plan.

Type 9: Dissemination of information tasks (non-McGrath): The task is to distribute information among members of the group. Information can be distributed by group members sharing information with each other or a superior sharing information with others in the group. There may or may not be a question and answer session.

The complete subsection describing work task types, specific measures and examples, as found in Cugini *et al* (1997) Methodology for Evaluation of Collaboration Systems, is available in Appendix A.

3.3.2 Transition Tasks

Transition tasks are tasks required to move between work tasks. Examples include summarising the outcome of the last task, noting dates for completion of assignments, role taking, reading minutes, viewing agendas and planning for the next session. Transition tasks may occur formally or informally, depending on the social protocols adopted by the group.

3.3.3 Social Protocols

Social protocols define the way in which collaborative sessions are conducted. Table 3.2 lists a few social protocol parameters. Cugini *et al* (1997) specify three social protocol capabilities which should be considered in collaborative environments: communication between group members; awareness of group members, group activities and group objects; and basic meeting conduct. Particular measures for social protocol include conflicts in turn taking and awareness breakdowns.

Meeting Conduct	
Chair	Strict, loose, none
Agenda	Strict, modifiable, none
Rules of Order	Yes, no
Titles	Yes, names only, anonymous
Floor control	On agenda, yes (possible on if chair), informal turn-taking, or free-for-all
Hierarchy support	Voting, contributing - restricted, contributing - free access, observing only
Communication Needs	
Communication	Private û public, 1 way û n way
Dependency (interaction)	Loose û tight
Level of security needed	None û secret
Awareness support	
Presence	Who?
Location	Where?
Activity level	How active?
Actions	What?
Intentions	What next?
Changes	Who did what? Where?
Objects	What objects?
Extents	What? How Far?
Abilities	What can be done?
Influence	What can be done?
Expectations	What am I to do next?

Table 3.2 Parameters for Social Protocol (Cugini *et al*, 1997).

3.3.4 Group Characteristics

Group characteristics are dependent on the makeup of the group. They are influenced by the location of the members, and the time requirements for collaborative sessions (Cugini *et al*, 1997). Table 3.3 details these dimensions which constitute group characteristics. In addition to this, a supporting collaborative environment should cater for changing group characteristics.

Dimension	**Values**
Time	
Spontaneity of collaboration	Planned, spontaneous
Duration of sessions	# hours û days
Time frame for collaborative sessions	Synchronous, asynchronous
Location	Same for all û different for all
Group Type	
Number of participants	#
Stage of development	Newly formed û working group
Homogeneity	Gender diversity, peer diversity, computer experience diversity, cultural diversity
Computer Requirements	
Hardware, software requirements	Platforms, resources available (time, money)
Training	Walk-up and use û formal classes
Computer expertise	Novice û expert

Table 3.3 Group Characteristics (Cugini *et al*, 1997).

3.3.5 Summary of Foundation Framework

The framework aims to provide guidelines for developers, purchasers and users of collaborative systems by suggesting capabilities for work and transition tasks, and services best suited to certain capabilities, and the appropriate usability, performance and feature levels needed for specific services.

3.4 Proposed New Framework

The focus of the new framework is on collaborative activities (Work Task Types) and on collaborative environments (Resource Configurations), illustrated basically in figure 3.3.

Task Types	9					
	8					
	7					
	6					
	5					
	4					
	3					
	2					
	1					
		1	2	3	4	*n*
		Collaborative Environment Configurations (In increasingly intensive resource configurations.)				

Figure 3.3 Basic Task vs. Resource Matrix Framework.

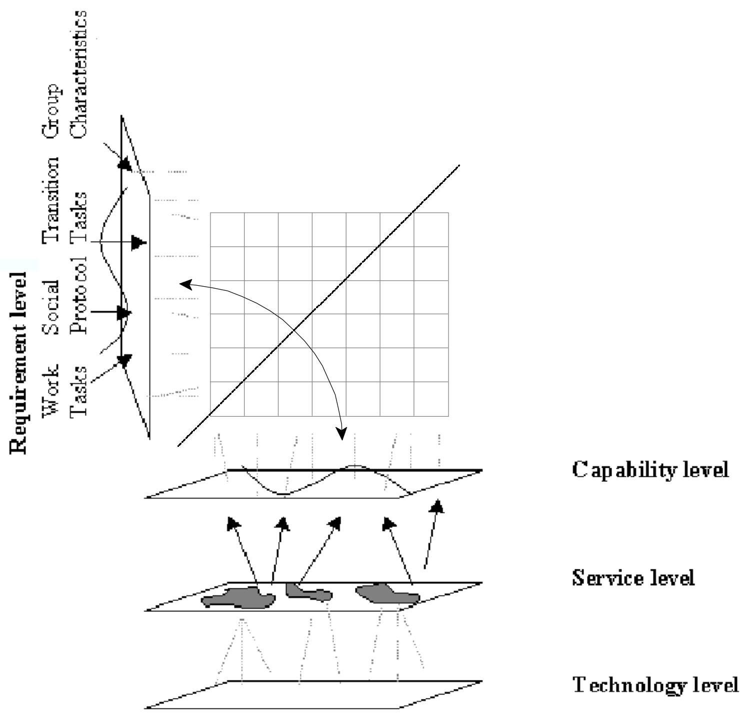


Figure 3.4 Cugini *et al*'s (1997) Framework Separated to Represent Collaborative Tasks and Collaborative Environments.

In terms of Cugini *et al*'s (1997) framework, the proposed framework separates the requirement level (representing aspects of collaborative activities), from the lower three levels (representing aspects of collaborative environments) in order to evaluate collaborative environments required to support collaborative work (figure 3.4).

3.4.1 Collaborative Environments

The framework is primarily divided in two axes: collaborative tasks and collaborative environments. A collaborative environment is a system which supports users in performing tasks collaboratively. It could be a specific software product, such as Lotus Notes, or a collection of simpler components, which when used together, enable collaboration (Cugini *et al*, 1997). Notice that a collaborative environment constitutes three layers, namely: capability, service and technology. An example of this hierarchy is: For the collaborative *capability* of synchronous communication, one *service* which may be used is video conferencing. One of the many *technologies* used to implement video conferencing is Microsoft's NetMeeting™ tool.

However, providing capabilities, supporting services and implementing technologies has an associated cost. Some are 'cheap' while others are 'expensive'. These costs draw upon an organisation's and/or individual's resources. The expected behaviour is that higher resource environments will facilitate the completion of more complex tasks (as they offer more and better services) than lower resource environments.

The primary costs (or resources) involved in a collaborative environment include: capital, people and time. This research does not seek to evaluate the efficiency of collaborative tasks conducted with collaborative technology and therefore time is omitted as a resource criterion. Examples of capital and human costs are:

Capital

- Product and/or Application
    - a) Once off purchase cost or periodic rent/lease.
    - b) Maintenance/running costs.
- Environment
    - a) Physical hosting environment
        - Cost of hardware required to use video conferencing equipment.
        - Cost of setup environment (room layout, lighting, screens, etc.).
    - b) Network environment
        - Type of network required.
        - Amount of network used/‘consumed’.

Human

- Once off labour cost: Installation/setup × number of people required.
- Continual labour cost: People required to support/operate × number of people required.

Combinations of the above resources are required for any geographically dispersed collaborative task to take place, over and above any costs that would be incurred in a normally occurring collaborative task. The utilisation of these resources and their associated costs are generally available upfront and easy to calculate. In the case of calculating capital costs, one would refer to the technology level of the collaborative environment, where these costs are readily quantifiable. Any resource combination will henceforth be referred to as a resource configuration.

3.4.2 Collaborative Activities or Tasks

Much has already been said of collaborative work activities. Recall the two approaches offered in section 3.2: task centric and system centric. With the task centric approach, decomposing collaborative activities into their generic task types is suggested (section 3.3.1.1). This is an important preliminary action to be fulfilled in order to apply this framework. By doing so, one is able to identify all the generic tasks that are required to be completed, in order to achieve the overall collaborative activity. Once these generic task types have been identified, the minimum resource configuration can be identified by finding the first resource configuration which supports the successful completion of that generic task type. The minimum resource configuration to satisfy all the required generic task type activities is the configuration selected.

3.4.3 Factors for 'Success'

The mapping functionality and the issues of task and resource have been detailed. What remains is to elaborate on how to determine the values that fill the matrix, and how to calculate whether or not a task/resource combination is 'successful'.

Recall that Cugini *et al*'s (1997) methodology has 4 levels: Requirements, Capability, Service and Technology. Each level provides a multitude of factors and issues that impact on a successful collaborative activity. However, the factors with which this research is concerned reside at the requirements level. At this level the objective is to evaluate how well a CSCW system supports work tasks, social protocols and specific group characteristics. The abstraction of the CSCW system is represented by the Capability and Service level, while the Technology level is the instantiation of the CSCW system. The implementation of the CSCW represents the resource configuration.

Cugini *et al* (1997) describe the *requirements level* as "the requirements of the group with respect to the tasks being performed by the group (1 of 9 generic tasks) and support necessitated by the characteristics of the group". Requirements for supporting different groups include: support for the social interactions of the group as well as the requirements due to group size, location and computer platforms. Cugini *et al* (1997) further state that "matching the task and the service must be done taking into account how well the service supports the capabilities and whether the service is acceptable given the group characteristics". Figure 3.5 shows how these four factors, at a requirements level, fit into this research matrix.

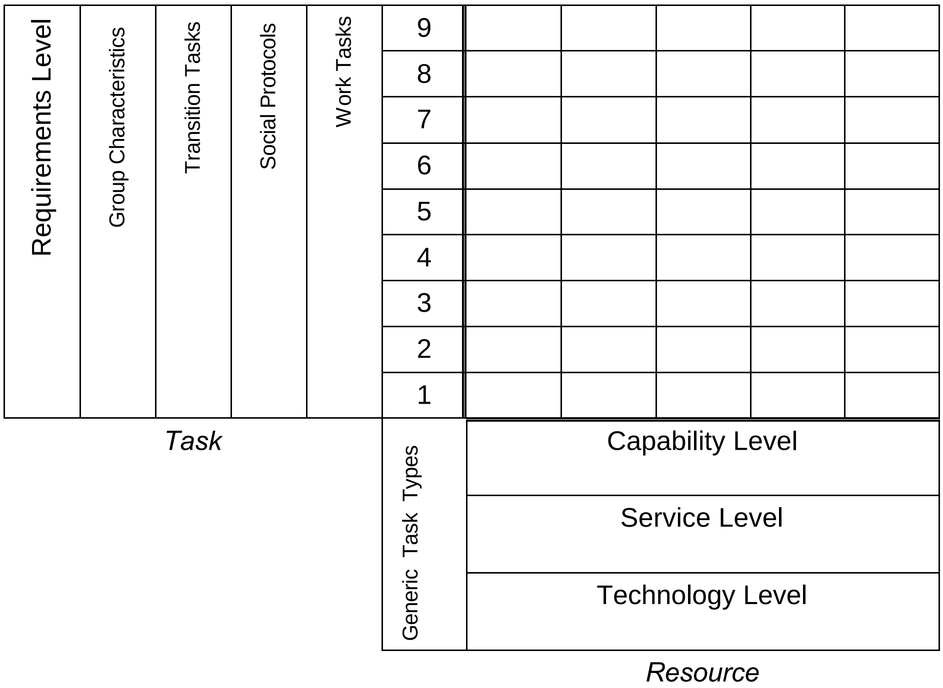


Figure 3.5 Requirement Factors in the Task vs. Resource Composition Matrix**.**

3.4.3.1 Measures and Metrics

Cugini *et al* (1997) suggests that a metric should be thought of as an observable value, while a measure associates meaning to that value by applying human judgement. Metrics are indicators of user, system and group performance that can be observed while executing an activity. Other metrics include directly measurable countables such as time, length of turn, etc. They further state that human judgement is also import as humans themselves can be a source of data in the evaluation of a system. To collect data pertaining to the metric selected, one would use data collection instruments such as logging tools, audio and/or video taping and questionnaires.

At the requirements level, Cugini *et al* (1997) suggest the following nine measures which are determinable:

1. *Task outcome*: A measure of the state of a particular task. There is a set of artifacts produced during the execution of the task, such as documents, programming code, ideas, solutions and defined processes.
2. *Cost*: The measure of time invested in the system and the resources consumed in executing an activity.
3. *User satisfaction*: A subjective measure of satisfaction with respect to the four aspects of group work.
4. *Scalability*: The measure of a system's accommodation for larger or smaller group sizes.
5. *Security*: A measure of the protection of information and resources.
6. *Interoperability*: A measure of how well system components work together, sharing functionality and resources.
7. *Participation*: The measure of an individual's involvement in a group activity.
8. *Efficiency*: A measure of group and system effectiveness and productivity.
9. *Consensus*: The measure of general agreement or group unity in outcome.

They further state that in general all these measures can be applied to all tasks. However, some measures may have little or no relevance for a particular instantiation of a task type. For example, measuring participation may not be important to a dissemination of information task (type 9), whereas it appears to be very important in a brainstorming and creativity task (type 2).

The nine measurement categories list above assess one, some or all of the four requirements level aspects of group work (work tasks, social protocols, transition tasks and group characteristics). Each measure has a set of identified metrics. Some or all of these metrics may be used. The choice of metrics is left up to the evaluator, but is often influenced by the data collection tools or instruments available (table 3.4). Metrics include countables, expert ratings, and user ratings. Cugini *et al* (1997) supply no formalised user or expert ratings (metrics used in this study). Therefore, a questionnaire is used as the tool for collecting user and expert ratings.

	Data Collection Tools				
Metrics	Logs	Observations	Questionnaires	Audio	Video
Countables	X	X		X	X
Expert Judgements		X	X		X
Length of Turns	X	X		X	X
Turn Overlap	X			X	
Resource Cost	X	X	X	X	X
Task Completion	X	X			
Time	X	X			X
Tool Usage	X	X	X		X
User Ratings			X		
Conversational Constructs	X	X		X	
Repair Activities	X	X	X		

Table 3.4 Metrics and Supporting Data Collection Tools (Cugini *et al*, 1997).

The questionnaire as an instrument is further discussed here. The actual implementation of the questionnaire and its application are discussed in the next chapter.

3.4.3.2 A Questionnaire as a Data Collection Tool

The questionnaire provides a useful tool in assessing expert judgements and user ratings, and provides a means for identifying common trends. Of the nine measures at the requirement level, only cost and security are not suitable for questionnaires. But for the majority, a sufficiently high level of information about each measure may be obtained from users through the use of a questionnaire. Obviously, to do so it is necessary to present questions which result in a rating value. To probe deeper into aspects of a particular measure, more questions which target those aspects need to be constructed. For example, in Task Outcome, we wish to know whether or not a task was completed. But we also want to know about the quality of that task and how the quality was affected by the choice of the resource configuration.

In constructing a questionnaire the selection of a scale and semantics is left to the evaluator (and a good statistical reference) as the results need to match the needs and objectives of the evaluator. An example of a question with a 6 point semantic differential scale, with a Not Applicable option is:

How would you judge the quality of the task outcome?	1 Poor	2	3	4	5	6 Excellent	N/A

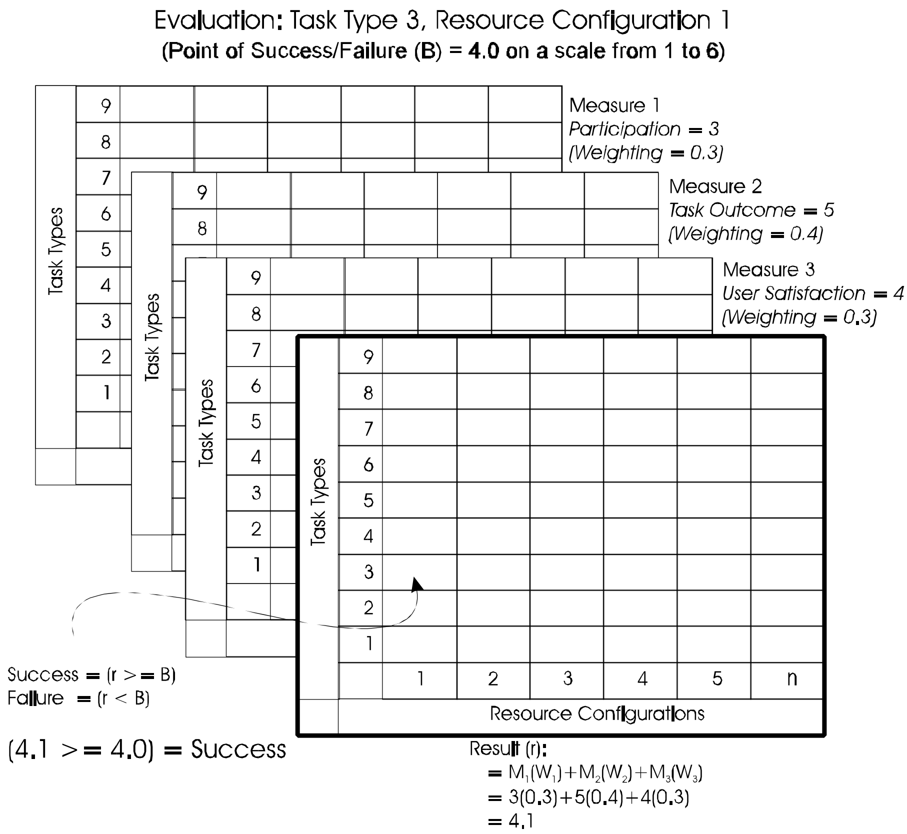
Lastly, it is important to decide where the failure and success boundary is. This is dependent on the scale and semantics used. Ideally an evaluator should use a scale which provides an equally divided continuum. In that case half way would be an ideal boundary, one half representing a degree of 'failure' while the other a degree of 'success'. Yet again it is stressed that the choice of the boundary is dependent on the evaluator's requirements and needs of the technology. Should an organisation have stringent requirements about the technology's collaborative ability, often where great value is placed on the collaborative activity, then the point can be moved higher: In effect, survival of only the best technology configurations. The opposite is true for more relaxed requirements.

3.4.3.3 Calculating 'Success'/'Failure'

Using the questionnaire, with categorised measures, to collect user responses, the determination of 'success' or 'failure' for the framework is dependent on:

Scale: Lower Boundary	$l \quad (failure)$
Scale: Upper Boundary	$u \quad (success)$
Success/Failure Boundary	$B \quad where \quad (l \leq B \leq u)$
Number of Respondents	i
Participant's Response per Question	$P \quad where \quad (l \leq P \leq u)$
Question Result	$Q \quad where \quad Q = \left(\frac{P_1 + \ldots + P_i}{i} \right)$
Number of Questions per Measure	j
Measure Result	$M \quad where \quad M = \left(\frac{Q_1 + \ldots + Q_j}{j} \right)$
Number of Measure Components	n
Weighting Factor	$0 \leq W_k \leq 1 \quad where \quad \sum_{k=1}^{n} W_k = 1,2,..,n$
Result	$r = M_1(W_1) + M_2(W_2) + \ldots + M_n(W_n)$ $Success = (r \geq B) \quad Failure = (r < B)$

Example



To be statistically accurate and to provide a better margin for error, the questionnaire needs to be completed by as large an audience as is feasible (or a statistically representative sample). The same activity need not be repeated. Rather, any activity with the same generic task type and the same resource configuration can be tested. For a once off, quick and dirty test, one could just try out the activity with its resource configuration and evaluate selected measures. In the above example, only the questions pertaining to task outcome, participation and user satisfaction are measured.

In summary, it can be seen that this framework provides a mechanism for matching work requirements, based on generic work task types, with various levels of system capabilities, services and technologies, which are ordered from low to high resource cost. The mechanism is used to provide a relatively easy matching of activities versus minimum resources required for teams which wish to collaborate electronically.

3.5 Conclusion

This chapter indicated the need and drive towards collaboration. It has shown a framework for matching collaborative work with supporting technology. It differs from the framework methodology offered by Cugini *et al* (1997) in that it is simplified to target a ‘system centric’ and ‘task centric’ approach to practical usability. A detailed composition of the proposed framework has been conducted, including a description of the composition of a collaborative environment with its associated costs; conceptualised as a resource, and represented by a resource configuration. Also discussed are collaborative tasks and how they consist of smaller generic task types. Finally, factors of success, their measures and metrics are detailed, from the construction of a data collection tool for the metric to a formula for deriving a ‘success’ or ‘failure’ result.

In the next chapter, the framework is tested and populated with certain ‘success’ values.

CHAPTER 4
EXPERIMENTAL STUDY

4.1 Introduction

This chapter describes the pilot study conducted to test and support the framework developed in the previous chapter. It details the context, construction and execution of the experiment.

4.2 Purpose

In order to determine the limitations of video conferencing in supporting collaborative tasks, a framework was proposed. The framework is now tested by:

C Selecting measures for evaluation;

- Formalising a data collection tool and establishing metrics to measure selected measures. In the case of a questionnaire: constructing questions targeting characteristics of a measure;
  - Define a scale (upper and lower boundaries), a 'failure'/'success' boundary and weightings for measures;
- Constructing a real world scenario which requires a meaningful task to be completed, and specifying the resource configuration required. Enacting the scenario with a real work group while collecting data;
- Calculating results from data; and
- Drawing conclusions from results pertaining to success or failure of the technology to support collaborative work.

4.3 Method

In this section, subjects, materials and equipment, procedures and data analysis are discussed.

4.3.1 Subjects

A judgmental sample of four participants was selected from the Rhodes University Information Systems Requirements Analysis Research Team (ANALYZE) team. The purpose of this was threefold. Firstly, the participants were involved in the research of aspects of communication, group dynamics, group facilitation and Joint Application Development (JAD) (Wood and Silver, 1995). This heightened their awareness to collaboration mechanisms and requirements. Consequently they were more aware of failures of the technology in supporting collaboration and could also provide a deeper insight into the evaluation of the technology. Further, they could be extra-critical of the technology and group processes. Secondly, the JAD experiment scenario (explained shortly) provided each member with an environment for observation and theory testing of issues relevant to their research. More importantly, it provided them with first hand experience in being part of the merger of collaborative technology and traditional group activities. This was appreciated as it provided insight into factors not considered in their work. Thirdly, the subjects were appropriate as they had experience in the traditional co-located JAD process, which was essential since they needed to use that experience to rate the questionnaire answers comparatively. The participants' experience in JAD ranged from 4 years to 2 years in small system projects (requirements of the Information Systems honours degree). As part of the experiment, the participants had certain roles to fulfill. Due to the limited number of participants, they performed different roles at times. These roles are listed below in table 4.1 and described in table 4.2.

Main Role	Other Roles Fulfilled
Sponsor/End User	Facilitator Trainer
Software Developer Director	End User Trainee
Software Developer 1 (mainly a Scribe)	End User Trainee
Facilitator	End User Trainee

Table 4.1 Participants' Roles.

Role Title	Description
Sponsor	An individual or group, representing a client organisation, that endorses the scope and goals of a project and represents that project in management councils. The sponsor has primary responsibility for finding the resources needed to fund the project.
Software Developer Director	An individual having primary responsibility for the welfare of the system project. Further, they act as a liaison between the developers and the client.
Software Developer	The individual(s) responsible for the modelling analysis, programming, testing and/or implementation of an information system. (AKA: Modeler, Developer, Application Developer, or Programmer/Analyst)
Scribe	A person who writes, reviews, maintains and releases all product documentation; including detailed system specifications; and designs and defines documentation standards.

Facilitator	A person who facilitates the process of gathering the client users' system requirements. The facilitator must assist the group in the process of their working together.
Facilitator Trainer	An organization unit or individual which prepares and/or teaches the user community about the newly developed system.
End User	An organization unit or individual which supplies and/or utilizes business information.
End User Trainee	An organization unit or individual who receives instruction and training from the facilitator trainer with regard to the system developed.

Table 4.2 Role Descriptions.

4.3.2 The Selection of a Collaborative Activity for Experiment Scenario

In selecting a collaborative activity, several characteristics about the activity were desired:

- It needed to be a real work activity, commonly found in the information technology industry.
- The activity should have the ability to scale in scope. (In which case a reduced scale of the activity could be implemented, leading to the knowledge that a successful evaluation of the core components of the task would indicate that a larger scale activity could be successfully evaluated.)
- Ideally the activity would require a range of different sub-task types to be completed in order to provide evaluations for numerous task types.
- The activity would require a high degree of collaboration, in order to complete the task.

For this purpose, the scenario selected was the development of a software application for a client. This is a typical task found in the Information Technology (IT) industry where a software development firm (or in-house division) creates an application (or a range of applications in a project) for a client. It is well recognised that Joint Application Development is a highly successful approach to developing applications that fulfill the client's/user's requirements. The entire process from conceptualisation to product delivery is a complex process, requiring communication and collaboration between developers and users. Traditionally, such a process has required that all parties involved be co-located in order to the complete co-operative tasks. This evaluation exercise geographically disperses the parties in order to evaluate the limitations of video conferencing in supporting the collaboration which is required for the development of the application. Therefore, the JAD process is used as it identifies and utilises a range of tasks and communication requirements for groups.

The actual project was conceived by the sponsor, who required a system to manage a Toastmasters International club. The desired functionality included: manage the club details with basic financial summaries, manage club members (track biographic, demographic, speaking experience, leadership experience, and other information), manage club committees and members with portfolios, manage club meetings and notify members, and generate reports about the above managed items.

4.3.3 Materials and Equipment

Hardware

- 2x Microsoft Windows 95 Workstations (figure 4.1). Each workstation was placed in a separate room, far enough such that no normal sound could physically travel between them (figure 4.2):
    - 1x Intel P200 MMX, 64MB ram, 20" monitor.
    - 1x Intel P100, 16Mb RAM, 14" monitor.
- 2x Intel Proshare 2.0 video conferencing systems, with standard multimedia kit full duplex speakers and microphones.

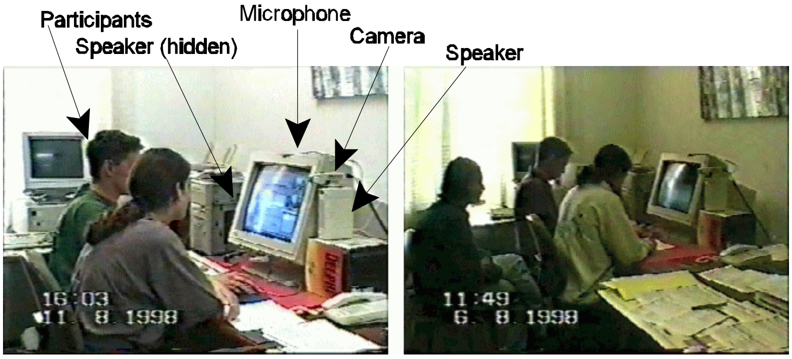


Figure 4.1 Video Conference System.

Network

- 10Mb/s TCP/IP LAN network (average packet delay time 12ms).

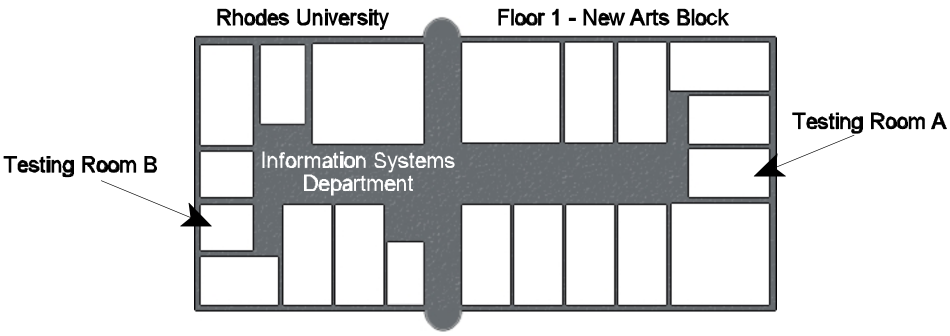


Figure 4.2 Floor Plan Indicating the Rooms in which the Study was Conducted.

Software

- Intel Proshare 2.0 video conferencing software with application sharing support (Intel Corporation) (figure 4.3).
- ASCII text editor, Professional File Editor 0.07.002 (32 Bit) (Allan Phillips).
- Corel Presentations 8 (Corel Corporation).
- Project Scheduler 7.5 (Scitor Corporation).
- ERWin/Quickstart 2.0 (Logic Works).
- Borland Delphi 3.01 (Inprise Corporation).
- Questionnaire Program (electronic version of paper based questionnaire).

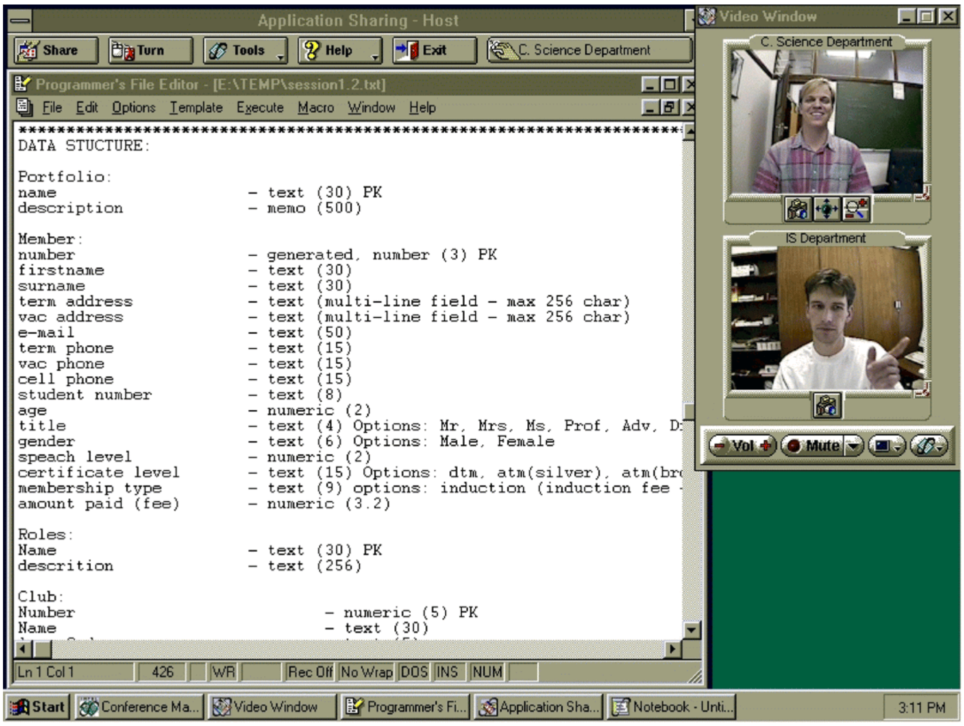


Figure 4.3 Video Conference Software User Interface.

In addition to the above, a video camera was placed in the corner of the host video conference unit room and the recording transferred on to a standard VHS VCR. Further materials included questionnaires and interview forms, and JAD session deliverables.

4.3.4 Preparation

In order to give the participants some exposure to the video conference environment, a collaborative exercise was conducted, where the participants received instruction and gained exposure to: application sharing, mouse sharing, audio and video characteristics, desktop space utilisation and management, and general group functioning and co-ordination. This was followed by a group feedback session to discuss the participants' initial experiences and factors mentioned above. In general, minimal instruction was required as the participants had considerable experience with graphical user interfaces and were well versed with computer communication systems.

To assist the participants in understanding the experiment and the questionnaire, the documents *Collaborative Conferencing Experiment Design* (Appendix B) and *Explanation of Questionnaire* (Appendix C) were given before hand. Questions from the participants relating to these documents were also answered.

4.3.5 Experiment Activities

Initially an attempt was made at following a system development methodology which defines each step to be taken throughout the process (*Collaborative Conferencing Experiment Design,* Appendix B). On the surface this methodology is very thorough, in fact too thorough for that small scale project experiment. Consequently some steps were combined, and others omitted. For clarification it is necessary to describe the actions which occurred during each activity. This section outlines the activity sessions conducted. It states the original task title, the actual activities conducted, the task type and time taken to complete the task. In table 4.3, activities are described using the roles played by the participants.

	Summary of Experiment Activities
Key	*Activity:* Title and general description of activity. *Activity Number:* The number of the activity appearing in the *Collaborative Conferencing Experiment Design* (Appendix B). Signifies selected activity in the pre-planned JAD sequence of events. *Task Type:* Task types 1 of 9 as described by Cugini *et al* (1997) (c.f. 3.3.1.1 Task Type Definitions) *Duration:* Length of time taken to complete activity.
1	*Activity: Initial Contact and Orientation Meeting* Activity Number: 0.1 Task Type: 6C Duration: 8 minutes The sponsor contacted the system developer director (SDD) and discussed the possibility of a system development project. A positive agreement was reached to investigate the possibility and another meeting was set to discuss the project in more depth with additional developers.

2 *Activity: Set initial project objectives and scope*
Activity Number: 1.1
Task Type: 9
Duration: 11 minutes

In this session the sponsor described to the developers the nature of the system, what problems should address. Developer 1 acted as a scribe, noting the system functionality in a shared text editor.

3 *Activity: Refine project scope*
Activity Number: 1.2
Task Type: 4
Duration: 20 minutes

This activity built on previous stage, but sought to finalise the scope of the system. Agreement was reached as to what was to be included and what was not. This session was characterised by some degree of confusion as to the expected outcome.

4 *Activity: Define project's benefits*
Activity Number: 1.3
Task Type: 9
Duration: 5 minutes

A short session in which the sponsor highlighted the perceived benefits of the system.

5 *Activity: Prepare preliminary project time line*
Activity Number: 1.4
Task Type: 1
Duration: 10 minutes

This session involved a rough plan of the project lifespan. An end date was determined after considering the prior agendas, involvement and commitment levels of the participants, and the estimated effort required to complete the development of the project.

6 *Activity: Determine preliminary project costs*
Activity Number: 1.5
Task Type: 6B
Duration: 22 minutes

This session resulted in a complete formalisation of projects costs. The distinction between preliminary and final costs was too fine to split over two sessions. The two parties bargained and negotiated to determine the project costs. Agreed costs were noted in a contract form.

7 *Activity: Establish business user participation*
Activity Number: 1.6
Task Type: 4
Duration: 4 minutes

This very short activity sought to identify the participants and their roles for the project duration. Since the number of participants were few, and the project was manageable for the group size, agreement did not take long to reach.

An activity not evaluated was 1.8 *Decide whether to continue with project*. After a very quick assessment of project scope the participants agreed to commence with the project.

8 *Activity: Prepare project plan*
Activity Number: 1.9
Task Type: 1
Duration: 35 minutes

This stage required the use of a project planning tool. It was shared to allow the sponsor to view the planning process. Discussion focussed on estimated times for each activity in the JAD process.

9 *Activity: Develop outline system area model*
Activity Number: 2.3
Task Type: 3
Duration: 28 minutes

This activity involved constructing a high level area model. The developers questioned the user about the main elements involved in the systems and the relationships between them. This was annotated diagrammatically as the information became available.

10 *Activity: Identify development environment*
Activity Number: 2.6
Task Type: 3
Duration: 7 minutes

In this session the user stated the desired hardware and software *deployment* environment. The developers further refined and confirmed this with knowledge about hardware and software requirements demanded by the development products. Other deployment considerations, such as security and screen resolution, were also explored.

11 *Activity: Complete entity relationship diagram*
Activity Number: 3.1
Task Type: 3
Duration: 58 minutes

Initially this stage was attempted with an ERD modelling tool. But it failed to function under shared conditions. This protracted the time taken to complete the task. Once again the text editor was used to detail all the entities, attributes and relations between entities based on the system model developed earlier.

12 *Activity: Complete process model*
Activity Number: 3.2
Task Type: 3
Duration: 24 minutes

This session required the developers to understand and model the high level processes that are required by the system, as described by the user.

13 *Activity: Define system procedures*
Activity Number: 3.6
Task Type: 3
Duration: 22 minutes

Building on the previous activity, the process model is refined to include lower level system procedures.

14 *Activity: Design system structure*
Activity Number: 3.7
Task Type: 3
Duration: 38 minutes

This session involved describing and structuring the attributes of each entity. Essentially each attribute field was assigned properties. This was done by questioning the user about the characteristics of each attribute.

15 *Activity: Design screen/report layouts*
Activity Number: 3.8
Task Type: 3
Duration: 38 minutes

This session was different, a more normal JAD environment was attempted. It utilised a higher resource configuration: a camera operator and video projector. Consequently more physical space could be used and developers no longer had to cram together to stay in front of a monitor and a fixed camera view. This took the focus away from the scribe to the facilitator. The camera operator would focus on the contents of the whiteboard and prominent speakers. The user described to the developers the kind of reports that the system would need to produce. Developers in turn asked questions pertaining to the attributes of the reports.

16 *Activity: Confirm consistency and completeness of system area model*
Activity Number: 3.11
Task Type: 4
Duration: 25 minutes

This was the final activity before commencing with the application development. It involved reviewing every prior activity output and making amendments where required, and after agreement by both parties.

17	*Activity: Conduct user training* Activity Number: 5.2 Task Type: 9 Duration: 26 minutes This session required a reversal of roles. The system had been coded to specifications. The sponsor/user took on the role of a trainer while the development team took on the role of trainees. The trainer lead the trainees step-by-step through the developed application explaining and discussing each element. Questions asked by the trainees were answered by the trainer.

Table 4.3 Experiment Activities Summary.

4.3.6 Trial Run

The first activity was conducted as a trial run for testing the collaborative environment, the questionnaire and its associated electronic version. It was discovered that question 1.4 (G4) required a change in wording to express the question better (*Questionnaire,* Appendix D). Further refinements to the questionnaire program user interface were also required.

4.3.7 Session Procedure

At the beginning of each session, participants met at their respective workstations (in different offices), the larger group at the video conference host PC as it offered a larger monitor. Usually the participants would start a session with a short 'ice-breaker' (a joke or arbitrary conversation) to re-familiarise themselves with the video conference environment and at the same time to give themselves an opportunity to adjust the camera position and audio volume. Then the participants would get familiar with the activity to be conducted, and the expected deliverables of that activity. They would then commence with the task at hand, utilising whatever software they felt necessary to complete the task. When the participants agreed that the activity was satisfactorily completed, they would fill out a questionnaire. Each session required that they complete at least one 'User Assessment'. In sessions where more time was available, the participants continued with the following activity. In such cases, it was unnecessary to repeat the 'User Assessment' as it was felt that too much time would be taken up filling out a questionnaire where feelings of expertise, comfort and confidence were unlikely to have changed in less than 30 minutes. At the end of the session, the participants would set a time and date for the next session. Common time slots became apparent as the participants had fairly predictable time schedules. Seventeen activities were evaluated over the period of ten weeks.

One session in particular requires special mention. The participants requested that one session be conducted in the Rhodes University department of Information Systems JAD laboratory. The objective was to use the tripod mounted video camera, instead of the standard Intel desktop video camera, operated by a person who would focus on the participants and the writing on a whiteboard. This occurred in a larger room and instead of a standard monitor, the video display was projected on a whiteboard for all the participants to see. The scribe would transcribe the writing on the whiteboard and the remote participant could further confirm the results of the discussion. The results of this session are also discussed later.

4.4 Data Collection

Chapter 3 introduced measures and metrics, and the various data collection tools available to the researcher. This research employs questionnaires, interviews, observation and video tape recording as data collection tools. The tool most favoured is the questionnaire as it provides statistical trend data and values which can be easily used for comparative purposes. Follow-up interviews and observation are used to assist and verify trend analysis findings and to explain anomalies.

In using a questionnaire as a data collection tool, the researcher has endeavoured to formalise user ratings as a metric for each one of the chosen measures. The final questionnaire can be found in Appendix D.

4.4.1 Construction of the Questionnaire

To match a value to the user's response, a 6 point, semantic differential Lickert scale has been used for all but one of the questions, which has a 2 point scale. A Not Applicable (N/A) option is also available for many of the questions. The six point scale was used to prevent users from 'sitting on the fence', and to get a range of responses which reflect a marginal failure or success to a complete failure or success result of the technology's ability to support the collaborative task. In terms of the formula presented in Chapter 3, the scale then has a lower boundary (l) of 1 and an upper boundary (u) of 6.

The participants were asked to rate their answers according to their previous and current experience in collaborative tasks. Each user was considered accomplished in the selected collaborative task. Hence confidence was placed on their ability to draw comparisons between two very similar collaborative task activities (in task type and processes), one occurring in a co-located environment and the other in a geographically dispersed environment but mediated by collaborative technology. The result was that a comparative evaluation was conducted. The experiment may be repeated with two equally skilled groups with one group functioning as a control group. The results of the participants, for each question, were aggregated to provide a final group value.

Equal importance was placed for the weightings for the selected measures: task outcome, user satisfaction, scalability and participation, hence the weighting factors for $W_{1\text{-}4} = 0.25$.

A neutral point of 3.5 was selected when setting the 'failure'/'success' boundary (B). Thus a result less than 3.5 is considered 'failure' of the supporting technology while a result equal and above was considered a 'success'.

4.4.2 Explanation of the Questionnaire

The questionnaire is broken down into the four preselected measures: Task outcome, user satisfaction, scalability and participation. The metrics, measured as responses to the questions asked in the various categories, sought to find deeper understanding and clarity about the selected measures.

Task Outcome

1. Was the task Completed?

   Fundamental to task outcome is that in order for a task to be completed, the task's objectives need to be met. Participants are asked to determine if the original objectives of the task or activity have been achieved.

2. How well did the given collaborative system configuration lend itself to the task?

   Some tasks may not be suitable for a given level of technology. Participants rate the given collaborative system's suitability to the type of task at hand.

3. How would you judge the quality of the task outcome?

   Participants are called to make a value judgment regarding the quality of the deliverable or decision made in the task.

4. How did the given collaborative system configuration affect the quality of the task outcome?

   Building on the notion of quality, this question refers to the system's impact on the quality of the task outcome. Certain collaborative tools may intrinsically produce a quality deliverable, if it is a good tool. An example of this is: a good collaborative project planning tool should produce a well structured, usable project plan.

User Satisfaction

1. How satisfied are you with the given collaborative system's ability to support the task outcome?

   In any collaboration exercise actions by participants and interactions between participants are required to complete a task. This question requires that participants rate their level of satisfaction with the system’s ability to support those actions and interactions required in order to complete the task.

2. How satisfied are you with the given collaborative system's ability to meet your requirements for activities which are needed to complete one task and begin a new task? (Transition Tasks)

   Certain tasks and activities are required in order to complete one task and to start another task. These activities are usually peripheral to the main task at hand (activities include summarising task outcome and assigning action items/responsibilities). E.g. In order to complete a meeting, minutes are required to be written up. In this example if the system allowed this to occur seamlessly, then a high degree of satisfaction may be recorded.

3. How satisfied are you with the given collaborative system's ability to support the required group processes?

   Various processes occur in group interaction. A system should be able to satisfactorily support those group processes. Support may be found in the following areas: Meeting conduct, communication needs and support for awareness (awareness in terms of other participants’ presence, location, actions, changes, etc.).

Scalability

1. How well did the given collaborative system support the given group size?

   A system has a limitation to the amount of people who can comfortably use it for specific tasks. Sometimes it may only be suitable for one person, other times many more, depending on the task and the capability of the system.

Participation

1. How satisfied are you with your level of participation in the task?

   Participants are asked to rate their degree of satisfaction with their level of participation in the conference.

2. To what extent did the given collaborative system hinder or aid your ability to participate?

   Certain characteristics of a collaborative system may influence the participants' ability to fully participate in a collaborative activity. Therefore, participants are required to rate the system's ability to support the participants desired level of participation in the activity.

3. How satisfied are you with the group's level of participation in the task?

   Participants are required to rate their satisfaction about the remote group's level of participation in the conference.

4. To what extent did the given collaborative system hinder or aid the rest of the group's ability to participate?

   Similar to question 2 on participation, except that a rating about the system's ability to support the participant's desired level of the remote group's participation in the conference is required.

User Assessment

In order to monitor the growing experience of participants with the technology, and the impact that it would have on the participant's ratings, a user assessment section was included as a check. It was proposed that as a participant's experience with the collaborative system increases, it was expected that participant would become familiar with the limitations and capabilities of the system, and hence affect the ratings. As an example: at the beginning of the experiment, when participants were fairly inexperienced, a participant might have found that it was difficult to complete a task because of the system's constraints. However at the end, the same task would be easy to complete because the participant was now familiar with the system. In this way the assessment process would still show tasks which would remain difficult to complete because the system simply cannot effectively support the functionality required by the task.

4.5 Conclusion

This chapter completes the experiment planning and execution phase. The work has detailed the experiment from its objectives, methods (including: the subjects, the selected scenario, materials and equipment, preparation and procedure), to the data collection and a summary of the activities conducted. This has been in accordance with the process of verification and testing of the proposed framework. What remains is to analyse and comment on the data collected during the execution of the experiment. This is done in the next chapter.

CHAPTER 5
DISCUSSION OF THE RESULTS

5.1 Introduction

To complete the experiment set in motion in the previous chapter, the analysis of results is now conducted. Firstly, the calculations, as per the proposed framework, are performed to determine the success of the technology's ability to support the collaborative work. Secondly, an in-depth analysis of the entire experiment is conducted focussing on the selected measures employed. Lastly, interaction analysis is conducted, in which breakdown analysis is performed to characterise communication flows and to compare this experiment with similar previous experiments.

5.2 The Framework Applied

In chapter 3, certain equations are prescribed in order to use the proposed framework.

In order to apply the framework, the equations are now evaluated. To illustrate the process the following calculation workings are presented. For the complete set of results, table 5.1 displays the results of the participants aggregated ratings per task type. Note that, for the sake of neutrality, each measure (task outcome, user satisfaction, scalability and participation) is equally aggregated to provide a final 'success' value.

5.2.1 Calculations (an example)

For this example, a subset of raw data from experiment Activity 2.6 (identify development environment) is used. Note the equation variables used (denoted in *italics*) and calculations performed.

Lower Boundary (l) = 1

Upper Boundary (u) = 6

Success/Failure Boundary (B) = 3.5

Number of Respondents (i) = 4

Participants Response, Question Results and Measure Results:

Measure (j)	Measure Result (M)	Question Result (Q)	Participants' Response (P)	Question Number	Participant (i)
Task Outcome	5.25	(Task Outcome is calculated as per Participation.)			
User Satisfaction	5.22	(User Satisfaction is calculated as per Participation.)			
Scalability	4.00	(Scalability is calculated as per Participation.)			
Participation	4.00	4.00	1	4.1	Sponsor
	$M = \left(\frac{Q_1 + \ldots + Q_j}{j}\right)$		4	4.1	SD1
			5	4.1	Facilitator
			6	4.1	SDD
		3.75	2	4.2	Sponsor
			3	4.2	SD1
			4	4.2	Facilitator
			6	4.2	SDD
		4.25	2	4.3	Sponsor
			4	4.3	SD1
			5	4.3	Facilitator
			6	4.3	SDD
		4.00	3	4.4	Sponsor
		$Q = \left(\frac{P_1 + \ldots + P_i}{i}\right)$	3	4.4	SD1
			4	4.4	Facilitator
			6	4.4	SDD

Number of Measure Components (n) = 4

Weighting Factors (W): $W_{1\ (task\ outcome)} = 0.25$

$W_{2\ (user\ satisfaction)} = 0.25$

$W_{3\ (Scalability)} = 0.25$

$W_{4\ (Participation)} = 0.25$

Result = 5.25(0.25) + 5.22(0.25) + 4(0.25) + 4(0.25)

= 4.62 > 3.5 = Success!

5.2.2 Calculations (complete)

The experiment involved 16 activities of various task types. These activities were conducted sequentially, but for the framework results, the activities are grouped in their task types. Table 5.1 presents all the final 'success' results (grouped by task type), listing the activity number and the selected measures for the single resource configuration employed. Once again, it should be noted that the predetermined 'success'/'failure' boundary is set at 3.5 (neutral point).

Task Type	Activity	Task Outcome	User Satisfaction	Scalability	Participation	Success
1	*1.4*	4.67	4.82	4.50	4.81	4.70
	1.9	3.83	4.44	4.50	3.63	4.10
		4.25	4.63	4.50	4.22	**4.40**
3	*2.3*	3.75	3.63	4.50	3.69	3.89
	2.6	5.25	5.22	4.00	4.00	4.62
	3.1	3.67	3.00	3.50	3.94	3.53
	3.2	4.89	4.71	5.33	4.75	4.92
	3.6	4.22	4.50	5.00	4.75	4.62
	3.7	5.11	5.67	4.67	4.83	5.07
		4.48	4.45	4.50	4.33	**4.44**
4	*1.2*	5.25	4.83	3.50	4.44	4.51
	1.6	5.42	5.67	4.75	5.13	5.24
	3.11	4.25	4.88	3.75	4.56	4.36
		4.97	5.13	4.00	4.71	**4.70**

6	*0.1*	4.80	6.00	6.00	4.50	5.33
	1.5	4.92	4.73	4.75	4.44	4.71
		4.86	5.36	5.38	4.47	**5.02**
9	*1.1*	5.25	5.50	4.75	4.50	5.00
	1.3	5.25	5.00	4.25	4.69	4.80
	5.2	5.08	4.50	4.00	3.31	4.22
		5.19	5.00	4.33	4.17	**4.67**

Table 5.1 'Success' Calculations of Participants' Aggregated Responses.

The 'success' values are inserted into the basic task versus resource configuration matrix (figure 5.1). The matrix is complete for task types 1, 3, 4, 6 and 9 under the resources of the tested configuration. The framework indicates that, based on the measures, weightings and 'success'/'failure' boundary, the technology successfully supported the tasks executed. Clearly the framework can house results from experiments that involve the same activity using different resource configurations and different activities composed of various combinations of task types. An example of the framework application is: Given a dissemination of information task, such as a presentation (task type 9), the given technology configuration (1) supports the activity.

Task Types	9	**4.67**				
	8					
	7					
	6	**5.02**				
	5					
	4	**4.70**				
	3	**4.44**				
	2					
	1	**4.40**				
		1	2	3	4	n
		Resource Configurations (In increasingly intensive resource configurations.)				

Figure 5.1 Basic Task vs. Resource Matrix Framework with Experiment Results.

5.3 Data Analysis

Further data analysis is provided to discuss trends and anomalies found in the experiment. Figure 5.2 and figure 5.3 graph the experiment historically and sequentially, from the first task to the last task. Figure 5.3 plots each of the measures (including user assessment) separately for clarity. The four selected measures, user assessment and general observations are discussed. Of interest are factors causing high and low points. It should be noted that activity 3.8 is not displayed due to its different resource configuration. The participants' comments are stated in greyed text boxes.

5.3.1 General

Immediately it can be observed that the high and low points of measures do not necessarily correlate to the task type undertaken, but rather to other factors. Activities 1.6 and 2.6 appear as positive spikes in figure 5.2. This is attributed to the simple nature of the activities and short time (4 and 7 minutes respectively) taken to complete the task. Activity 2.1 by contrast scored the lowest ratings, but it also was the activity that took the most time, almost an hour. The fact that the software crashed several times (due to incompatibility problems) in this task contributed to the time taken for the task. These incidents contributed to the participants frustration and resulted in a very low user satisfaction score.

> Software Developer 1: "It was really irritating not being able to use a proper ERD tool. The crashes in the beginning were really frustrating - there were occasions where I just wanted to turn the PC off and give up."
>
> Software Developer Director: "Because of the fact that the modelling tool kept crashing whenever is was shared. I'd say the collaborative system didn't lend itself very well to the task. In the end we just used Corel presentations and a text editor which didn't work quite so well."

Of the measures selected, task outcome and user satisfaction displayed the closest correlation to each other. The indication is that when a task was perceived to have been successful, participants felt satisfied. Perhaps psychologically, a feeling of satisfaction is closely linked to a sense of achievement.

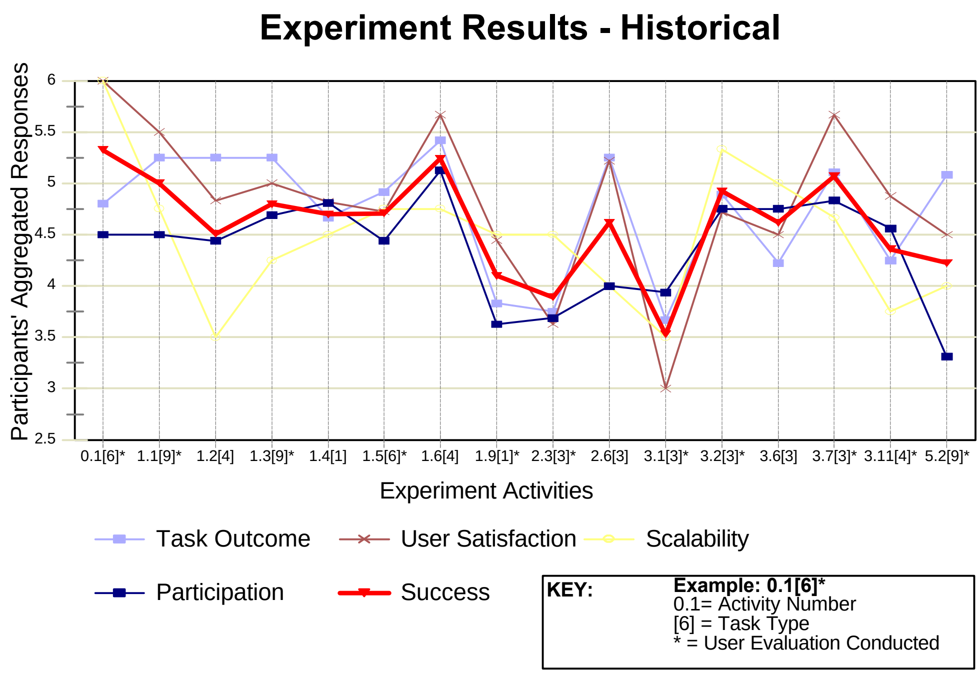


Figure 5.2 Experiment Results - Historical.

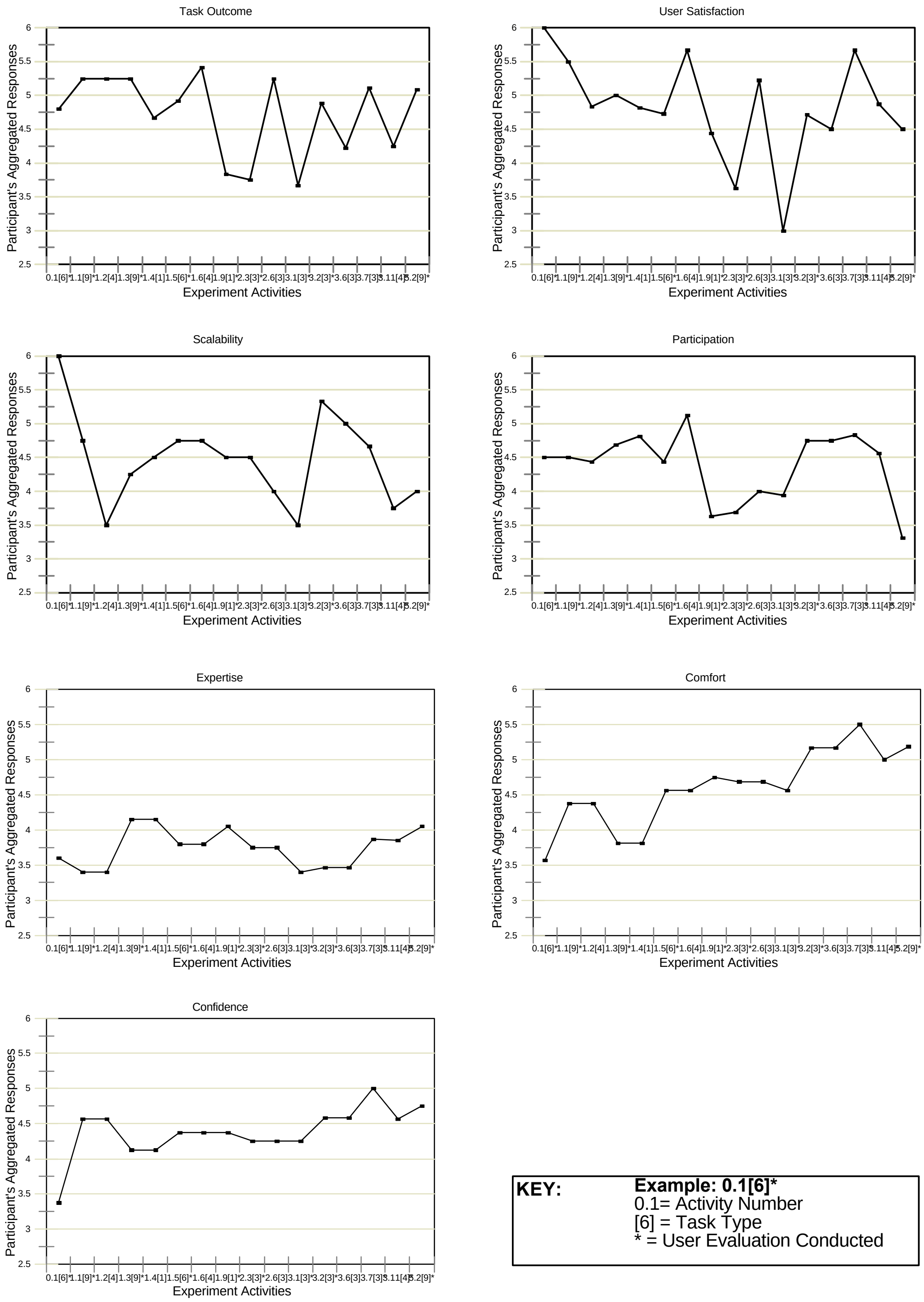


Figure 5.3 Experiment Results - Individual Measures.

5.3.2 Task Outcome

Throughout the experiment, the participants agreed that task outcome was successful. Every task was completed. Yet at times there were doubts about the thoroughness and quality of the task outcome. At times (activities: 2.3 and 3.1) the technology failed to lend itself well to the task, but this was overcome by using an inferior but more robust tool (a text editor). Consequently the quality of the task outcome was degraded.

> Facilitator: "We completed the task in description fairly well yet I don't feel that we actually produced a properly drawn-up ERD due to failure with the technology."

A task type in which task outcome was particularly affected was task type 6. The participants felt that the nature of communication involving negotiation requires more body language and conversation flow. This was hindered by the level of technology used.

5.3.3 User Satisfaction

Generally, extreme satisfaction scores headed the overall success rating of an activity. So where a high user satisfaction score was measured, the other ratings were correspondingly high, and vice-versa. The user satisfaction graph is characterised by 3 very high scores (activities: 1.6, 2.6 and 3.7) and 2 low scores (activities: 2.3 and 3.1). *High Scores:* Activity 1.6 and 2.6 have high user satisfaction scores. The tasks are simple, short and easily completed. Activity 3.7, while taking more time, was also considered simple and the technology used was appropriate for the task.

> Scribe: "This task was very short and simple and as such easily achieved with the system. The assistance of the system was that everyone could see what was being typed."
>
> End User: "This worked quite nicely. It is simple to use etc." "Simple task... worked very well."

Low Scores: Activity 2.3 and 3.1 received low scores due to the participants general unease with several factors including: inappropriate choice of software tools to execute task and lack of experience in using it, software applications crashing and general fatigue.

> Scribe: "I found it a little cumbersome doing this task especially using presentations. It feels as though we waste so much time concentrating on the technology and not getting on with what needs to be done. Corel Presentations was the wrong choice to diagram the model. This is not really a reflection on the Proshare application, but rather on the lack of experience with Corel. (If we had more experience, we would

not have used it!) It hindered me because I was spending time fiddling instead of working on the task. I know this has been a problem before, but this time was definitely worse."

Software Developer Director: "The presentation application wasn't as clear on this side, there were greyed out areas etc due to the poor quality of the refresh (and the application sharing tool). I don't think Corel Presentations was the ideal medium to use as it was very slow. The end user and I were sitting here feeling a bit out of it until all the entities and links had been drawn. An electronic whiteboard or something more interactive would have been a better medium to use."

Question 2 regarding transition tasks was consistently scored N/A (Not Applicable) from early on. This was due to the fact that participants felt that they did not need to execute transition tasks.

5.3.4 Scalability

The two points of interest are the high (activities: 0.1 and 3.2) and low (activities: 1.2, 3.1 and 3.11) participation responses. The high scores are predictably so as those activities involved only 2 or 3 participants, giving the participants more space and freedom, hence the technology scaled well.

Facilitator: "It was different having only 2 on one side. I felt as though I could get more involved without worrying about who could see over my shoulder etc."

Activity 1.2 involved the whole development team. The sudden decline in ratings is largely influenced by the particular difficulties experienced by the sponsor.

Sponsor: "I couldn't see the scribe when he was typing. Zoom was too small, couldn't see facial expressions and other body language. Eventually I felt like I was talking to the computer, or as if I was talking on the phone. The other group members were phantoms" and "...I can't monitor body language, I need cues from the development team to know whether or not they understood me".

The other low scores are brought about by the participants experience using the technology and the growing realisation that the technology did not support the given group sizes very well.

5.3.5 Participation

The participation measure best reflected the task type undertaken. In the case of activity

1.6, where a general verbal consensus was sought in a simple task, everyone could easily contribute and feel part of the discussion. Activity 5.2, a dissemination of information task, received a particularly low participation score. The lack of participation can be attributed to two factors: 1) The technology not supporting the feedback loop mechanism (figure 5.4) found in communication, and 2) the participants intimate understanding of the developed system. The end user trainee makes a particularly good suggestion for future testing.

1) Facilitator: “Not enough user involvement. It was limiting. Interaction was low, the users could not point to "things" on the screen etc.”, “I did virtually all the talking” and “Feedback loop was highly restricted. For this exercise one really needs to be able to see how people are responding to the session”.

2) End User: “Having been part of the analysis & design process, it was easy to understand the system. The implementation was what I expected. i.e. I felt that it met the requirements which we laid out. Participation was not really an issue - because I understood the system, there was no need to involve myself. My feeling is that the ability of the CSCW system to facilitate training needs to be tested further with users who have never seen the system.”

At a social and group process level, there was one general complaint regarding participation by the sponsor/end user throughout the process. As an individual, in the remote group, he often felt excluded from the team activities. At times it was the result of a slow visual update of the shared referenced object (the text editor) while at other times the development team just focussed on the technology and ignored him. The following comments reflect this.

Sponsor: “This technology makes it very easy for the group of 3 to ignore me, to hold a private conversation, and leave me ‘hanging’. This was very frustrating... it was as if I wasn't even there. Believe it or not, we are in a meeting... if you need a private session, then have the courtesy to call one!”

Sponsor: “I did a lot of 'watching'. This amounted to time wasted. I was largely ignored by the developers. Feedback was not forthcoming in some instances. In one instance the feedback was in the form of writing, which took time to appear on my screen.”

Sponsor: “The development team were focussed on the PS7 chart, and not on me. I think that there were times when they felt that I didn't exist.”

Sponsor: “I felt left out at some points... the developers were talking quietly among themselves. Furthermore, my software was 'moving slower' than theirs and I was left behind at times. The camera image was also freezing, leaving me feeling disconnected.”

Lastly, the participants later indicated that when certain tools failed to support the intended task, they became more withdrawn and participated less.

5.3.6 User Assessment

User assessment is broken up into experience, comfort and confidence. The graphs reveal little out of the ordinary. The three measures show a natural, expected rise. As the participants use the technology and gain familiarity with their environment, they become gradually more comfortable and confident with video mediated collaboration. Perhaps noteworthy is experience. The results indicate a very slight increase throughout the experiment. Participants attributed this to an aversion of over-rating their expertise and an uncertainty to the level of expertise required in future sessions. At the same time they felt that they had a lot more to learn about video mediated collaboration.

5.3.7 Activity 3.8

Activity 3.8 deserves special mention. An experiment within an experiment, the participants suggested that they would like to conduct a session in an environment that they were used to performing JAD in. This was accommodated and a session was conducted in the Information Systems Department JAD laboratory with a camera operator and a video data projector to allow all to see. The participants positioned themselves in the venue, wherever they felt comfortable. The facilitator resumed her traditional role and transcribed the end user's (remote party) ideas on an ordinary whiteboard. The participants had the following to say about the various measures:

5.3.7.1 Task Outcome

> End User: "I think that this is probably the first time that I have felt entirely happy (normally I have a little unexplained unease) with the quality of our task outcome."

5.3.7.2 User Satisfaction

> End User: "Using this technology was certainly different to our other sessions. I am satisfied that we can perform the tasks, but I am not sure whether or not things could be better, happen faster etc. in a normal

environment."

End User: [On the collaborative's system to support group processes] "This definitely falls short for me. The cameraman was not able to perform the duties of my eyes for me (understandably so!) Zooming in etc. was good, and made a difference to previous sessions, but because I could not see everybody involved, their presence was not felt. I actually forgot that the software developer director was there at times. Discussions didn't really take place... or perhaps they did and I am just relying more heavily on the audio channel than other channels."

Overall user satisfaction received the highest rating in this activity. The sentiment amongst the participants was that they were more than satisfied (rating of 5.5) with the collaborative system's ability to support the task outcome, but were less than satisfied with the support for group processes (rating of 3.75).

5.3.7.3 Scalability

End User: "The JAD room was very disparate to me... perhaps we need a camera focussed on each person, and 3/4 windows open on my screen, or perhaps the others could have sat closer together."

Facilitator: "For me as the facilitator I felt that the setup was better for me. I was able to facilitate in the traditional manner."

The space gave the development team more freedom than their normal, but somewhat cramped, situation, huddled in front of a small camera. It is clear that for the group the improved space proved beneficial, but for the single user it had the opposite effect.

5.3.7.4 Participation

End User: "I participated fine. In fact this was much better than before. The facilitator actually engaged me for a change. This was very good. The Software Developer Director hardly offered anything, perhaps poor facilitation? The scribe also seemed a bit distant. I know we all contributed, it just doesn't feel right."

Facilitator: "I did feel that having the camera zooming in gave people the opportunity to be excluded. The Software Developer Director never said anything, and hence the camera never focussed on her. I don't think people participated as much as before."

Software Developer Director: "I found that I could totally switch off and fall asleep because I wasn't on the camera most of the time. Therefore I could totally divorce myself from the whole session. The facilitator was definitely more in charge of the whole process with the ability to use the whiteboard. The scribe participated far less than in a normal JAD."

From these comments, the impact of a different kind of technology can be seen. When the participants were all forced into the camera angle of the smaller static camera, they were aware of their own presence in the conference and their level of participation. They felt more compelled to participate. However with a single human operated camera they were filmed when they spoke, thus allowing them not to participate if they did not want to.

5.4 Further Analysis

This section is a departure from the analysis of the framework. Further analysis is in the form of a semi-structured interview which looks at larger video mediated communication issues, some of which were identified in the review of the related literature. The last theoretical analysis is provided by the interaction analysis process, specifically breakdown analysis, where communication flow from the experiment is analysed. Comparisons are made with another study's breakdown analysis.

5.4.1 Semi-Structured Interview

A semi-structured interview session was conducted at the end of the experiment as a mechanism to discuss issues and to provide feedback. Most of the observations made and issues raised related to softer group or people issues and reflect upon aspects of video mediated communication as a whole. These findings are discussed below.

In terms of the selection of participants, a participant felt that all the participants were too knowledgeable about the communication processes and the experiment activity (JAD). It was felt that some activities would not have been achieved if the participants were not as knowledgeable about the problem area and the processes required to solve the problem. Ordinary users would have struggled with the technology supporting the task.

Group issues, such as commitment, were also not explored in the experiment. It was felt that it would have been difficult to gain user commitment to the process which involved this technology. Yet another social issue was trust. It was felt that trust was more likely to develop in face-to-face situations than video mediated situations. A participant believed that trust between participants is essential in nurturing user commitment, which in turn was vital for project success. Other human factors, such as resistance to change and 'techno phobia', were also not encountered in the experiment. This is a reflection on the evaluation approach taken, in that the experiment conditions varied from that of a business driven environment with it's financial incentives and business needs.

The lack of participants from diverse fields and knowledge areas was also considered problematic, and non reflective of the targeted organisational environment. In the experiment the participants had a common education and understanding of processes, therefore the experiment was characterised by few conflicts and a high degree of co-operation.

Another group characteristic was personal space. The participants were comfortable with each other's presence. But it was felt that if strangers were put in the same confines as dictated by the video equipment, they would have difficulties and feel uneasy. This issue impacts the resource configuration, requiring more physical space and more resource intensive video equipment to overcome the difficulties imposed by larger space. Allied to this is the practice of using 'ice-breakers' to make participants more comfortable with each other. This practice was never formally initiated, but it was noted that in situations where sessions started with off-topic banter, the sessions seemed to flow more easily as the participants were more relaxed. In future, this practice in a video conferencing medium needs further study.

In collaborative work, especially in an environment with a hierarchy, such as in an organisation, power structures often influence the outcome of a task. It was felt that video mediated communication can influence the effect of power structures in a group by neutralising those power structures. However this study did not encounter this phenomenon as the participants shared a similar power base.

A participant felt that a co-located group would have generated more discussion and ideas. He felt that the medium limited free interaction. This is supported by the findings of Kies (1997). At the same time it was felt that there was more of a focus on the task at hand and that the environment resulted in things happening more quickly. On a similar note, a participant felt that the technology limited socialisation. This was attributed to the loss of the feeling of presence as the remote group was considered as a mere object on the screen. This links very closely with the use and value of video in communication. Participants felt restricted and limited in the ability to make eye contact and zoom in/out on people, something they deemed important for certain tasks.

Sponsor: "Zoom was too small, couldn't see facial expressions and other body language. Eventually I felt like I was talking to the computer, or as if I was talking on the phone. The other group members were phantoms."

Scribe: "For the first time I was trying to note the sponsor's body language, normally he expresses himself a great deal in his body movement. However with video conferencing he seems very stiff and rigid - is this the technology?"

End User: "One dimensional... them and us... picture of them (and me no doubt) too small..." " I found that I was talking to the 'people on the screen' as opposed to the whole group. It is too one-dimensional... people just aren't people. Even with the software developer director sitting next to me... she didn't seem real. She was too close (so that she could be in camera view), I didn't want to look her in the eyes. I felt as though I was in a movie cinema... sit next to me, look straight ahead, whisper if you want to talk, and don't take your eyes off the screen."

Sponsor: "Today I took telephone calls and allowed people to come into my office for a 'chat'. It was incredibly disruptive. Strangely, I did not feel at all bad about simply ignoring the developers. They were decidedly one-dimensional, it was almost as if they were the computer and it was not rude to simply 'put them on hold'. I didn't even feel the need to excuse myself (which I normally do in a co-located meeting.) The scribe later pointed out that it would be good etiquette to excuse oneself for phone calls and other interruptions. Still, it did not seem as rude as it normally would!"

Sponsor: "Static camera angle, small viewer window, not enough detail, not enough intimacy."

Social presence theory attributes this to the richness of the media, which in this experiment, is considered low. In order to address this problem a more media rich and consequently a more resource intensive configuration would be required.

A times, the support for awareness was not supported by the technology. A participant felt lost when without video, but noted that his audio senses were more attentive. This action was also required in order to compensate for the loss of touch and smell. The lack of visualisation prompted the following comments.

> Software Developer Director: "Interesting to note that when the sponsor was out of view, we couldn't interrupt him - it was awkward when we didn't know where he was."
>
> Scribe: "It is also irritating not knowing whether or not the sponsor is in the room when he is out of camera view."

On several occasions, participants expressed concerns about how the technology affected the roles of the participants. The experience was that there was a shift in control and power away from the traditional session controllers to the person controlling the technology.

> End User: "It still seems to me that the scribe is the most important person in this environment. The scribe is in fact the facilitator - he holds the key to the entire communication process... we rely heavily on the diagrams etc.
>
> End User: "Once again, the scribe is too dominant. Control of the mouse is almost ultimate power."

This was further evidenced when the facilitator assumed the role of scribe.

> Facilitator: "I felt far more involved and more of a facilitator, doing the actual typing and work on the computer. But did get a little lost at times worrying about the technology."
>
> Software Developer: "[Not the scribe for once, Facilitator took on that role] It was nice not to be 'tied' to the technology, gave me room to sit back and think. But at times I felt a bit out of control, frustrated esp. when the end user didn't listen to me."

By using a camera operator, who focussed on the speaker in session 3.8, which happened in a traditional JAD environment, the balance of power shifted back.

> Facilitator: "For me as the facilitator I felt that the setup was better for me. I was able to facilitate in the traditional manner."
>
> Software Developer Director: "The facilitator was definitely more in charge of the whole process with the ability to use the whiteboard. The scribe participated far less than in a normal JAD."

The facilitator felt that when using the technology as a facilitator it required that the person be very skilled, while in a face-to-face situation one could get away with being a poor facilitator. The effect of technology on the social protocols and group characteristics is an important consideration for the application of this kind of technology, one that should not be ignored. Implementors of this technology must be cognisant of this impact and ensure that the technology supports the functions of roles.

Ross *et al* (1995) consider some important issues essential to communication. Firstly, they consider whether the mechanisms found in face-to-face communication and collaboration are relevant, and indeed desirable to reproduce in a computer mediated environment. Further, they consider if the essentials of the interaction are not altered by the very medium used. Central to their work is the notion of shared understanding and the communication processes that support shared understanding between communicating parties. Different media may change the way people share their understanding. But they are also concerned about the additional costs incurred when shared understanding is mediated through a computer mediated channel, such as video conferencing. Ross *et al* (1995) suggest analysing costs by characterising the interactions and conversations between the participants in terms of the coordination of social (between people), cognitive (within individuals) and technological (use of artefacts) mediations, distributed across time, as well as the kinds of breakdowns. This is done in breakdown analysis, which is discussed later in this chapter. These issues are serious considerations in this study as much may be explained by them.

A particular concern of a participant was the constant unease about shared understanding. The participant did not receive the desired level of feedback to reassure him that the remote party understood him fully. This finding was shared by the participants of Ross *et al*'s (1995) study, who felt that shared understanding was less complete than that in a face-to-face session.

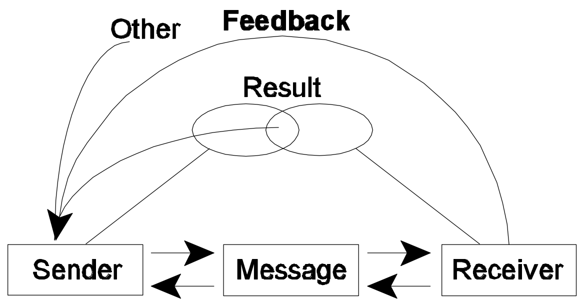


Figure 5.4 The Nature of Feedback (Fielding, 1993).

Other participants agreed that the medium degraded the feedback loop mechanism but felt that experience and awareness to the problem would build skills and explicit communication structures to overcome it to a certain degree. Notice that the repair mechanisms, of awareness and skill, constructed by the participants to overcome the medium is a cost incurred by using the medium. Figure 5.4 depicts the nature of feedback. In this study the communication medium restricted non-verbal (and at times verbal) cues which would have normally assisted the communication processes and the maintenance of underlying shared understanding.

Sponsor: "I think that I was restricted in terms of my normal communication style. I'm not sure that the SDD was paying attention to what I was saying... I couldn't see what she was writing down... basically her body language was 'non-existent'."

Sponsor: "The task was completed, but I can't seem to assess the development team's understanding of it."

1.2 Sponsor: "This is bugging me! I couldn't see the scribe. I can't monitor body language, I need cues from the development team to know whether or not they understood me. The software developer director was reading something and I couldn't see it. The scribe whispered something in software developer director's ear and I couldn't glare in disapproval at him. The feedback loop is hugely restrictive. Of course, this is also the communication channel. Voice and a small image are not enough. It is frustrating, yet somehow it seems to stop me from being over-elaborate in my communication. Perhaps more complex tasks will start to show real limitations in terms of our ability as a group to communicate our thoughts and feelings!

Sponsor: The technology hindered my participation as "I am frustrated with the limitation on feedback".

Facilitator: "I feel an important part of participating in a decision is simply nodding one's head in agreement etc. This is lost with this type of technology."

Yet the participants believed that they adapted their communication style to overcome the inability of the medium to support subtle communication. A particular repair mechanism was to make communication more explicit. This was to the detriment of natural interaction and conversation flow.

> Sponsor: "I am used to the short comings and am learning to communicate in a different way. I am adjusting to the technology. I think this is a bad thing, but the test will come later when we are doing more complex stuff. Generally, I am feeling less restricted, more comfortable and less frustrated."

Support for the feedback loop mechanism appears to be vital for communication and shared understanding. Where the medium results in breakdowns and hence compensation by the users, inexperienced users should be trained to understand and be aware of the short comings and use a modified set of communication protocols to achieve effective communication. The expectation of modern video conferencing technology is that it will support normal face-to-face communication styles. Unfortunately this is not true as the medium simply cannot replicate that environment. Humans can still however achieve a high level of effective communication, through adapting the style of communication to work with the limitations of the medium employed. This may however incur additional costs (effort, time and even money).

5.4.2 Interaction Analysis

The method selected for interaction analysis is based directly on the work conducted by Kies (1997) and provides a very good opportunity for a comparative study. Kies selects the extensive research and experience provided by Jordan and Henderson (1995) as the basis of his work. Jordan and Henderson (1995) present various foci of analysis: Event structure, turn taking, participation structure, trouble and repair, and artifacts and documents. This study focuses on trouble and repair. To analyse this, breakdown analysis (based on the work of Doerry, 1995) is employed to measure the degree of communication support offered by the adopted resource configuration. This, in effect, quantifies and characterises the type of communication breakdowns that occur.

5.4.2.1 Breakdown Analysis

Fourteen sessions were analysed to determine the frequency and type of communication breakdown. This was accomplished by the researcher watching video tapes of the video conferencing session and recording incidents of communication breakdown. Six classes of breakdown were recorded: verbal turntaking, reference, topic, audio, video, and shared understanding. Each breakdown is defined in Table 5.2.

Verbal Turntaking	An incident in which two or more participants are talking at the same time. This does not include specific interruptions (i.e. "...Excuse me, but...").	
A	One Stopped, one continued	A turntaking breakdown which was resolved by one participant ceasing to speak while the other continues
B	Request for other to stop	A turntaking breakdown in which a participant asked another to stop talking
C	Two continue longer than 3 seconds	A turntaking breakdown in which both participants talking simultaneously continue for longer than 3 seconds
D	Other	Any other example of a turntaking breakdown not described above
Reference	An incident in which the sharing of an object (papers, pencil, notes, mouse, etc.) becomes problematic (i.e. two users "battle" for use of the mouse).	
Topic	An incident in which there is a failure to maintain topical orientation by one or more of the participants.	
A	Request to be updated, result of side conversation	A topic breakdown in which one or more participants request to be updated. The breakdown is the result of a side conversation
B	Request to be updated, result of other activity	A topic breakdown in which one or more participants request to be updated. The result of an activity other than a side conversation
C	Other	An other topic breakdown not described above
Visual	An incident in which visual communication suffers.	
A	Request for shift in seating	A visual breakdown evidenced by one participant requesting another to shift seating
B	Request for camera movement on participant	A visual breakdown evidenced by a request for the repositioning the camera on a participant
C	Unable to see a participant	A visual breakdown in which a participant is unable to view another participant
D	Request for an object to be re-positioned	A visual breakdown in which a participant requests that an object of interest be repositioned in the camera field-of-view
E	Request for camera movement on an object	A visual breakdown evidenced by a request for the repositioning the camera on an object
F	Other	Any other visual breakdown not described above

Audio	An incident in which a breakdown results due to loudness, feedback, or static difficulties. Requests for repeating due to these problems.	
A	Request for repeat, other repeats	An audio breakdown in which one participant asks to repeat a statement and another participant honours the request
B	Request for repeat, other does not repeat	An audio breakdown in which one participant asks to repeat a statement and no other participant honours the request
Shared Conversation	An incident in which a statement or question is directed at an adjacent (or co-located) participant with no attempt to include the rest of the group.	
A	One side conversation	A shared conversation breakdown in which only one side conversation occurs
B	Two side conversations	A shared conversation breakdown in which two side conversations occur

Table 5.2 Interaction Breakdown Classifications, Sub-Categories and Definitions.

The six breakdown classifications are based on Doerry (1995) and Kies' (1997) work and research using breakdown analysis. In this study, approximately 6½ hours of video footage, representing 14 video conferencing sessions, are analysed. Table 5.3 displays the total number of breakdowns, per breakdown category, in column VC (Video Conference). It should be noted that Kies' findings are represented in the first 3 columns, namely: Face-to-Face, 25 frps (frames per second) and 10 frps (adjusted per hour).

		Face-to face		25 fps		10 fps		VC	
Verbal Turntaking	(Total)	306.23		145.18		134.76		38	
A	One Stopped, one continued	158.86	**52%**	123.14	**85%**	118.70	**88%**	32	**84%**
B	Request for other to stop	3.67	**1%**	0		1.67	**1%**	1	**3%**
C	Two continue longer than 3 seconds	134.80	**44%**	22.04	**15%**	12.32	**9%**	2	**5%**
D	Other	8.90	**3%**	0		2.07	**2%**	3	**8%**
Reference	(Total)	0		1.03		0		8	
Topic	(Total)	1.24		7.89		11.66		19	
A	Request to be updated, result of side conversation	1.24	**100%**	1.30	**16%**	8.33	**71%**	2	**11%**
B	Request to be updated, result of other activity	0		5.61	**71%**	3.33	**29%**	2	**11%**
C	Other	0		0.98	**12%**	0		15	**78%**

Visual	(Total)	0		3.22		9.82		2	
A	Request for shift in seating	0		0		4.40	**45%**	1	**50%**
B	Request for camera movement on participant	0		0		0		0	
C	Unable to see a participant	0		0		0		1	**50%**
D	Request for an object to be repositioned	0		0		0		0	
E	Request for camera movement on an object	0		0		0		0	
F	Other	0		3.22	**100%**	5.42	**55%**	0	
Audio	(Total)	3		19.44		29.81		42	
A	Request for repeat, other repeats	0		16.69	**86%**	26.06	**87%**	38	**90%**
B	Request for repeat, other does not repeat	3	**100%**	2.75	**14%**	3.75	**13%**	4	**10%**
Shared Conversation	(Total)	51.33		65.64		94.34		122	
A	One side conversation	14.75	**29%**	52.84	**80%**	88.89	**94%**	116	**95%**
B	Two side conversations	36.58	**71%**	12.80	**20%**	5.45	**6%**	6	**5%**

Table 5.3 Communicative Breakdown Totals.

Unlike Kies' analysis in which there were two analysers, this analysis was performed by one observer, hence the reliability of the data is untested. The results do however show a close correlation between the results found in Kies' study in the 10 and 25 frps groups for various breakdown categories, as indicated by the marked circles in the Breakdown Analysis - Comparison of Studies (figure 5.5). The implication is that many characteristics displayed by the video conferencing sessions, conducted by Kies, bear remarkable resemblance in this study. It is known that the nature and level of the technology are very similar. For example, the very similar proportion of communication breakdowns displayed in the Audio category can be traced to the similar equipment used in the separate studies. Each study used full-duplex speakers which suffer certain quality problems. In both cases, the parties shared a single line at the same time and the audio from one speaker could be channelled back through the microphone, resulting in echo. Further, the audio signal required encoding and decoding, resulting in a brief period of lag. In both cases, care was taken to minimise these effects.

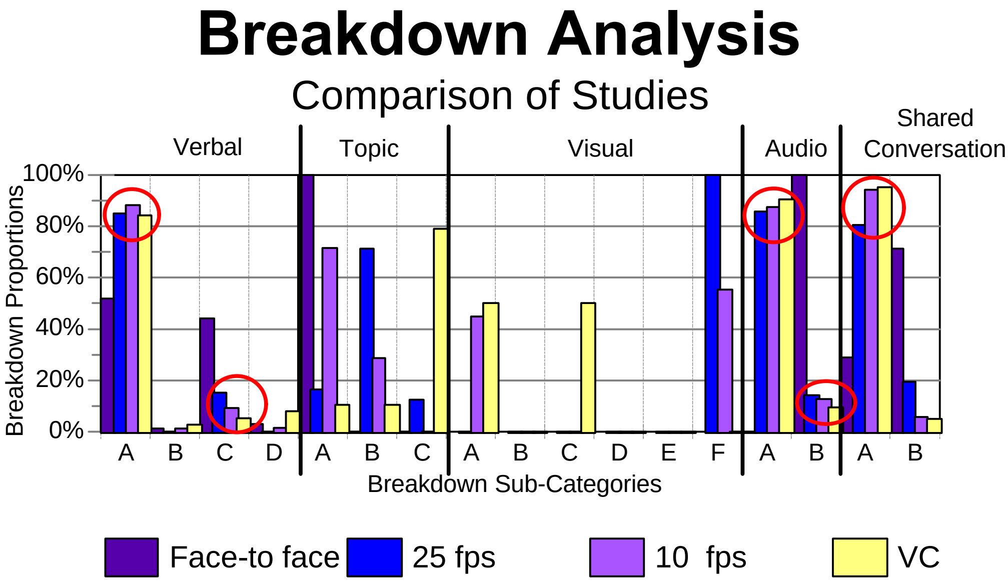


Figure 5.5 Breakdown Analysis: Comparison of Studies.

5.4.2.2 Breakdown Analysis Results

Each of the six communication breakdown categories is discussed with particular reference to prior findings from Kies (1997) and Doerry (1995).

Verbal Turntaking (An incident in which two or more participants are talking at the same time. This does not include specific interruptions.): Also referred to as simultaneous speech. The results of this study fell in line with the video conference results found in Kies' study. The majority of incidents fell into the category where one person stopped speaking while another continued. Video analysis showed that participants were very aware of the communication restrictions placed by the technology and would wait longer than usual (as in face-to-face communication) for remote members to finish speaking before attempting to converse. This sensitivity was also reflected in the low count of simultaneous speech lasting longer than 3 seconds. It seemed that participants were conscious of the medium and could not employ normal visual communication cues which directed communication flow in face-to-face situations. This situation is further expounded upon by Kies, in comparing video and face-to-face communication. He notes that the frequency of occurrences simultaneous speech in face-to-face is significantly more. He suggests that the audio system may be cause for stilted video mediated communication. Short utterances are easier to make in face-to-face settings where casual comments are not perceived as attempts to control the floor control. Video supported communication tends to lead to more economised communication, and is hence less rich. This finding is not fully supported by the work of Doerry (1995), but Kies proposes that the difference in the quality of audio systems plays a significant role between the studies not supporting this notion. This study, as in Kies', utilised poorer quality audio technology.

Reference (An incident in which the sharing of an object (papers, pencils, notes, mouse, etc.) becomes problematic.): Kies (1997) found very few reference breakdowns, as in this study. He suggests that the low reference breakdown count is due to the conversational nature of his study. He further suggests that a higher count should result where a task is dependent on a shared collaborative application, as evidenced in Doerry's study. Even though the tasks were largely collaborative in nature, this study reports a lower than expected count. This can perhaps be attributed to the training exercises the participants conducted in order to understand shared mouse and application control. Further reference breakdowns occurred due to screen resolution and colour depth differences between the parties. Consequently, items shared were not always properly displayed, necessitating user action which caused conflicts.

Topic (An incident in which there is a failure to maintain topical orientation by one or more of the participants.): The primary cause (78%) for topic breakdowns can be attributed to computer software failure. This was particularly frustrating, often requiring a system reboot and disrupting the task at hand. One of the differences between studies includes the operating system. This study used Windows 95 which is unstable and not as robust as a Unix variant operating system.

Visual (An incident in which visual communication suffers.): As in Kies' study surprising few breakdowns of this nature occurred, despite comments from the users participants regarding static camera angles, and restricted views. Although it should be noted that participants from either side constantly saw the images being sent to the other participants. This enabled them to make sure that they stayed in the camera's view at all times.

Audio (An incident in which a breakdown results due to loudness, feedback, or static difficulties, including requests for repeating due to these difficulties.): As stated earlier, the results of this study correlated very closely to that of Kies' due to the similar audio technology employed. As Kies observes, it is interesting to note that most of the audio breakdowns were repaired, demonstrating that communication and the work process was not severely impacted as a result of the breakdown; it was simply less efficient.

Shared Conversation (An incident in which a statement or question is directed at an adjacent (or co-located) participant with no attempt to include the rest of the group.): Once again there is agreement with Kies' study. The significant difference between face-to-face and video mediated conferencing is that the separated groups tend to have more side conversations. A reason for this is that participants feel much more detached from the other video conference party, hence they feel it is easier to disengage and chat to the people on their own side. Social presence theory may supply a reason for this. In video conferencing environments little presence may be felt from other remote parties, hence it is easier to ignore the remote group and conduct side conversations. This feeling was expressed by at least one participant in explain his behaviour.

Breakdown analysis has provided a mechanism to measure communication between groups and draw comparisons across studies using this method. As in previous studies (Kies, 1997; Sellen, 1992) this study has found a high degree of audio breakdowns and one-sided shared conversation in video supported communication. Similarly there have been low occurrences of reference, topic and visual breakdowns.

5.5 Conclusion

The analysis of the results has indicated that when the framework is applied, the measures of task outcome, user satisfaction, scalability and participation indicate that the tasks conducted in the experiment have been successfully supported. Further data analysis has revealed many weaknesses and few strengths in the collaborative technology's ability to support collaborative work requirements. But despite this, the participants have managed to complete their work. The semi-structured interview highlighted the vast soft issues pertaining to the use of such technology. These issues are important and warrant further consideration in future research. Finally, the interaction analysis has determined that the resource configuration used in this study is similar to that found in Kies' (1997) study. Therefore one can expect that, to a large degree, Kies' findings can also apply to this study.

The following chapter offers an exploration of the framework under different requirements and parameters.

CHAPTER 6
THE FRAMEWORK EXPLORED

6.1 Introduction

This chapter concludes the investigation of a framework to evaluate CSCW. Previous chapters have described the construction, testing and analysis of the framework. But in order to test the quality of the framework, it is necessary to test it under external user defined conditions, the same conditions in which it is expected to function.

6.2 The User Defined Framework Explored

To complete the user defined testing, various South African IT specialists were asked to give their weightings, a ‘pass mark’ for success and a justification for those values. The specialists all have some experience in system development, ranging from development to group management. They are also all familiar with the JAD process.

In order to conduct the test, the original user responses from the experiment, for each measure, grouped by task type, are multiplied with their respective user defined weightings. This is then compared against the user defined boundary of 'success' (or pass mark) to see if the technology configuration will support the task type.

Table 6.1 displays the measure weightings and 'success' boundary values submitted by the respondents. These values are summarised in table 6.2, which also includes the corresponding values used in the experiment. The aggregated measure responses, measured in the experiment, are summarised for each task type in table 6.3. Table 6.4 displays the 'success' or 'failure' results, calculated by applying the weighting from table 6.2 to the measure responses from table 6.3 (Figure 6.1 displays the results graphically).

Measure	Weighting Value	Comment
Respondent #1	Analyst / Programmer involved in JAD sessions with range of users. Delivering IT systems within a large corporate organisation.	
Task Outcome	30%	Successful system development is still a major concern: overshooting budgets, deadlines, etc. Any technology introduced should not in any way further hinder the outcome.
User Satisfaction	15%	Important, but not paramount to delivery.
Scalability	20%	Relevant to overall usefulness of technology in many situations.
Participation	35%	A principal factor required in order to extract premium knowledge from those in the know!
'Success' Boundary	66%	Due to the nature of users/participants the advantage gained using technology to facilitate development / JAD would have to greatly outweigh training costs and general techno-phobia.

Respondent #2	Analyst/Programmer for an internal IT system. Involved in JAD sessions with executive management and data capturers to get requirements for new releases of systems.	
Task Outcome	30%	To me this sums up the most important part of the whole exercise, i.e. what is actually extracted from the JAD. It includes participation.
User Satisfaction	10%	Though this should be of importance, in reality, in the end, I have found this to be less of an issue.
Scalability	20%	Pretty useful to make use of a technology that can be used in all situations - not just suited to a specific group size.
Participation	40%	Without participation of the users, the whole process is pretty useless - how else can the necessary info be found out!
‘Success’ Boundary	60%	Technology must not be a hindrance - rather ease the process, no great learning curve to understand the process.
Respondent #3	Analyst / Programmer / Designer who has been involved in a number of JAD sessions with users in both prototyping-type sessions as well as standard requirement-finding sessions.	
Task Outcome	50%	At the end of the day, this is what matters.
User Satisfaction	12.5%	Can affect the correctness of the deliverables as well as the ease with which they were reached.
Scalability	12.5%	Depends on what the task is; will be more important for certain tasks and less so for others (some tasks become unmanageable if you have too many participants wanting to have their say)
Participation	25%	You want everyone to at least have had their say in the outcome/deliverable to ensure consensus and buy-in.
‘Success’ Boundary	75%	

Respondent #4	Full Life Cycle Consultant assisting in the delivery of large enterprise wide solutions to large organizations in various industries.	
Task Outcome	40%	Results are crucial: within time and budget. Delivery has paramount importance in this industry and technology should be enabling greater task outcome and not hindering it.
User Satisfaction	15%	Important, but at the same time even if the collaborative technology is not offering optimum satisfaction, it is still providing a means to acquire information, understanding etc. which will create a more satisfied user for the system/environment/end product sought. Is this not what we are after at the end of the day?
Scalability	15%	This is situational in nature. Bigger is not always better! However, the ability to adhere to larger groups may be important from time to time and hence the rating is lower but not ignored. It should also be remembered that in a JAD session/environment the smaller knowledgeable group is generally more successful and size can hinder performance.
Participation	30%	An important factor, this measure integrates with task outcome. There will be little success where user participation is absent (both now and later). Ideally one would hope that all individuals would be able to collaborate effectively and be able to address all problems/solutions and thus ensure task outcome. This is however also subjective due to the nature of the individual and those chosen for the JAD / group work.
'Success' Boundary	75%	Get the balance - right people, technology, and remember not all situations adopt well to JAD. Group work is a must and when performed properly creates synergy and hence delivery. If this cannot be assured, think again!
Respondent #5	Educator in the field of Information Systems, especially JAD. Group project manager.	
Task Outcome	26%	Important because it will affect user satisfaction and feedback to participants who will become involved again.
User Satisfaction	26%	Also important.
Scalability	16%	Of reasonable importance, but the other factors must be in place first.
Participation	32%	This is the most important factor which will have a major impact on all other the other aspects.
'Success' Boundary	70%	

Table 6.1 IT Industry Respondents' Measure Weightings and Comments.

Parameters	Weightings					
	Experiment	Respondent #1	Respondent #2	Respondent #3	Respondent #4	Respondent #5
Task Outcome	0.250	0.300	0.300	0.500	0.400	0.260
User Satisfaction	0.250	0.150	0.100	0.125	0.150	0.260
Scalability	0.250	0.200	0.200	0.125	0.150	0.160
Participation	0.250	0.350	0.400	0.250	0.300	0.320
'Success'/'Failure' Boundary	3.50	3.96	3.60	4.50	4.50	4.20

Table 6.2 Summarised Respondents' Measure Weightings (including Experiment).

Task Type	Task Outcome	User Satisfaction	Scalability	Participation
1	4.25	4.63	4.50	4.22
3	4.48	4.45	4.50	4.33
4	4.97	5.13	4.00	4.71
6	4.86	5.36	5.38	4.47
9	5.19	5.00	4.33	4.17

Table 6.3 Summarised Aggregated Measure Responses (from Experiment).

Task Type	Experiment (Pass = 3.50)	Respondent #1 (Pass=3.96)	Respondent #2 (Pass = 3.60)	Respondent #3 (Pass = 4.50)	Respondent #4 (Pass = 4.50)	Respondent #5 (Pass = 4.20)
1	4.40	4.35	4.33	(4.32)	(4.34)	4.38
3	4.44	4.43	4.42	(4.44)	(4.43)	4.43
4	4.70	4.71	4.69	4.80	4.77	4.77
6	5.02	4.90	4.86	4.89	4.89	4.95
9	4.67	4.63	4.59	4.81	4.73	4.68

Table 6.4 Respondents' 'success' or 'failure' Calculation Results (including Experiment).

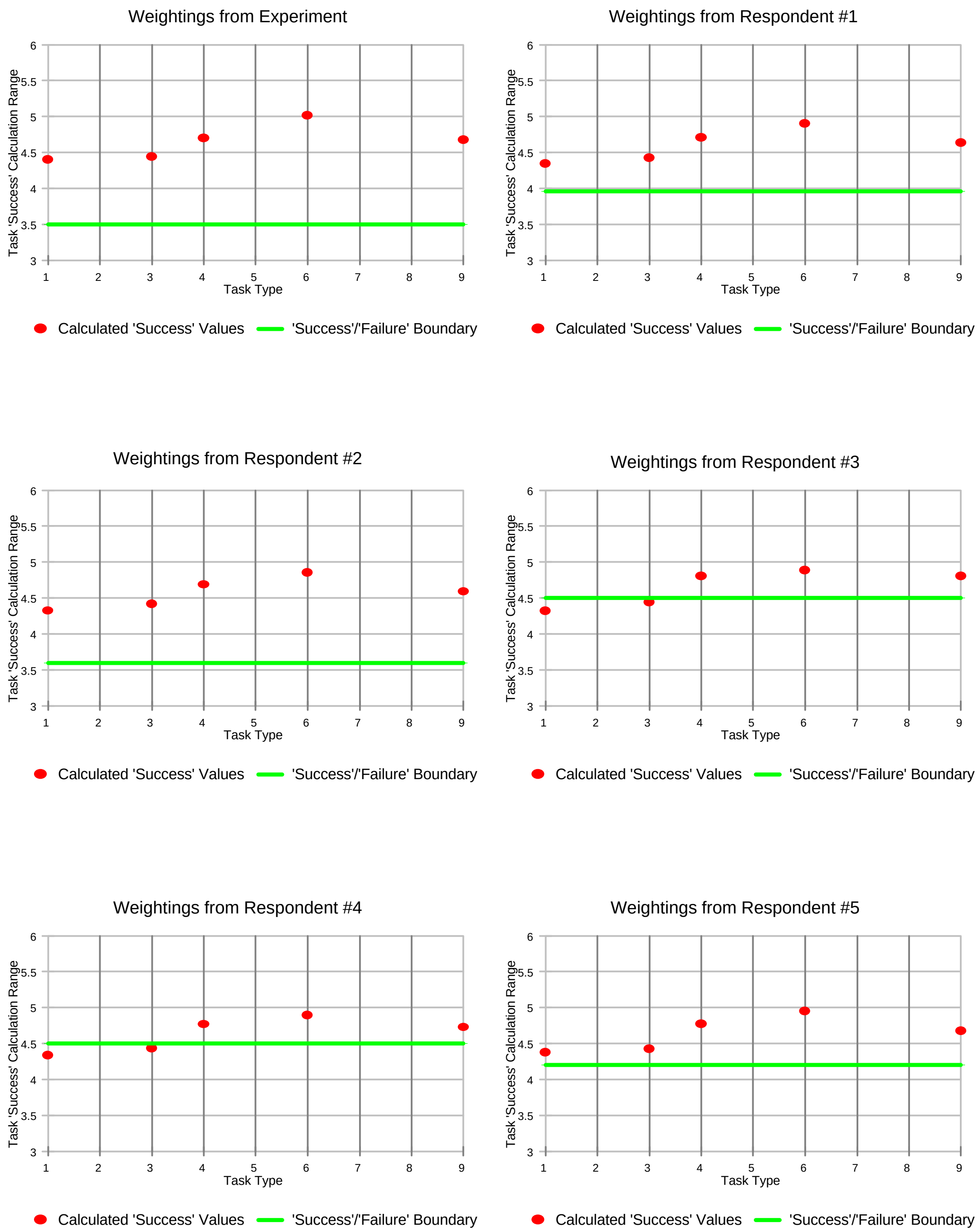


Figure 6.1 Respondents' 'success' or 'failure' Calculation Results (including Experiment).

6.2.1 Observations

Several observations can be made from the brief exploration of the framework under user defined parameters.

Firstly, the parameter driven framework proved sufficient for the industry respondents. None of the respondents indicated a deficiency in the selection of measures nor suggested additions to the evaluation.

The weightings suggested by the independent respondents reflect a consensus about the importance of the task outcome and participation weightings. It therefore appears that for activities that elicit information from a group, successful participation by group members is linked to successful task outcome. It is generally accepted that this is true of system development, where the final task outcome (or product), indicated by user acceptance, is dependent on maximum participation by the users themselves. The low user satisfaction and scalability weightings perhaps reflect their minimal importance in corporate environments, where time and budget constraints are the concerns of the day.

The framework's parameter driven nature is best illustrated by respondents 3 and 4. Their high 'success' requirements have shown that the resource configuration is insufficient to support task types 1 and 3. In these cases, a higher resource configuration needs to be adopted. These results indicate that for its intended environment the framework mechanism has performed as designed and according to expectations.

Lastly, gathering information from across a broad range of tested environments allows the framework to essentially become a repository or knowledge base containing degrees of successful work and supporting resource configurations. This information would be more useful than an archive of case studies and more accessible than expert knowledge.

6.3 Conclusion

This chapter has explored the proposed framework in its intended environment. IT respondents have defined their weightings and framework results have reflected those weightings in either success or failure values. This process demonstrates the successful application of the framework under its designed conditions. Finally, the notion that the framework can function as a knowledge base has been expressed.

CHAPTER 7
CONCLUSION

7.1 Introduction

This study has highlighted the emerging trend of collaboration work, facilitated by ubiquitous computers and networking. The knowledge and processes required to take advantage of this trend are not well established. A step taken towards solving this problem is the investigation of a framework to evaluate computer supported collaborative work.

7.2 Contribution of Thesis

In order to understand the issues involved in the investigation, the study has explored the nature of collaboration and aspects of collaborative technology, focussing on desktop video conferencing. The investigation also included aspects of communication and how technology impacts the process. Essential to the investigation has been the exploration of methods and techniques of evaluation. To achieve a satisfactory evaluation, a selection of methods was chosen, as this was shown to be the best practice. The proposed evaluation framework itself is based on a scenario based methodology for the evaluation of collaborative systems. To test the framework, the study, once again, employed scenario based evaluation to establish an evaluation environment. Further evaluation techniques employed to analyse the experiment are ethnographic based. These techniques are questionnaires, contextual inquiry and interaction analysis.

The framework application has been indicated by the 'task centric' and 'system centric' approaches. The essence is the playoff between resources and work. The framework aims to indicate minimum resources required to support work. The framework's flexibility is demonstrated by its parameter driven nature where measures and metrics are selected according to the evaluator's or implementor's needs. Formulae for the determination of successful supporting technology are provided.

The experiment conducted demonstrated the viability of the framework. The measures and supporting metrics revealed how important each requirement of group collaboration is. These requirements deserve due consideration for any implementor or evaluator of collaborative technology. Despite the initially extensive scope of the experiment scenario, refinement and adaptation allowed for a successful conclusion of the process and a validation of the framework application.

Analysis of the experiment data, and follow-up interviews, revealed many underlying problems relating to the experiment and to using video mediated communication (problems identified in previous literature). Essentially the findings are divided into two areas. The first is the framework's measures. The calculations indicated that the resource environment successfully supported their collaborative work needs, but only their basic needs. Consequently the work was always completed, but often at the expense of softer issues, particularly participation. As the participants became more experienced, they became more aware of the many important softer issues which required system support, in particular: support for building trust amongst participants, awareness, role support, creativity and communication flow, particularly feedback. The findings also indicate that, at a low level of technology, the sense of presence is lacking and not well supported. Equally, the same technology fails to deliver a rich medium for communication. The second area revealed omissions in the experiment scope. Certain issues, thought to be important in system design and group work, were untested. These issues include: user commitment, resistance to change, participants from diverse fields, personal space and power structures.

For comparative purposes, and to compare the differences between face-to-face communication and video mediated communication, direct conversation measures (breakdown analysis) were employed. Results indicate a close correlation between the study undertaken by Kies (1997) and this study.

Finally, the framework was explored from user defined parameters. Results demonstrate the successful application of the framework under its designed conditions, proving sufficient for the industry respondents. None of the respondents indicated a deficiency in the selection of measures nor suggested additions to the evaluation. Observations reveal that framework testing in actual work environment would provide additional validation. Lastly, it is suggested that the framework may function as a knowledge base containing information pertaining to collaborative work supported by collaborative systems.

7.3 Future Work

It is suggested that future work should include framework evaluation in real business conditions to reflect factors not encountered in a scenario environment. This will also reflect the validity of the user response data across real and scenario environments and across implemented systems.

Additional interesting work also lies in analysing measure selection (including the additional measures of consensus, efficiency, security and interoperability) and weighting trends particular to different types of collaborative work (such as training and support). It is theorised that various types of work focus on selected measures and display similar weighting trends, as noted in Chapter 6, where JAD type activities focus on task outcome and participation, with similar weightings. These requirements are dependent on the function and support needs of the group. By doing so the process of task and resource matching is refined.

Lastly, future collaborative system evaluation research must take a step further and address the soft issues not fully explored in this study, including: creativity, trust, user commitment, and power structures. For without consideration of these factors, collaborative technology will fail to fully support collaborative group work and processes. Results from this deeper evaluation could suggest further measures to the framework, and possible changes to weighting trends.

REFERENCES

Author Unknown (1995) Communication, Collaboration, Coordination: The "Three Cs" of Workgroup Computing. YankeeWatch, 3(3). The YankeeGroup. Available at: http://www.collabra.com/articles/yankee.htm

Berdie, D. R. and Anderson, J. F. (1974) *Questionnaires: Design and Use*. Metuchen, N.J: The Scarecrow Press, Inc.

Bunge, M. (1974) *Semantics I: Sense and Reference, Vol. 1 of Treatise on Basic Philosophy.* Dordrecht: Reidel.

Buxton, W. A. S. (1992) *Telepresence: Integrating shared task and person spaces.* In Proceedings of Graphic Interface '92 (pp.123-129) San Francisco, CA: Morgan Kaufman Publishers.

Coleman, D. (1997) *Groupware: Collaborative Strategies for Corporate LANs and Intranets.* Prentice Hall. Available at: http://www.collaborate.com/chapt1.html

Coleman, D. (1996) *Intranet Study: Collaboration tools moving from LAN to Intranet over the next two years and then onto the Internet.* Available at: http://www.collaborate.com/mlpress.html

Collaborative Strategies™ (1997) *Electronic Collaboration on the Internet and Intranets.* (White Paper). Available at: http://www.collaborate.com/intranet.html

Cugini, J., Damianos, L., Hirschman, L., Kozierok, L., Kurtz, J., Laskowski, S. and Scholtz, J. (1997) *Methodology for Evaluation of Collaboration Systems*. The Evaluation Working Group of the DARPA Intelligent Collaboration and Visualization Program. Available at: http://www.antd.nist.gov/~icv-ewg/documents/meth_index.html

Daft, R. L. and Lengel, R. H. (1986) *Organizational information requirements, media richness and structural design.* Management Science, 32(5), 554-571.

DeSanctis, G. and Gallupe, B. (1987) *A foundation for the study of group decision support systems.* Management Science, 33(5), 589-609.

Diamantopoulos. A. and Schlegelmilch. B. B. (1997) *Taking the fear out of data analysis.* London: The Dryden Press.

Doerry, E. (1995) *An empirical comparison of copresent and technologically-mediated interaction based on communicative breakdown.* Unpublished Doctoral Dissertation. Eugene, OR: University of Oregon.

Fafchamps, D. (1991) *Ethnographic workflow analysis: Specifications for design.* In Bullinger, H-J. (Ed.) Human aspects in computing: Design and use of interactive systems and work with terminals. pp.709-715. Elsevier Science Ltd.

Field, A. (1996) *Group Think.* Inc. Technology, No3, 1996, pp38. Available at: http://www.inc.com/incmagazine/archives/17960381.html

Fielding, M. (1993) *Effective Communication in Organizations: Preparing messages that communicate*. Juta & Co, Ltd.

Fowler, F. J. (1984) *Survey Research Methods.* London: Sage Publications, Ltd.

Fulk, J., Steinfeld, C. W., Schmitz, J. and Powers, J. G. (1987) *A social information processing model of media use in organisations.* Communications Research, 14(5), 529-552.

Garfinkle, H. (1967) *Studies in ethnomethodology.* Englewood Cliffs, NJ: Prentice-Hall, Inc.

Gaver, W., Sellen, A., Heath, C. and Luff, P. (1993) *One is not Enough: Multiple Views in a Media Space.* In INTERCHI '93 (pp. 335-341). New York, NY: Association for Computing Machinery.

Goldstein, J. (1995) *Video Conferencing and money, money, money*. Boca Press, Inc.

Grudin, J. (1994a) *Groupware and Social Dynamics: Eight Challenges for Developers.* Communications of the ACM, 37, 1, pp92-105, 1994. Available at: http://www.ics.uci.edu/~grudin/Papers/CACM94/cacm94.html

Grudin, J. (1994b) *CSCW: Its History and Participation.* Available at: http://www.ics.uci.edu/~grudin/Papers/IEEE94/IEEEComplastsub.html

Grudin, J. (1990) *Groupware and cooperative work: Problems and prospects.* In Laurel, B. (Ed.) The art of human-computer interaction. Reading, MA: Addison-Wesley.

Hammersley, M. and Atkinson, P. (1995) *Ethnography: Principles in practice.* New York, NY: Routledge.

Handley, M., Kirstein, P. T. and Sasse, M. (1992) *Multimedia Integrated Conferencing for European Researchers (MICE): Piloting Activities and the Conference Management and Multiplexing Centre*. London: Department of Computer Science, University College.

Hewitt, K. (1996) *Desktop Video Conferencing Products.* Available at: http://www3.ncsu.edu/dox/video/products.html

Hughes, J. A., King, V., Rodden, T., and Andersen, H. (1994) *Moving out from the control room: Ethnography in system design.* In CSCW '94: Computer Supported Cooperative Work. (pp. 429-439) New York, NY:Association for Computing Machinery.

Intel (1994) *A Traffic Model for LAN Video Conferencing*. Intel Document #8150. Santa Clara, CA: Intel Corporation.

Intel (1995) *Video Conferencing on ISDN and LANs*. Available at: http://www.jf.intel.com:80/comm-net/proshare/prod/pc97.htm

Jordan, B. and Henderson, A. (1995) *Interaction analysis: foundations and practice.* The Journal of the Learning Sciences, 4(1), 39-103.

Kies, J. K. (1997) *Empirical Methods for Evaluating Video-Mediated Collaborative Work.* Ph.D. Blacksburg, VA: Virginia Polytechnic Institute and State University.

Kies, J. K., Williges, R. C., and Rosson, M. B. (1996) *Evaluating desktop video conferencing for distance learning applications.* Computers and Education. Blacksburg, VA: Virginia Polytechnic Institute and State University.

Kies, J. K., Kelso, J. and Williges, R. C. (1995) *The Use of Scenarios to Evaluate the Effects of Group Configuration and Task on Video-Teleconferencing Communication Effectiveness.* Third Annual Mid-Atlantic Human Factors Conference, Blacksburg, VA.

Luff, P., Heath, C. and Greatbatch, D. (1992) *Tasks-in-interaction: paper and screen based documentation in collaborative activity.* In Proceedings of CSCW '92, pp.163-170.

Martinsen, H. and Joly, G. C. (1994) *Evaluation Report. MICE - Esprit Project 7602.* Available at: http://www-mice.cs.ucl.ac.uk/multimedia/projects/mice/eval0.html

McGrath, J. E. (1984) *Groups: Interaction and Performance.* Englewood, NJ: Prentice-Hall.

McGrath, J. E. (1995) *Methodology matters: Doing research in the behavioral and social sciences.* In Baecker, R.M., Grudin, J., Buxton, W. A. S., and Greenberg, S. (Eds.) Readings in human-computer interaction: Toward the year 2000. San Francisco, CA: Morgan Kaufman.

Mühlbach, L., Böcker, M, and Prussog, A. (1995) *Telepresence in videocommunications: a study on stereoscopy and individual eye contact*. Human Factors, 37 (2), 290-305.

Neale, D. C. and McGee, M. K. (1998) *Making Media Spaces Useful: Video Support and Telepresence.* Technical Report HCIL-98-01. Blacksburg, VA: Virginia Polytechnic Institute and State University. Available at: http://hci.ise.vt.edu/~hcil/htr/HCIL-98-01/HCIL-98-01.html

Oppenheim, A. N. (1966) *Questionnaire Design and Attitude Measurement.* London: Heinemann Educational Books, Ltd.

Pervan, G. P. (1995) *Group Support Systems at Curtin University of Technology: Combing Consulting and Research.* Available at: http://www.is.curtin.edu.au/research/pervan/prism95a.htm

Pfeifer (1995) *The Domain and Goals of CSCW.* Available at: http://ksi.cpsc.ucalgary.ca/courses/547-95/pfeifer/cscw_domain.html

Ramage, M. (1995) *Evaluation of Co-operative Systems: First Year Report.* Available at: http://www.comp.lancs.ac.uk/computing/research/cseg/projects/evaluation/1yr_contents.html

Ramage, M. (1996a) *Systemic Evaluation for Stakeholder Learning (SESL).* Available at: http://www.comp.lancs.ac.uk/computing/research/cseg/projects/evaluation/SESL-desc.html

Ramage, M. (1996b) *CSCW Evaluation in Five Types.* Report CSEG/17/96, Computing Department, Lancaster University, UK. Available at: http://www.lancs.ac.uk/computing/research/cseg/projects/evaluation/Five_Types.html

Ramage, M. (1997) *Developing a methodology for the evaluation of cooperative systems.* Draft paper submitted to IRIS (Information Systems Research in Scandinavia) 20, August 1997. Available at: http://www.lancs.ac.uk/computing/research/cseg/projects/evaluation/developing.html

Rosen, E. (1996) *Personal Videoconferencing.* Available at: http://www.manning.com/Rosen/index.html

Ross, S., Ramage, M., Rogers, Y. (1995) *PETRA: Participatory Evaluation Through Redesign and Analysis.* CSRP No. 375, March 1995.

Sellen, A. J. (1992) *Speech Patterns in Video-Mediated Conversations.* In CHI '92: Human Factors in Computing Systems (pp. 49-59). The Association for Computing Machinery.

Shapiro, D. (1994) *The limits of ethnography: Combining social sciences for CSCW.* In CSCW '94: Computer Supported Cooperative Work. (pp. 417-428) New York, NY: Association for Computing Machinery.

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

Suchman, L. (1983) *Office procedure as practical action: Models of work and system design.* ACM Transactions on Office Information Systems, 1(4), 320-328.

Suchman, L. and Trigg, R. H. (1991) *Understanding practice: Video as a medium for reflection and design.* In J. Greenbaum & M.. Kyng (Eds.), Design at work, pp. 65-90. Hillsdale, NJ: Lawrence Erlbaum Associates.

Urquijo, S. P., Scrivener, S. and Palmen, H. (1993) *The use of breakdown analysis in synchronous CSCW system design.* In Proceedings of ECSCW '93, pp.281-294.

Watabe, K., Hamalainen, M., Whinston, A. B. (1995) *An Internet Based Collaborative Distance Learning System: CODILESS.* In Computers in Education. Vol 24, No. 3, pp 141-155, Elsevier Science Ltd.

Winograd, T. and Flores, F. (1987) *Understanding computers and cognition: A new foundation for design.* Reading, MAL Addison-Wesley.

Wood, J. and Silver, D. (1995) *Joint Application Development.* 2nd Ed. John Wiley and Sons.

Woofitt, R. (1991) *On the Analysis of Interaction: an Introduction to Conversational Analysis.* In Paul Luff, Nigel Gilbert and Dave Frohlich (Eds), Computers and Conversation. London: Academic Press.

Zuboff, S. (1988) *In the age of the smart machine: The future of work and power.* New York, NY: Basic Books.

3.3.1.1 Work Task Types

The task descriptions are based mainly upon tasks from group research (McGrath, 1984). We have added an additional task type that is necessary to form a comprehensive collection of current work practices. We have noted in the description of task type nine that it is not from McGrath's original set.

The tasks described by McGrath should be thought of as a continuum, not discrete tasks. Along this continuum there are four higher level types: generate tasks, choose tasks, negotiate tasks, and execute tasks. Within these four task types, generic tasks are numbered [1-8, original McGrath] with successive tasks related to each other. The task descriptions and examples should enable users of the framework to select generic tasks that are comparable to the type of work they do.

In our detailed description, each task type has suggested measures of task outcome. In addition, for many task types, research has uncovered problems that may occur with groups performing this type of task. In some instances, computer-mediated processes or other group processes may be able to alleviate these problems. We have listed known problems so that comparison measures can be made to see if there is any effect. Where there is research about computer-mediated work or group interactions and the effect on the task outcome, we have included it under the heading "known research." An example of each task is also provided to help in understanding how the generic task maps to a real world task. Under "suggested capabilities" are listed those capabilities which the research suggests may be valuable in carrying out that particular generic task.

Type 1: Planning tasks (McGrath)

Group members are given a goal (previously chosen objective) and asked to develop a written plan for carrying out the steps needed to reach that goal. The written plan should include alternative paths or actions.

Specific measures for this type of task:

- Amount of time per participant
- Amount of calendar time
- Practicality of plan (quality of task outcome)

Known research:

- Social relations hinder task efforts
- There can be a strong effect on the group due to social influence and conformity.
- Groups often have trouble seeing alternatives - tend to focus on only a few alternatives.
- Participation can be very unequal. This increases as group size grows.
- Groups tend to avoid conflict and spend more time on non-controversial issues. Controversial issues tend to become personalized.

Example: The group has to produce an advertising campaign for a new account by the end of the month. They have a meeting to plan the different tasks that each member will carry out, complete with time lines for doing so and different coordination points.

Suggested capabilities:

- Calendar support
- Text object creation, editing, displaying, arranging, storing

Type 2: Brainstorming and group creativity

Members of a group are given a particular topic area and asked to brainstorm on ideas.

Specific measures for this type of task:

- Number of ideas
- Originality of ideas

Known research:

- Creativity of individuals is stifled by social influence of group
- Individuals are able to take advantage of creativity-enhancing forces in group - social support, cross stimulation

Example: The group has a goal to raise $200,000 to build a new community center. They generate ideas for funding raising events, people to ask for contributions and possibilities for loans or selling "shares" to the community members to raise this money.

Suggested capabilities:

- Anonymous communication
- Synchronous communication
- N way communication
- Shared workspace

Type 3: Intellective tasks

The group is asked to solve a problem for which there is a recognized solution. The group is asked to determine a concept, given instances of the concept. Alternatively, groups can be asked to generate an instance of a concept and are given feedback as to whether it is or is not the concept.

Specific measures for this type of task:

- Number of trials to solution
- Solution (quality of task outcome)
- Errors
- Inferred strategies

Known research:

- Written media is slower to arrive at a solution than voice media. But voice media uses more messages than written.
- Audio only does not differ significantly from face to face (and hence, probably video)
- Interacting groups are almost always more accurate than their average member
- Groups seldom do as well as their best members

Example: A logical reasoning problem such as the cannibal and missionary problem is an example of an intellective task with a demonstrable right answer.

The missionary and cannibal problem: Three cannibals and three missionaries are on a river bank. They need to cross to the other side. There is a row boat that can hold only two people. Only missionaries know how to row. At no time can there be more cannibals than missionaries on either side of the river. What is the minimum number of trips that can be made to transport all six to the other side of the river?

Suggested capabilities:

- Shared workspace
- Gesturing, pointing, agreeing, disagreeing
- N way communication
- Private group communications

Variant: The twenty-question task

A target object is selected. A group or individual is asked to determine that object by asking a series of questions that can be answered by "yes" or "no". The goal is to determine the target object with as few "no's" as possible with a maximum of 20 allowed.

Specific measures for this type of task:

- number of problems correctly answered
- number of questions needed to answer each problem
- time to solution
- time-per-person to solution.

Type 4: Decision making task

Group members are asked to develop consensus on issues that do not have correct answers.

Specific measures for this type of task:

How far and in what direction (if any), the group as a group and the individuals in the group shift. [Attitudes are measured before and after group discussion]

Example: The group is asked to decide which of three possible job candidates should be hired. All candidates are computer science graduates with specialties in computer engineering. However, their work experiences are quite different. The group must decide which candidate would be the best match for the job.

Suggested capabilities:

- Shared workspace
- N way communication
- Side chats

Type 5: Cognitive conflict tasks

Members of the group hold different viewpoints. The group is asked to make a series of decisions from available information that is imperfectly correlated with criterion. The group has to arrive at a decision.

Specific measures for this type of task:

- Agreement among members
- Interpersonal trust
- Changes in member's views

Known research:

- Verbal interactions can lead to clarification of why group members are consistently using different policies. But if policies are used inconsistently, this leads to a distrust of and a reduction in understanding of the other.
- Group members may change policy to increase accuracy.

Example:

The group is hiring a designer for its User Interface Group. Three candidates are at the top of the list. One candidate is a computer scientist major with some interface design experience, another is a psychology and human factors major, and the third is a graphics art and industrial design major. The group is divided about the type of experience best suited to this position. The group is interdisciplinary and each discipline tends to favour hiring the candidate most closely aligned with their discipline.

Suggested capabilities:

- Shared workspace
- N way communication

Type 6: Mixed motive tasks

Mixed motive tasks present a range of tasks, differentiated by the degree to which a group member's outcome is affected by a combination of his own actions and the group's outcome. McGrath also includes dilemma tasks in this category. Dilemma tasks involves a conflict of interest where the choices made by individuals or groups are combined to jointly determine the outcome. However, the collaboration between the individuals or groups is not directly related to determining the choices of each. Therefore, we have not included dilemma tasks in our framework.

Type 6A: Negotiation task: The group is divided into x subgroups with a negotiator elected for subgroup. The different subgroups disagree on an issue but an outcome has to be reached. Tradeoffs have to be made in multiple dimensions. It is not necessarily a zero-sum problem.

Specific measures for this type of task:

- Quality of solution as evaluated by each subgroup
- Time to solution

- Attainment of solution (task completion)
- Evaluations of negotiators by group
- Interpersonal relations between group members

Example:

Company A and Company B are negotiating the sale of supplies from A to B. Company A wants to sell more of the supplies at a lower price to company B, but this means that company B, while saving money on the sale, will have to arrange financing with company A.

Suggested capabilities:

- N way communication
- Group private communication
- Shared workspace
- Private workspace

Type 6B: Bargaining task: (suitable for two individuals)

A conflict of interest must be resolved among two individuals, but in this case whatever one individual gains results in a loss for the other individual. A tradeoff is made on a single dimension, such that what one party gains, the other party loses.

Specific measures for this type of task:

- Frequency of no-solution trials
- Absolute and relative gains of the two individuals over series of trials
- Responses to different strategies
- Opponents ratings of each other's bargaining strategies

Known research:

Negotiators are more competitive when any of these conditions hold:

- They think constituents distrust them
- They were elected
- They are being observed
- They have a prior commitment
- Their constituents belong to a highly cohesive group

Negotiators who do not belong to the group feel freer in the negotiation process but are less supported by the group.

Example:

There has been a price set by Company A for a machine that company B wishes to purchase. Company B does not feel that the price is low enough. Company A is trying to maximize profit as the company is having cash flow problems, but losing the sale will be a problem also.

Suggested capabilities:

- N way communication
- Group private communication

- Shared workspace
- Private workspace
- Text object manipulation

Type 6C:Winning coalition tasks

Subsets of members make agreements. The subset that wins then allocates the resources among the group members. The two research questions are the formation of the coalition, and the allocation of the resources.

Specific measures for this type of task:

- Which coalitions form
- The division of outcomes
- Any shift over time

Example:

A variant of pachisi is played in which a player's piece is given a weight. Moves are based on product of the weight of the piece and the roll of a pair of dice. Players can play alone or can combine with one other player by adding their moves together. They must then agree on how to divide the payoff assuming they win.

Suggested capabilities:

- N way communication
- Side chats
- Shared workspace
- Private workspace
- Gesturing, pointing, agreeing, disagreeing
- Support for computational object
- 2D object manipulation

Type 7: Competitive performances

Groups are competing against each other with no resolution of conflict expected. Rather the goal of each group is to win over the other group. Subgroups are paired against each other an equal number of times, under an equal pattern of situations.

In the original McGrath work, these performances are physical. In this framework, these types of tasks may be physical or nonphysical performances.

Specific measures for this type of task:

- Team performance (quality of task outcome)
- Individual performance (quality of task outcome)
- The overall winner

Known research:

- Inter-group competition increases within-group cohesion.

- Success in a competitive task also increases within-group cohesion.
- Groups do not always distinguish between good group performance and winning.

Example:

A focal group competes with an opposing team that has a series of preplanned, semi-standardized patterns. The responses to the focal group's moves are based on pre-planned strategies. A reconnaissance patrol or defence of a position is an example of such an activity.

Suggested capabilities:

- N way communication
- Side chats
- Private communication
- Secure communication
- Private (to group) workspace

Type 8: Non -competitive contests - against standards

Groups perform some sort of complex group task. The plan for the task has already been decided upon. In this type of task, the group is merely executing the plan.

Specific measures for this type of task:

- Cost and efficiency of performance - speed and errors
- Evidence of performance level changes over time (quality of task outcome but can only be measured for repetitions of task)
- Member satisfaction with the task, the group, their own role

Known research:

- Increased interpersonal interaction does not always lead to higher productivity
- Groups influence their members toward conformity with the group's standards - this may increase or decrease productivity

Example:

A survival task or rescue task in which a group has to perform to achieve a goal: getting back to base or saving individuals.

Suggested capabilities:

- Shared workspace
- N way communication

Task Type 9: Dissemination of information tasks (non-McGrath)

The task is to distribute information among members of the group. Information can be distributed by group members sharing information with each other or a superior sharing information with others in the group. There may or may not be a question and answer session.

Specific measures for this type of task:

- Shared understanding of information
- Time for distribution
- Audience reached

Examples:

A corporate officer gives a briefing to a division about the new sales strategy.

A professor gives a lecture to a class.

Suggested capabilities:

- 1 way communication
- Feedback channel
- Object displaying
- Summarization capabilities

Collaborative Conferencing Experiment Design

	Contents
A	Introduction
B	Meta Description of Stages
C	Work Task Types
D	JAD Work Activities
1	Role Players
2	Evaluation Stages and Activities 0. Initial Contact and Orientation Stage 1. Project Initialisation Stage 2. Requirements Planning Stage 3. User Design Stage 4. Construction Stage 5. Implementation Stage 6. Post Implementation Assessment Stage

A Introduction

This document details a collaborative conferencing experiment scenario. The aim is to provide an environment where collaborative tasks can be evaluated for the purpose of determining the limitations of low resource video conferencing in supporting collaborative tasks. A further goal is the incorporation of certain objectives as set out by the ANALYZE project.

Objectives

1. The primary objective is to design a range of evaluation scenarios that:
   - utilise real and relevant collaboration tasks,
   - have value (ie. Solve real problems),
   - involve a range of collaboration task types (eg. Decision Making, Design & Writing, Idea Generation, Intellective, Planning, Conflict Resolution),
   - require different group configurations, and
   - require different technology configurations.
2. Further objectives, which relate to ANALYZE:
   - To provide a evaluation environment for the participants, who are themselves involved in researching aspects of communication, group dynamics and management and JAD.
   - To provide an evaluation environment to test ANALYZE's grounding concepts and ideas.

Evaluation Exercise

The overall task at hand is to develop an application for a client. This is a typical task found in the Information Technology (IT) industry where a software development firm (or in-house division) creates an application (or a range of applications in a project) for a client. It is well recognised that Joint Application Development (JAD) is a highly successful approach to developing applications that fulfill the client's/user's requirements. The entire process from conceptualisation to product delivery is a complex process, requiring communication and collaboration between developers and users. Traditionally, such a process has required that all parties involved be co-located in order to complete co-operative tasks. This evaluation exercise geographically disperses the parties in order to evaluate the limitations of video conferencing in supporting the collaboration which is required for the development of the application. The JAD process is used as it identifies and utilises a range of tasks and communication requirements for groups. The JAD process used will be that from the Application Development Methodology. (Interestingly, the Application Development Methodology (ADM) as found at **http://sysdev.ucdavis.edu/WEBADM/** which aims to provide a standard and consistent way of developing and maintaining information systems, makes very little direct reference to the James Martin JAD process, even though parts of it are designed under a Rapid Application Development (RAD) construct (first termed by James Martin). The stages and processes are however **extremely** similar to that of a classical JAD process. Since the stages and activities outlined in ADM are finely detailed, ADM's activity breakdown will be used in the name of JAD.)

Cugini *et al* (1997), in developing a methodology for evaluating collaborative systems, have identified nine work task types (eight which are McGrath) (See below in section C. Work Task Types). The given JAD process is sub-divided into stages and activities, which are then classified according to a work task type. Each activity is executed and evaluated by the participants via a questionnaire. In so doing, the provided technology is measured against the work task type to draw conclusions about the technology's ability to support that task type.

B Evaluation Stages and Activities

Each stage is broken down into the following descriptors:

Required Activities	Activities to be conducted throughout stage
Activity	The activity
Task Type	The activity's task type
Participants	Participants required for the activity
Description	Description of the stage
Stage Scope	Boundaries and delimitations of the stage
Stage Input	Required input in order to fulfill the stage's activities
Stage Output	Deliverables, actions to be carried out and/or decisions reached, during and at the end of the stage

C	Work Task Types

The following are work activity types as described by Cugini *et al* (1997):

Type 1: Planning task
Type 2: Brainstorming and group creativity task
Type 3: Intellective task
Type 4: Decision making task
Type 5: Cognitive conflict task
Type 6: Mixed motive task
 Type 6a: Negotiation task
 Type 6b: Bargaining task
 Type 6c: Winning coalition tasks
Type 7: Competitive performance
Type 8: Non-competitive contests - against standards
Type 9: (Non-McGrath) Dissemination of information task

See Appendix A for Full Description of Cugini *et al*'s (1997) Work Task Types.

D	JAD Work Activities

ADM identifies seven stages as part of its methodology (incorporating the RAD path):

Stage 1: Project Initiation
Stage 2: Requirements Planning
Stage 3: User Design
Stage 4: Rapid Construction
Stage 5: Implementation
Stage 6: Post Implementation Assessment
Stage 7: System Modification

(The Application Development Methodology as prescribed by the University Davis, California actually uses a reduced set of stages for Rapid Application Development, namely; only stages 3, 4 and 5. However for the purpose of a more complete development cycle, the normal ADM path is taken, substituting the RAD components in where the normal ADM stages would be found. The RAD stages are more appealing and applicable given the RAD environment.)

The ADM methodology, in original form, appears to be complete and an excellent one, finely detailing all the steps to the carried out in developing a system. However, as it stands, the ADM approach is too detailed to used in a small experiment. Therefore the essential JAD processes have been extracted and those stages will to be carried out. For each activity, role players have been indicated and responsibilities delegated.

It can also be seen that sub-tasks usually consist of some decision making task resulting in some deliverable which is the execution and completion of that decision (Type 8).

1	Role Players	
S	Sponsor (Business: Project champion)	Nick Vat
SDD	System Developer Director (Software Development)	Lauren Dewdney
EU1	End User 1	Nick Vat
EU1	End User 2	

Obs1	Observer 1	
Obs2	Observer 2	
F	Facilitator (Software Development)	Lauren Harpur
SD1	System Developer 1 (Software Development)	Rob Stead
SD2	System Developer 2 (Software Development)	Lauren Harpur
JAD	JAD team comprising of End Users and System Developers (Software Development)	

2	Evaluation Stages and Activities		
Stage 0	**Initial Contact and Orientation**		
	Activity	Task Type	Participants
Required Activities	1. Initial Contact and Orientation Meeting	Type 9	
Description	Due to the small size of the project, the Sponsor approaches a potential Software Developer to discuss a possible business venture.(The process may be reversed if a tender was put out and the developer contacts the sponsor.)		
Stage Scope	Venture agreement. Developer understanding of project needs. Client understanding of developer capabilities.		
Stage Input	A request from a client to examine the possible undertaking of a software development venture.		
Stage Output	The joint agreement to pursue the venture further and formally.		

Stage 1	**Project Initiation**		
	Activities	Task Type	Participants
Required Activities	1.1. Set initial project objectives and scope 1.2. Refine project scope 1.3. Define project's benefits 1.4. Prepare preliminary project time line 1.5. Determine preliminary project costs 1.6. Establish business user participation 1.7. Identify source of project funding/resources 1.8. Decide whether to continue with project 1.9. Prepare project plan 1.10. Create formal project planning document	4 4 2/4 1 6a 5 4 4 1 8	
Description	This is when the individual project is initiated. The project is scoped; the project objectives and benefits are established; the end users identified, the project SWOT is identified; risk analysis is performed; project sponsor are identified; project funding is obtained; and a project plan is approved.		
Stage Scope	A business area (major subset of the enterprise defined via business activities, business events, and/or entity types) or a pre-scoped BPR, Feasibility Study or IT development project.		
Stage Input	A request to analyse an area of the business, to launch either a business process re-engineering project, a feasibility study or assessment or an information technology development project.		

Stage Output	Approval to launch a project of defined mission and scope: 1 Information System Preliminary Requirements, 2 Project Scope Document, 3 Preliminary Project Plan, 4 Next Stage Project Plans, 5 Needs Analysis Report, 6 Decision As To Whether To Proceed With Project As Defined.

Stage 2	**Requirements Planning**		
	Activities	Task Type	Participants
Required Activities	Research Current Situation:	-	
	2.1. Examine current system	2	
	2.2. Structure overall objectives of the system	4	
	Define Requirements:	-	
	2.3. Develop outline system area model	4	
	2.4. Scope system	4	
	2.5. Identify potential benefits	2	
	Finalize requirements:	-	
	2.6. Identify development environment	2	
	2.7. Estimate implementation schedule	3	
	2.8. Estimate development cost	3	
	2.9. Present results to sponsor	9	
Description	During this stage an outline of the system area and definition of the system scope are developed. Business executives, end users and IS professionals take part in workshops which progress through a structured set of steps; with the results recorded in the CASE tool. Throughout the life-cycle all the information gathered is stored in the Information repository, ultimately to become a computerized design from which code can be generated.		
Stage Scope	A vision of a stand-alone system.		
Stage Input	A request to build an information system.		
Stage Output	A requirements definition statement and logical models to guide the user design for an information system.		

Stage 3	**User Design**		
	Activities	Task Type	Participants
Required Activities	Produce detailed system area model: 3.1. Complete entity relationship diagram 3.1.1 Produce ERD 3.2. Complete process model 3.2.1 Produce process model 3.3. Perform interaction analysis 3.4. Confirm system area model 3.5. Develop clustered process/entity type matrix Develop outline system design: 3.6. Define system procedures 3.7. Design system structure 3.8. Design screen/report layouts 3.9. Identify implementation requirements 3.10. Identify open issues Refine system design: 3.11. Confirm consistency and completeness of system area model 3.12 Develop preliminary data structure 3.13 Develop prototypes Prepare implementation plan: 3.14. Estimate construction effort 3.15. Finalize construction approach 3.16. Develop testing strategy 3.17. Develop implementation plan Finalize system design: 3.18. Resolve open design issues 3.19. Discuss suggested design improvements 3.20. Review implementation plan Obtain approval for construction 3.21. Obtain approval to proceed	- 4 8 4 8 4 4 8 - 4 8 8 2 2 - 3 8 8 - 3 4 2 2 - 6a 4 4 - 6a	
Description	End users participating in JAD workshops perform the analysis and design tasks associated with this stage. These tasks are led by the JAD workshop leader and assisted by IS professionals. The results of the workshops are recorded in the CASE tool. Information in the repository developed in the previous stages are used as input. If a BAA has been completed then the workshop focuses on the design of the system with a subsequent reduction in the time scale required for this stage.		
Stage Scope	The concept of a stand-alone system expressed in terms of organization units, business locations, business activities or entity types.		
Stage Input	A requirements definition statement and logical models to guide the user design for an information system.		
Stage Output	The User Design stage produces a detailed system area model, an outline system design and an implementation plan.		

Stage 4	**Construction (Not to be Tested)**		
	Activities	Task Type	Participants
Required Activities	System Construction	8	
Description	The design of the proposed system, initially described in the User Design stage, is completed in the Construction stage, and application software to implement that design is developed and tested. Tasks necessary in preparation for the transition of the system to production status are also performed.		
Stage Scope	A system expressed in terms of its business and technology design.		
Stage Input	The business and technology design of an information system expressed through structure charts, data structure diagrams, screen/report layouts and dialogue diagrams.		
Stage Output	Operational system with all documentation and training completed.		

Stage 5	**Implementation**		
	Activities	Task Type	Participants
Required Activities	Train users:	-	
	5.1. Schedule user training sessions	1	
	5.2. Conduct user training	9	
	Install production system:	-	
	5.3. Adjust hardware and system software	8	
	5.4. Migrate system components to production	8	
	Accept system installation:	-	
	5.5. Negotiate system/procedure startup schedule	1	
Description	The implementable module and its documentation are deployed and placed in operational use. This includes the information system software, files and databases which are utilized by the information system, operational documentation, system and program documentation, trained staff and integration of the foregoing into the operational environment.		
Stage Scope	An implementable module defined in a construction project.		
Stage Input	An Implementable Module.		
Stage Output	Operational system integrated with pre-existing operational systems: 1 Training, 2 Data Conversion, 3 Production Environment, 4 User Acceptance Agreement, 5 Project Initiation Request.		

Stage 6	Post Implementation Assessment		
	Activities	Task Type	Participants
Required Activities	6.1. Define project(s) to evaluate 6.2. Gather & Publish evaluated project's information	4 8	
Description	The IT project(s) which led up to and included the implementation of an operational system, a business process re-engineering project or a feasibility/assessment project are examined and evaluated to improve the JAD. The objective is to utilize the knowledge and experience acquired during the project(s) to correct flaws and secure improvements to the JAD process. The post implementation assessment is not intended to evaluate the quality of the implemented system - only to assess the methods and techniques which were followed to develop and implement that system.		
Stage Scope	The group of IT development project(s), BPR or Feasibility/Assessment projects which had a common mission.		
Stage Input	Project team and end user experiences related to the newly implemented system.		
Stage Output	Assessment of the JAD process employed by the project and recommended changes to the process: 1. Post Implementation Assessment report.		

Explanation of Questionnaire

Any text in this Font (Arial) is part of the questionnaire, remaining text is for the purpose of explaining the questionnaire.

Collaborative Conferencing Questionnaire

Introduction

The following questionnaire applies to a study which aims to provide a match between the success of particular generic tasks and activities versus a set computer technology configurations. The tasks are centred around collaborative group activities, while the computer technology involves the use of (mainly) video conferencing hardware and supporting software.

Instructions

Please complete this questionnaire to the best of your ability. Where applicable, please **tick (T)** the block that best matches your choice. Thank-you for your time in participating in the study and answering the questionnaires, it is appreciated.

A	Date	d	d	m	m	y	y

B	Session Start and End Time	start	end

Please tick off the role that you are playing in the exercise.

C	**Respondent** (please tick in open block)
	S - Sponsor
	SDD - System Developer Director
	F - Facilitator
	SD1 - System Developer 1
	SD2 - System Developer 2
	EU1 - End User 1
	EU2 - End User 2
	Obs1 - Observer 1
	Obs2 - Observer 2
	Other:

The total number of participants actively involved in the task being carried out in the exercise.

D	Total Number of Participants	

The number of participants located on your side of the conference.

E	**Number of Co-located Participants**	

The stage and activity (or activities) will have been determined before the conference begins, please tick off that activity. Please remember that a questionnaire needs to be filled out for each activity (as they may represent different tasks).

F	**Evaluation Stage and Activity** (please tick in open block)		
	0.0 Initial Contact and Orientation Stage		1.10 Create formal project planning document
	0.1 Initial Contact and Orientation Meeting		
			2.0 Requirements Planning Stage
	1.0 Project Initiation Stage		Research Current Situation:
	1.1 Set initial project objectives and scope		2.1 Examine current system
	1.2 Refine project scope		2.2 Structure overall objectives of the system
	1.3 Define project's benefits		Define Requirements:
	1.4 Prepare preliminary project time line		2.3 Develop outline system area model
	1.5 Determine preliminary project costs		2.4 Scope system
	1.6 Establish business user participation		
	1.7 Identify source of project funding/resources		
	1.8 Decide whether to continue with project		
	1.9 Prepare project plan		

(More stages and activities on actual questionnaire.)

Scales: Most of the questions asked in the questionnaire require an answer which represents a scale. Each scale has 6 degrees, ranging from LEAST on the left to MOST on the right. In the example below:

		1 Poorly	2	3	4	5	6 Excellently	N/A
1	How well did the given collaborative system support the given group size?				U			

A tick was placed in the 4th cell, indicating that the respondent felt that marginally positive about the system's ability to support the given group size. If you feel that the question is not applicable to the current situation, place a tick in the N/A (Not Applicable) cell.

G	**Task Outcome**			
1	Was the task Completed?	No	Yes	
	In order to state that a task has been completed, the task's objectives need to be met. Decide if the original objectives of the task or activity have been achieved.			

2	How well did the given collaborative system configuration lend itself to the task?	1 Poorly	2	3	4	5	6 Excellent	N/A
	This refers to the system's suitability to the type of task at hand. (Some tasks may simply not be suitable for this kind of technology.)							
3	How would you judge the quality of the task outcome?	1 Poor	2	3	4	5	6 Excellent	N/A
	This refers to the quality of the deliverable or decision made.							
4	How did the given collaborative system configuration affect the quality of the task outcome?	1 Negatively	2	3	4	5	6 Positively	N/A
	This refers to the system's impact on the quality of the task outcome.							

H	User Satisfaction							
1	How satisfied are you with the given collaborative system's ability to support the task outcome?	1 Dissatisfied	2	3	4	5	6 Satisfied	N/A
	Certain actions by participants and interactions between participants are required to complete a task. Rate your level of satisfaction with the systems ability to support those actions and interactions required in order to complete the task.							
2	How satisfied are you with the given collaborative system's ability to meet your requirements for activities which are needed to complete one task and begin a new task? (Transition Tasks)	1 Dissatisfied	2	3	4	5	6 Satisfied	N/A
	Certain tasks and activities are required in order to complete one task and start another task. These activities are usually peripheral to the main task at hand (activities include summarising task outcome and assigning action items/responsibilities.) eg. In order to complete a meeting, minutes are required to be written up. In this example if the system allowed this to occur seamlessly, then a high degree of satisfaction may be recorded.							
3	How satisfied are you with the given collaborative system's ability to support the required group processes?	1 Dissatisfied	2	3	4	5	6 Satisfied	N/A
	Various processes occur in group interaction. A system should be able to satisfactorily support those group processes. Support may be found in the following areas: Meeting conduct, communication needs and support for awareness (awareness in terms of other participants presence, location, actions, changes, etc).							

I	Scalability							
1	How well did the given collaborative system support the given group size?	1 Poorly	2	3	4	5	6 Excellently	N/A
	A system has a limitation to the amount of people who can comfortably use it for specific tasks. Sometimes it may only be suitable for one person, other times many more, depending on the task and the capability of the system.							

J	Participation							
1	How satisfied are you with your level of participation in the task?	1 Dissatisfied	2	3	4	5	6 Satisfied	N/A
	Your degree of satisfaction with your level of participation in the conference.							
2	To what extent did the given collaborative system hinder or aid your ability to participate?	1 Hindered	2	3	4	5	6 Aided	N/A
	Your rating about the systems ability to support your desired level of participation in the conference.							
3	How satisfied are you with the group's level of participation in the task?	1 Dissatisfied	2	3	4	5	6 Satisfied	N/A
	Your degree of satisfaction with the remote group's level of participation in the conference.							
4	To what extent did the given collaborative system hinder or aid the rest of the group's ability to participate?	1 Hindered	2	3	4	5	6 Aided	N/A
	Your rating about the systems ability to support your desired level of the remote group's participation in the conference.							

User Assessment: As your experience with the collaborative system increases, it is expected that you will become familiar with the limitations and capabilities of the system. As an example, at the beginning when you were set a task, you might have found that it was difficult to complete because of the system's constraints. However at the end, the task would be easy to complete because you were now familiar with the system. Some tasks, however, may always remain difficult to complete because the system simply can't support the functionality required by the task.

K	User Assessment							
	Expertise							
1	How would you rate your level of expertise with regard to: Personal Computers?	1 Novice	2	3	4	5	6 Expert	N/A
2	How would you rate your level of expertise with regard to: Working in groups (co-located)?	1 Novice	2	3	4	5	6 Expert	N/A
	"Co-located" refers to collaborative work that you have done in the same physical environment. This therefore excludes the use of the telephone or other technology.							
3	How would you rate your level of expertise with regard to: Working in distributed groups (mediated by technology)?	1 Novice	2	3	4	5	6 Expert	N/A
	"Distributed" refers to collaborative work that you have done in a distributed environment. This includes the use of the telephone or other technology. Examples include a telephonic conference or previous video conference sessions.							
4	How would you rate your level of expertise with regard to: The given collaborative system hardware?	1 Novice	2	3	4	5	6 Expert	N/A
5	How would you rate your level of expertise with regard to: The given collaborative system software?	1 Novice	2	3	4	5	6 Expert	N/A
	Comfort							
6	How would you describe your level of comfort with regard to: Video conferencing audio (speaking)?	1 Uncomfortable	2	3	4	5	6 Comfortable	N/A
7	How would you describe your level of comfort with regard to: Video conferencing video ("being watched")?	1 Uncomfortable	2	3	4	5	6 Comfortable	N/A
8	How would you describe your level of comfort with regard to: Using collaborative applications?	1 Uncomfortable	2	3	4	5	6 Comfortable	N/A
9	How would you describe your level of comfort with regard to: Using computer technology?	1 Uncomfortable	2	3	4	5	6 Comfortable	N/A
	Confidence							
10	How would you describe your level of confidence with regard to: Video conferencing audio (speaking)?	1 Unsure	2	3	4	5	6 Confident	N/A

11	How would you describe your level of confidence with regard to: Video conferencing video ("being watched")?	1 Unsure	2	3	4	5	6 Confident	N/A
12	How would you describe your level of confidence with regard to: Using collaborative applications?	1 Unsure	2	3	4	5	6 Confident	N/A
13	How would you describe your level of confidence with regard to: Using computer technology?	1 Unsure	2	3	4	5	6 Confident	N/A

Space provided for comments about a question or answer, or even a finding or opinion. When referring to a question, please include the question section and number. (Actual Questionnaire includes more space than shown below.)

L	Comments and Feedback

Collaborative Conferencing Questionnaire

Introduction

The following questionnaire applies to a study which aims to provide a match between the success of particular generic tasks and activities versus a set computer technology configurations. The tasks are centred around collaborative group activities, while the computer technology involves the use of (mainly) video conferencing hardware and supporting software.

Instructions

Please complete this questionnaire to the best of your ability. Where applicable, please **tick (T)** the block that best matches your choice. Thank-you for your time in participating in the study and answering the questionnaires, it is appreciated.

A	Date	d	d	m	m	y	y

B	Session Start and End Time	start	end

C	**Respondent** (please tick in open block)
	S - Sponsor
	SDD - System Developer Director
	F - Facilitator
	SD1 - System Developer 1
	SD2 - System Developer 2
	EU1 - End User 1
	EU2 - End User 2
	Obs1 - Observer 1
	Obs2 - Observer 2
	Other:

D	Total Number of Participants	

E	Number of Co-located Participants	

F	**Evaluation Stage and Activity** (please tick in open block)		
	0.0 Initial Contact and Orientation Stage		1.4 Prepare preliminary project time line
	0.1 Initial Contact and Orientation Meeting		1.5 Determine preliminary project costs
			1.6 Establish business user participation
	1.0 Project Initiation Stage		1.7 Identify source of project funding/resources
	1.1 Set initial project objectives and scope		1.8 Decide whether to continue with project
	1.2 Refine project scope		1.9 Prepare project plan
	1.3 Define project's benefits		1.10 Create formal project planning document

	2.0 Requirements Planning Stage
	Research Current Situation:
	2.1 Examine current system
	2.2 Structure overall objectives of the system
	Define Requirements:
	2.3 Develop outline system area model
	2.4 Scope system
	2.5 Identify potential benefits
	Finalize requirements:
	2.6 Identify development environment
	2.7 Estimate implementation schedule
	2.8 Estimate development cost
	2.9 Present results to sponsor
	3.0 User Design Stage
	Produce detailed system area model:
	3.1 Complete entity relationship diagram
	3.1.1 Produce ERD
	3.2 Complete process model
	3.2.1 Produce process model
	3.3 Perform interaction analysis
	3.4 Confirm system area model
	3.5 Develop clustered process/entity type matrix
	Develop outline system design:
	3.6 Define system procedures
	3.7 Design system structure
	3.8 Design screen/report layouts
	3.9 Identify implementation requirements
	3.10 Identify open issues
	Refine system design:
	3.11 Confirm consistency and completeness of system area model
	3.12 Develop preliminary data structure
	3.13 Develop prototypes
	Prepare implementation plan:
	3.14 Estimate construction effort
	3.15 Finalize construction approach
	3.16 Develop testing strategy
	3.17 Develop implementation plan
	Finalize system design:
	3.18 Resolve open design issues
	3.19 Discuss suggested design improvements
	3.20 Review implementation plan
	Obtain approval for construction
	3.21 Obtain approval to proceed
	5.0 Implementation Stage
	Train users:
	5.1 Schedule user training sessions
	5.2 Conduct user training
	Install production system:
	5.3 Adjust hardware and system software
	5.4 Migrate system components to production
	Accept system installation:
	5.5 Negotiate system/procedure startup schedule
	6.0 Post Implementation Assessment Stage
	6.1 Define project(s) to evaluate
	6.2 Gather & Publish evaluated project's information

G	Task Outcome							
1	Was the task Completed?	No			Yes			
2	How well did the given collaborative system configuration lend itself to the task?	1 Poorly	2	3	4	5	6 Excellent	N/A
3	How would you judge the quality of the task outcome?	1 Poor	2	3	4	5	6 Excellent	N/A

4	How did the given collaborative system configuration affect the quality of the task outcome?	1 Negatively	2	3	4	5	6 Positively	N/A

H	**User Satisfaction**							
1	How satisfied are you with the given collaborative system's ability to support the task outcome?	1 Dissatisfied	2	3	4	5	6 Satisfied	N/A
2	How satisfied are you with the given collaborative system's ability to meet your requirements for activities which are needed to complete one task and begin a new task? (Transition Tasks)	1 Dissatisfied	2	3	4	5	6 Satisfied	N/A
3	How satisfied are you with the given collaborative system's ability to support the required group processes?	1 Dissatisfied	2	3	4	5	6 Satisfied	N/A

I	**Scalability**							
1	How well did the given collaborative system support the given group size?	1 Poorly	2	3	4	5	6 Excellently	N/A

J	**Participation**							
1	How satisfied are you with your level of participation in the task?	1 Dissatisfied	2	3	4	5	6 Satisfied	N/A
2	To what extent did the given collaborative system hinder or aid your ability to participate?	1 Hindered	2	3	4	5	6 Aided	N/A
3	How satisfied are you with the group's level of participation in the task?	1 Dissatisfied	2	3	4	5	6 Satisfied	N/A
4	To what extent did the given collaborative system hinder or aid the rest of the group's ability to participate?	1 Hindered	2	3	4	5	6 Aided	N/A

K	**User Assessment**							
	Expertise							
1	How would you rate your level of expertise with regard to: Personal Computers?	1 Novice	2	3	4	5	6 Expert	N/A
2	How would you rate your level of expertise with regard to: Working in groups (co-located)?	1 Novice	2	3	4	5	6 Expert	N/A

3	How would you rate your level of expertise with regard to: Working in distributed groups (mediated by technology)?	1 Novice	2	3	4	5	6 Expert	N/A
4	How would you rate your level of expertise with regard to: The given collaborative system hardware?	1 Novice	2	3	4	5	6 Expert	N/A
5	How would you rate your level of expertise with regard to: The given collaborative system software?	1 Novice	2	3	4	5	6 Expert	N/A
	Comfort							
6	How would you describe your level of comfort with regard to: Video conferencing audio (speaking)?	1 Uncomfortable	2	3	4	5	6 Comfortable	N/A
7	How would you describe your level of comfort with regard to: Video conferencing video ("being watched")?	1 Uncomfortable	2	3	4	5	6 Comfortable	N/A
8	How would you describe your level of comfort with regard to: Using collaborative applications?	1 Uncomfortable	2	3	4	5	6 Comfortable	N/A
9	How would you describe your level of comfort with regard to: Using computer technology?	1 Uncomfortable	2	3	4	5	6 Comfortable	N/A
	Confidence							
10	How would you describe your level of confidence with regard to: Video conferencing audio (speaking)?	1 Unsure	2	3	4	5	6 Confident	N/A
11	How would you describe your level of confidence with regard to: Video conferencing video ("being watched")?	1 Unsure	2	3	4	5	6 Confident	N/A
12	How would you describe your level of confidence with regard to: Using collaborative applications?	1 Unsure	2	3	4	5	6 Confident	N/A
13	How would you describe your level of confidence with regard to: Using computer technology?	1 Unsure	2	3	4	5	6 Confident	N/A

L	**Comments and Feedback**